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DOCUMENTS

I #	PREF	DOCUMENT NUMBER SHEETS	ISSUE	SIZE	SHTS	B/L NO.	SS	MODEL NUMBER	WUC
1	DR	79K39622 Vol 1	New	F	174	558.00	LO	K60-3384	LOFSR9N000
						353.05	LO	K60-3385	LOFAC9N000
						558.00	LO	K60-3386	LOFWP9N000
						558.00	LO	K60-3387	LOFHV9N000
						501.10	LO	K60-3388	LOFSS9N000
						360.11	LO	K60-3389	LOFLU9N000
						355.00	LO	K60-3390	LOFFA9N000
						353.01	LO	K60-3391	LOFAC9NA000
						356.50	LO	K60-3392	LOFCW9N000
						505.22	LO	K60-3394	LOFEV9N000
						353.91	LO	K60-3395	LOFGE9N000
						360.10	LO	K60-3396	LOFFG9N000
						558.00	LO	K60-3397	LOFHV9NA00
						067.00	LO	K60-3393	LOFPA9N000
						360.02	LO	K60-3398	LOFSC9N000
						356.20	LO	K60-3399	LOFSH9N000
						495.50	LO	K60-3400	LOFSY9N000
						500.07	LO	K60-3401	LOFUC9N000
						353.06	LO	K60-3402	LOFUP9N000
						357.05	LO	K60-3403	LOFSF9N000
2	DR	79K39622 Vol 2	New	F	196	"	"	"	"
3	DR	79K39622 Vol 3	New	F	104	"	"	"	"
4	DR	79K39622 Vol 4	New	F	178	"	"	"	"
5	SP	79K39623	New	A	2079	"	"	"	"
6	SW	79K39622 Vol 1	New	M	1	"	"	"	"
7	SW	79K39622 Vol 2	New	M	1	"	"	"	"
8	SW	79K39622 Vol 3	New	M	1	"	"	"	"
9	SW	79K39622 Vol 4	New	M	1	"	"	"	"
10	SW	79K39623	New	M	1	"	"	"	"

TECHNICAL REMARKS

12-20-13

APPROVALS

Technical Contact B. KINNAIRD	Mail Code TA-B3A	Date 12/19/13	R&QA B. BRADEN	Mail Code SA-E3	Date 12/19/13
Technical W. SCHROEDER	TA-B3	12-19-13	Other		
Space and Weight			Joint Release		
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Replacement Headquarters Building, Phase 1
79K39623

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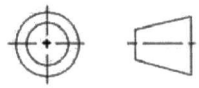

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KSC Central Campus
Replacement Headquarters Building, Phase 1

SIZE	CAGE CODE	DWG NO	REV
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Architect/Engineer of Record Certification

Project Title:	KSC Central Campus, Replacement HQ - Phase 1
Project Control Number:	98745.1a
Project Drawing Number:	79K39622
Project Specification Number:	79K39623
Project Calculations/Data Manual Number:	KSC-TA-12481

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Structural	Jaime Vasquez	FL	49103	
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Electrical	Toby Smith	FL	71672	
Fire Protection				

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SECTION 01 11 00

SUMMARY OF WORK
08/11

PART 1 GENERAL

1.1 DEFINITIONS

Definitions pertaining to sustainable development are as defined in ASTM E2114, and as specified.

a. "Environmentally preferable products" have a lesser or reduced effect on the environment in comparison to conventional products and services. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, or disposal of the product.

b. "Indoor environmental quality" is the physical characteristics of the building interior that impact occupants, including air quality, illumination, acoustics, occupant control, thermal comfort, daylighting, and views.

c. "Operational performance" is the functional behavior of the building as a whole or of the building components.

d. "Sustainability" is the balance of environmental, economic, and societal considerations.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Upon receipt of Government Furnished Equipment, the Contractor shall submit records in accordance with paragraph entitled, "Government Furnished Property," of this section.

Submit the following items to the Contracting Officer:

Utility Outage Requests
Utility Connection Requests

Excavation Permits

1.3 WORK COVERED BY CONTRACT DOCUMENTS

1.3.1 Project Description

A new headquarters building at Kennedy Space center will be constructed. This scope is for Phase 1 and will include administrative spaces, shared

services and the Center Director offices. The shared services function include the cafeteria, cyber café, credit union, hair shop, post office, lobby with display, gift shop, Engineering Documentation Center (EDC), reproduction facilities, resource center, and documents sections, and building shipping and receiving.

1.3.2 Options

A-1 THRU A-4 : NOT USED
A-5 REMOVE THE U-SHAPED PRECAST PANEL AND PRECAST CAP THAT CLADS THE SOUTH ELEVATION CONCRETE BEAMS TO SUPPORT THE SOUTH EXTERIOR ENVELOPE. THESE EXPOSED CONCRETE
STRUCTRUAL MEMBERS WILL BE EXTENDED UP TO MATCH THE PREVIOUS PRECAST PROFILE THAT RECEIVES THE GLAZING.
A-6 PROVIDE ADDITIONAL FOOD SERVICE EQUIPMENT AS OUTLINED IN SECTION 11 40 00.
C-1 ADD ADDITIONAL LANDSCAPING
C-2 ADD PHASE 2 PARKING IN NE QUADRANT
M-1 ADD HEAT EXCHANGER, CAMPUS CHILLED WATER PUMP, BUILDING CHILLED WATER PUMP, AND APPURTENANCES. THIS OPTION INCLUDES ALL PIPING CONNECTIONS, VARIABLE FREQUENCY DRIVES, INSTRUMENTATION, CONTROL PORGRAMMING, AND ELECTRICAL POWER DISTRIBUTION ASSOCIATED WITH EACH PIECE OF EQUIPMENT.
M-2 NOT USED
E-1 UPGRADE THE 800-kW EMERGENCY GENERATOR ENVIRONMENTAL RATING FROM TIER 2 TO TIER 4. PROVIDE DESIGN/BUILD SERVICES TO REVISE THE EMERGENCY GENERATOR ENVIRONMENTAL RATING FROM EPA TIER 2 REQUIREMENTS TO EPA TIER 4 REQUIREMENTS. INCLUDE ALL MANUFACTURER EQUIPMENT CHANGES, AND PROVIDE/INSTALL ALL RELATED EQUIPMENT.
L-1 NOT USED
L-2 NOT USED
L-3 ADD SEVEN DUAL-STATION ELECTRIC VEHICLE CHARGERS IN PARKING AREA AS INDICATED ON SHEET E101.
L-4 PROVIDE LED LIGHT FIXTURES INSTEAD OF FLUORESCENT AND COMPACT FLUORESCENT LIGHT FIXTURES AS INDICATED ON SHEET E011.

1.3.3 Location

The work shall be located at the Kennedy Space center Central Campus area, as indicated.

1.4 CONTRACT DRAWINGS

Contractor shall immediately check furnished drawings and notify the Government of any discrepancies.

1.5 OCCUPANCY OF PREMISES

Adjacent Building(s) will be occupied during performance of work under this Contract.

Before work is started, the Contractor shall arrange with the Contracting Officer a sequence of procedure, means of access, space for storage of

materials and equipment, and use of approaches, corridors, and stairways.

1.6 EXISTING WORK

In addition to "FAR 52.236-9, Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements":

a. Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.

b. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Contracting Officer. At the completion of operations, existing work shall be in a condition equal to or better than that which existed before new work started.

1.7 ON-SITE PERMITS

1.7.1 Utility Outage Requests and Utility Connection Requests

Notify the Contracting Officer at least 72 hours prior to starting excavation work. Contractor is responsible for marking and verifying all utilities not marked.

The Contractor shall verify the elevations of existing piping, utilities, and any type of underground obstruction not indicated or specified to be removed. Verify elevations before installing new work closer than nearest manhole or other structure at which an adjustment in grade can be made.

Work shall be scheduled to hold outages to a minimum.

Utility outages and connections required during the prosecution of work that affect existing systems shall be arranged for at the convenience of the Government and shall be scheduled outside the regular working hours or on weekends.

Contractor shall not be entitled to additional payment for utility outages and connections required to be performed outside the regular work hours.

Requests for utility outages and connections shall be made in writing to the Contracting Officer at least 14 calendar days in advance of the time required. Each request shall state the system involved, area involved, approximate duration of outage, and the nature of work involved.

1.7.2 Excavation Permits

The Contractor shall request and obtain excavation permits prior to performing any excavation. KSC Form 26-312V3 NS, Utility Locate/Excavation Permit Request, shall be prepared by the Contractor and submitted to the Government for approval at least 15 working days prior to the planned excavation date. The Contractor shall comply with the requirements of the Base Support Contractor' "Utility Locate / Excavation Permit Instruction" ENG-I-MP07 (latest revision), in the preparation, submission and use of the permit(s).

Permits shall be posted at a conspicuous location in the construction area.

Burning of trash or rubbish is not permitted on project site.

1.7.3 Welding/Hot Work Permits

Request permits for all welding and burning, and hot work operations. Requests for these permits shall be made in writing to the Government at least seven (7) working days in advance of the time required. Permit requests shall be submitted to the government inspector.

Permits shall be posted at a conspicuous location in the construction area.

1.8 LOCATION OF UNDERGROUND UTILITIES

Obtain digging permits prior to start of excavation. Mark the surface of the ground, pier deck or paved surface where existing underground utilities or utilities encased in pier structures are discovered. Verify the elevations of existing piping, utilities,and any type of underground or encased obstruction not indicated to be removed but indicated or discovered during scanning in locations to be traversed by piping, ducts, and other work to be conducted or installed. Verify elevations before installing new work closer than nearest manhole or other structure at which an adjustment in grade can be made.

1.8.1 Notification Prior to Excavation

Notify the Contracting Officer at least 48 hours prior to starting excavation work.

1.9 GOVERNMENT-FURNISHED MATERIAL AND EQUIPMENT (Refer also to A711 through A771)

Pursuant to Contract Clause "FAR 52.245-2, Government Property (Fixed Price Contracts)" , the Government will furnish the following materials and equipment for installation by the Government, unless noted otherwise.

Resource Center (2nd Floor):

EQUIPMENT	SIZE	INSTALLED BY	COMMENT
Spacer Saver High Density Shelving	25" x 98" x 6'-8" high	Contractor	
Spacer Saver High Density Shelving	25" x 17'-4" x 6'-8" high	Contractor	

Legal Department (7th floor):

EQUIPMENT	SIZE	INSTALLED BY	
Spacer Saver High Density Shelving	25" x 98" x 6'-8" high	Contractor	
Spacer Saver High Density Shelving	25" x 17'-4" x 6'-8"	Contractor	

1.9.1 Delivery Schedule

Notify the Contracting Officer in writing at least 28 calendar days in advance of the date on which the materials and equipment are required. Pick up materials and equipment no later than 30 calendar days after such date.

1.9.2 Delivery Location

The high-density shelving is currently installed in an adjacent building, M6-0399 on the first and second floors. The Contractor shall coordinate with the Contracting Officer prior to removal of the shelving. The Contractor shall provide all material, labor, and equipment necessary to remove the shelving from their current locations and install the shelving in the new building as indicated.

In addition to installing the existing equipment, some new material is required, as indicated by the Contracting Officer.

1.10 SALVAGE MATERIAL AND EQUIPMENT

Items designated by the Contracting Officer to be salvaged shall remain the property of the Government.

The salvaged property shall be segregated, itemized, delivered, and off-loaded at the Government designated storage area located within 5 miles of the construction site.

Contractor shall maintain property control records for material or equipment designated as salvage. Contractor's system of property control may be used if approved by the Contracting Officer. Contractor shall be responsible for storage and protection of salvaged materials and equipment until disposition by the Contracting Officer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 33 00

SUBMITTAL PROCEDURES
05/11

PART 1 GENERAL

The requirements of this section may apply to, and are a component part of, each section of the specifications.

1.1 DEFINITIONS

1.1.1 Submittal Descriptions (SD)

Submittals requirements are specified in the technical sections. Submittals are identified by Submittal Description (SD) numbers and titles as follows:

SD-01 Preconstruction Submittals

Submittals which are required prior to issuance of contract notice to proceed including, but not limited to, the following:

Certificates of insurance

Surety bonds

List of proposed Subcontractors

List of proposed products

Construction progress schedule

Network Analysis Schedule (NAS)

Schedule of prices

Health and safety plan

Site specific safety plan

Work plan

Quality Control(QC) plan

Environmental protection plan

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. (Testing must have been within three years of date of contract award for the project.)

Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation including, but not limited to, the following:

Investigation reports.

Daily logs and checklists.

Final acceptance test and operational test procedure.

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by

responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a manufacturer, supplier, installer or Subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and (MSDS)concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must be signed by an authorized official of a testing laboratory or agency and must state the test results; and indicate whether the material, product, or system has passed or failed the test.

Factory test reports.

SD-10 Operation and Maintenance Data

Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel, including manufacturer's help and product line documentation necessary to maintain and install equipment. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

This data is intended to be incorporated in an operations and maintenance manual or control system.

SD-11 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

Special requirements necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

Interim "DD Form 1354" with cost breakout for all assets 30 days prior to facility turnover.

1.1.2 Approving Authority

Office or designated person authorized to approve submittal.

1.1.3 Work

As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction.

1.2 SUBMITTALS

Submit all submittals in all sections of these specifications in accordance with the contract clause, "Shop Drawings". Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are submitted for record only.

Submit the following in accordance with this section.

;

1.3 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.4 PREPARATION

1.4.1 Transmittal Form

Transmit each submittal, except sample installations and sample panels in accordance with the contract clause, "Shop Drawings.".

1.4.2 Identifying Submittals

The Prime Contractor is to prepare, review and stamp with Contractor's approval all specified submittals prior to submitting.

Identify submittals, except sample installations and sample panels, with the following information permanently adhered to or noted on each separate component of each submittal and noted on transmittal form. Mark each copy of each submittal identically, with the following:

a. Project title and location.

b. Construction contract number.

c. Date of the drawings and revisions.

d. Name, address, and telephone number of subcontractor, supplier, manufacturer and any other subcontractor associated with the submittal.

e. Section number of the specification section by which submittal is required.

f. Submittal description (SD) number of each component of submittal.

g. When a resubmission, add alphabetic suffix on submittal description, for example, submittal 18 would become 18A, to indicate resubmission.

h. Product identification and location in project.

1.4.3 Format for SD-02 Shop Drawings

Shop drawings are not to be less than 8 1/2 by 11 inches nor more than 30 by 42 inches, except for full size patterns or templates. Prepare drawings to accurate size, with scale indicated, unless other form is required. Drawings are to be suitable for reproduction and be of a quality to produce clear, distinct lines and letters with dark lines on a white background. All shop drawings shall be submitted electronically, unless noted otherwise by the Contracting officer.

Present 8 1/2 by 11 inches sized shop drawings as part of the bound volume for submittals required by section. Present larger drawings in sets.

Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph entitled, "Identifying Submittals," of this section.

Number drawings in a logical sequence. Each drawing is to bear the number of the submittal in a uniform location adjacent to the title block. Place the Government contract number in the margin, immediately below the title block, for each drawing.

Reserve a blank space, no smaller than 5 inches on the right hand side of each sheet for the Government disposition stamp.

Dimension drawings, except diagrams and schematic drawings; prepare drawings demonstrating interface with other trades to scale. Use the same unit of measure for shop drawings as indicated on the contract drawings. Identify materials and products for work shown.

Include the nameplate data, size and capacity on drawings. Also include applicable federal, military, industry and technical society publication references.

1.4.4 Format of SD-03 Product Data and SD-08 Manufacturer's Instructions

Present product data submittals for each section as a complete, bound volume. Include table of contents, listing page and catalog item numbers for product data.

Indicate, by prominent notation, each product which is being submitted; indicate specification section number and paragraph number to which it pertains.All product data shall be submitted electronically, unless noted otherwise by the Contracting officer.

Supplement product data with material prepared for project to satisfy submittal requirements for which product data does not exist. Identify this material as developed specifically for project, with information and format as required for submission of SD-07 Certificates.

Include the manufacturer's name, trade name, place of manufacture, and catalog model or number on product data. Also include applicable federal, military, industry and technical society publication references. Should manufacturer's data require supplemental information for clarification, submit as specified for SD-07 Certificates.

Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as

American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

Collect required data submittals for each specific material, product, unit of work, or system into a single submittal and marked for choices, options, and portions applicable to the submittal. Mark each copy of the product data identically. Partial submittals will not be accepted for expedition of construction effort.

Submit manufacturer's instructions prior to installation.

1.4.5 Format of SD-04 Samples

Furnish samples in sizes below, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately same size as specified:

a. Sample of Equipment or Device: Full size.

b. Sample of Materials Less Than 2 by 3 inches: Built up to 8 1/2 by 11 inches.

c. Sample of Materials Exceeding 8 1/2 by 11 inches: Cut down to 8 1/2 by 11 inches and adequate to indicate color, texture, and material variations.

d. Sample of Linear Devices or Materials: 10 inch length or length to be supplied, if less than 10 inches. Examples of linear devices or materials are conduit and handrails.

e. Sample of Non-Solid Materials: Pint. Examples of non-solid materials are sand and paint.

f. Color Selection Samples: 2 by 4 inches. Where samples are specified for selection of color, finish, pattern, or texture, submit the full set of available choices for the material or product specified. Sizes and quantities of samples are to represent their respective standard unit.

g. Sample Panel: 4 by 4 feet.

h. Sample Installation: 100 square feet.

Samples Showing Range of Variation: Where variations in color, finish, pattern, or texture are unavoidable due to nature of the materials, submit sets of samples of not less than three units showing extremes and middle of range. Mark each unit to describe its relation to the range of the variation.

Reusable Samples: Incorporate returned samples into work only if so

specified or indicated. Incorporated samples are to be in undamaged condition at time of use.

Recording of Sample Installation: Note and preserve the notation of area constituting sample installation but remove notation at final clean up of project.

When color, texture or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

1.4.6 Format of SD-05 Design Data and SD-07 Certificates

Provide design data and certificates on 8 1/2 by 11 inches paper. Provide a bound volume for submittals containing numerous pages. All data shall be submitted electronically, unless noted otherwise by the Contracting officer.

1.4.7 Format of SD-06 Test Reports and SD-09 Manufacturer's Field Reports

Provide reports on 8 1/2 by 11 inches paper in a complete bound volume.

Indicate by prominent notation, each report in the submittal. Indicate specification number and paragraph number to which it pertains.

All data shall be submitted electronically, unless noted otherwise by the Contracting officer.

1.4.8 Format of SD-10 Operation and Maintenance Data (O&M)

Comply with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA for O&M Data format.

1.4.9 Format of SD-01 Preconstruction Submittals and SD-11 Closeout Submittals

When submittal includes a document which is to be used in project or become part of project record, other than as a submittal, do not apply Contractor's approval stamp to document, but to a separate sheet accompanying document.

1.5 QUANTITY OF SUBMITTALS

1.5.1 Number of Copies of all submittals, except SD-04, Samples, shall be in accordance with the contract clause, "Shop Drawings."

1.5.2 Number of Samples SD-04 Samples

a. Submit two samples, or two sets of samples showing range of variation, of each required item. One approved sample or set of samples will be retained by approving authority and one will be returned to Contractor.

b. Submit one sample panel or provide one sample installation where directed. Include components listed in technical section or as directed.

c. Submit one sample installation, where directed.

d. Submit one sample of non-solid materials.

1.6 VARIATIONS

Variations from contract requirements require both Designer of Record (DOR) and Government approval pursuant to contract Clause FAR 52.236-21 and will be considered where advantageous to Government.

1.6.1 Considering Variations

Discussion with Contracting Officer prior to submission, after consulting with the DOR, will help ensure functional and quality requirements are met and minimize rejections and re-submittals.

Specifically point out variations from contract requirements in transmittal letters. Failure to point out deviations may result in the Government requiring rejection and removal of such work at no additional cost to the Government.

1.6.2 Proposing Variations

When proposing variation, deliver written request to the Contracting Officer, with documentation of the nature and features of the variation and why the variation is desirable and beneficial to Government, including the DOR's written analysis and approval. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

1.6.3 Warranting That Variations Are Compatible

When delivering a variation for approval, Contractor, including its Designer(s) of Record, warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

1.6.4 Review Schedule Is Modified

In addition to normal submittal review period, a period of 10 working days will be allowed for consideration by the Government of submittals with variations.

1.7 SUBMITTAL REGISTER AND DATABASE

Prepare and maintain submittal register, as the work progresses.1.8 SCHEDULING

Schedule and submit concurrently submittals covering component items forming a system or items that are interrelated. Include certifications to be submitted with the pertinent drawings at the same time. No delay damages or time extensions will be allowed for time lost in late submittals.

a. Coordinate scheduling, sequencing, preparing and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow for potential resubmittal of requirements.

b. Submittals called for by the contract documents will be listed on the register. If a submittal is called for but does not pertain to the

contract work, the Contractor is to include the submittal in the register and annotate it "N/A" with a brief explanation. Approval by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but which have been omitted from the register or marked "N/A."

c. Re-submit register and annotate monthly by the Contractor with actual submission and approval dates. When all items on the register have been fully approved, no further re-submittal is required.

d. Carefully control procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Schedule."

At the Preconstruction conference, provide, for approval by the Contracting Officer, the following schedule of submittals:

a. A schedule of shop drawings and technical submittals required by the specifications and drawings. Indicate the specification or drawing reference requiring the submittal; the material, item, or process for which the submittal is required; the "SD" number and identifying title of the submittal; the Contractor's anticipated submission date and the approval need date.

b. A separate schedule of other submittals required under the contract but not listed in the specifications or drawings. Schedule will indicate the contract requirement reference; the type or title of the submittal; the Contractor's anticipated submission date and the approved need date (if approval is required).

1.9 DISAPPROVED OR REJECTED SUBMITTALS

Contractor shall make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes," is to be given to the Contracting Officer. Contractor is responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Government requiring rejection and removal of such work at the Contractor's expense.

If changes are necessary to submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change is to be accomplished until the changed submittals are approved.

1.10 APPROVED/ACCEPTED SUBMITTALS

Approval or acceptance will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the Contractor Quality Control (CQC) requirements of this contract is responsible for.

After submittals have been approved or accepted by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.11 APPROVED SAMPLES

Approval of a sample is only for the characteristics or use named in such approval and is not be construed to change or modify any contract requirements. Before submitting samples, the Contractor to assure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Match the approved samples for materials and equipment incorporated in the work. If requested, approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of the contract. Samples not approved will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make of that material. Government reserves the right to disapprove any material or equipment which previously has proved unsatisfactory in service.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. Contractor to replace such materials or equipment to meet contract requirements.

Approval of the Contractor's samples by the Contracting Officer does not relieve the Contractor of his responsibilities under the contract.

1.12 PROGRESS SCHEDULE

The Contractor shall provide a progress schedule in accordance with the contract clause "Progress Schedule",

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 33 29

LEED(TM) DOCUMENTATION
05/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2000) Principles and Criteria for Forest Stewardship

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)
LEED GBDC Reference Guide	(2009) LEED Reference Guide for Green Building Design and Construction
LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Construction Indoor Air Quality Management Plan (EQc3.1); G

LEED Implementation Plan; G

LEED Documentation Notebook; G

SD-11 Closeout Submittals

LEED Documentation Notebook; G

LEED Construction Submittal: Within 30 days of the Date of Substantial Completion, the contractor shall upload the LEED Construction Submittal to LEED online. The contractor shall provide any additional information as requested by the LEED reviewers.

1.3 DESCRIPTION

This project has been designed for, and shall be developed for a sustainable rating of gold in accordance with LEED NC Version 2009. The LEED checklist identifies the LEED NC credit items that are designed into or otherwise required for this project. This specification identifies the LEED prerequisites and credits where the contractor has primary responsibility for documenting an item on LEED online. No variations or substitutions to the LEED NC credits identified for this contract shall be allowed without written consent from the Contracting Officer's Representative. Should there be a case where there is any problem meeting the full requirements of a LEED NC credit identified for this project. The Contractor must bring this to the attention of the Contracting Officer's Representative immediately.

1.3.1 Credit Validation

This project will be registered with USGBC for validation of credits earned. Contractor is not responsible for registering the project with USGBC or for paying project registration fees to USGBC. Format and content of all construction documentation must be in accordance with the LEED GBDC Reference Guide requirements for supporting data required in event of USGBC audit of the particular credit. Contractor is required to coordinate through the Contracting Officer's Representative with Government's LEED NC consultant on assuring assembled data is acceptable to USGBC and responding to USGBC requests for additional construction data in the course of seeking project certification. Design documentation will be provided by others.

1.3.2 Contractor Responsibilities

Some LEED NC credits are inherent in the design provided and require no further submittal or documentation. Some LEED NC credits involve material selection and are generally identified within the technical sections with the notation "LEED NC," though not specifically identified in all occurrences. Some LEED NC credits are dependent on construction practices.

All LEED credits identified in the LEED checklist not inherent in the design provided shall be documented by the Contractor. The LEED checklist provides a general summary of applicable credits. Detailed submittal requirements are contained in the LEED GBDC Reference Guide and in the technical sections.

In all cases where a material, product, or execution requirement is identified by "LEED NC" in the contract documents, additional data or certificates shall be submitted with the individual component or process validating any LEED NC credits associated with the material, product or execution requirement. These additional data or certificates shall be separable from the other submitted data and a copy shall be included in the LEED NC Documentation Notebook in addition to the distribution indicated in the submittal register.

1.4 LEED IMPLEMENTATION PLAN

LEED NC Implementation Plan shall be submitted within 15 days after notice to proceed. The plan, when completed, shall provide a detailed description of all activities that relate to accomplishing project LEED NC requirements, including construction practices, procurement practices, and

proposed submittals and documentation for each LEED NC credit. Plan shall also include the following:

a. Name of individuals on the Contractor's staff responsible for ensuring LEED NC credits and prerequisites are earned and responsible for assembling documentation. A responsible individual shall be identified for each applicable credit.

b. Templates to be used for tracking LEED NC credits. Listing of documents to be provided for each credit and schedule for their inclusion in LEED Documentation Notebook. Include proposed materials, associated estimated costs, and details necessary for LEED calculations in order to determine if the listed matrials can be expected to achieve the project goal.

c. List of all plans required in the technical sections for LEED NC credit. Proposed submittal date for each plan. These shall be added to the LEED NC Implementation Plan as they are completed.

d. Implementation plan for cumulative materials credits, which shall use applicable template with proposed materials, associated estimated costs, and details necessary for LEED NC Calculations added in order to determine if the listed materials can be expected to achieve the project goal. Submit cumulative materials implementation plans before materials purchasing begins.

1.5 LEED DOCUMENTATION NOTEBOOK

The Contractor shall prepare a comprehensive notebook documenting compliance for each LEED NC credit identified in the LEED checklist. LEED NC Documentation Notebook shall be formatted to match LEED NC numbering system and tabbed for each credit and prerequisite. LEED NC documentation in notebook shall contain up to date information through the previous month's work, and at least one set shall be available on the jobsite at all times. The Notebook shall be maintained and available for reference electronically and be in the form of a searchable PDF file available at all times. Completed pages shall be prevented from being altered. If the Contractor fails to maintain the LEED NC Documentation Notebook as specified herein, the Contracting Officer's Representative will deduct from the monthly progress payment an amount representing the estimated cost of maintaining the Notebook. This monthly deduction will continue until an agreement can be reached between the Contracting Officer 's Representative and the Contractor regarding the accuracy and completeness of the Notebook. The original, 6 copies, and an electronic version on CD of the notebook shall be submitted at project closeout.

1.5.1 Content

Notebook shall include the LEED checklist, applicable product data for material selection, final calculations, certifications for construction practices, procurement data, cumulative calculations and other items as identified in the approved LEED NC Implementation Plan. Notebook must contain all required data to support full compliance with the indicated LEED NC credit. LEED NC credits that are inherent to the design will be documented by the designer of record.

1.5.2 LEED Calculations

Calculations showing compliance with a required LEED NC credit identified

in the LEED checklist or within the LEED NC Implementation Plan. Calculations shall be current and available for monthly review. Final calculations shall be included in the LEED NC Documentation Notebook under the appropriate tab.

1.5.3 Submittals

All "G" designated submittals required for inclusion in the LEED Documentation Notebook shall be separable from other submitted data and shall be included in the LEED NC Documentation Notebook in addition to the distribution indicated on the submittal register.

1.6 REQUIREMENTS

LEED NC credits as identified in the LEED checklist shall be incorporated and documented as required by the Contract documents and in full compliance with the LEED GBDC Reference Guide. LEED NC credits not identified elsewhere in the Contract documents and those requiring further instruction are specified below. Refer to the LEED GBDC Reference Guide for further definitions and requirements.

1.6.1 Materials and Resources Credit 4, Recycled Content

Contractor shall select materials so that the sum of post-consumer recycled content value plus one-half of post-industrial recycled content value constitutes at least 20 percent of the total materials cost for the project.

1.6.1.1 Calculations

LEED NC Letter Template forms shall be used for tracking and documentation. Recycled content value of project materials shall be determined by the method described in the LEED GBDC Reference Guide.

1.6.1.2 Substitutions

In the case of conflict between this requirement and individual technical section requirements, Contractor may submit for Government approval proposed alternative products or systems that provide equivalent performance and appearance and have greater contribution to project recycled content requirements. All such proposed substitutions shall be submitted with the LEED NC Implementation Plan accompanied by product data that demonstrates equivalence.

1.6.2 Materials and Resources Credit 5, Regional Materials

Contractor shall select materials so that a minimum of 20 percent (by dollar value) of materials and products for the project are extracted, harvested, or recovered, as well as manufactured, regionally within a 500 mile radius of the project site.

1.6.2.1 Calculations

LEED NC Letter Template forms shall be used for tracking and documentation. Amount of regional project materials shall be determined by the method described in the LEED GBDC Reference Guide. For this credit, performance is measured separately for each building.

1.6.2.2 Substitutions

In the case of conflict between this requirement and individual technical section requirements, Contractor may submit for Government approval proposed alternative products or systems that provide equivalent performance and appearance and have greater contribution to project recycled content requirements. All such proposed substitutions shall be submitted with the LEED NC Implementation Plan accompanied by product data that demonstrates equivalence.

1.6.3 Materials and Resources Credit 7, Certified Wood

Contractor shall select materials so that a minimum of 50 percent (by dollar value) of permanently installed wood-based materials and products for the project are certified in accordance with FSC STD 01 001.

1.6.3.1 Calculations

LEED NC Letter Template forms shall be used for tracking and documentation. Amount of FSC-certified project materials shall be determined by the method described in the LEED GBDC Reference Guide. For this credit, performance is measured separately for each building.

1.6.4 Indoor Environmental Quality Credit 3.1 Construction IAQ Management Plan - During Construction

Contractor shall develop and implement a Construction Indoor Air Quality Management Plan (EQc3.1) as required for this LEED credit. The plan shall address the protection of the ventilation system components during construction and cleanup of contaminated components after construction is complete, including the applicable SMACNA approaches. The contractor shall take a minimum of six photographs at three different occasions during construction (18 total photographs) to verify compliance with the plan. Each photograph shall be annotated with an identification of the SMACNA approach featured by each photograph. The contractor shall also provide a list of all filtration media installed during construction, including manufacturer, model number, MERV rating, and location of installed filter to the Contracting Officer.

1.6.5 Indoor Environmental Quality Credit 3.2 Construction IAQ Management Plan - Before Occupancy

The Contractor shall perform IAQ testing in accordance with LEED EQc3.2 and earn the associated LEED point for IAQ after construction. The Contractor shall coordinate this testing into the overall schedule.

1.6.6 Indoor Environmental Quality Credit 4.1 Low Emitting Materials - Adhesives and Sealants

The Contractor shall provide a listing of each indoor adhesive, sealant, and sealant primer product used on the project, including the manufacturer name and product name to the Contracting Officer. The list shall provide specific VOC data for each product and the corresponding allowable VOC from the referenced standard.

1.6.7 Indoor Environmental Quality Credit 4.2 Low Emitting Materials - Paints and Coatings

The Contractor shall provide a listing of each indoor paint and coating

used on the project, including the manufacturer name and product name to the LEED Consultant. The list shall provide specific VOC data for each product and the corresponding allowable VOC from the referenced standard.

1.6.8 Indoor Environmental Quality Credit 4.3 Low Emitting Materials - Flooring Systems

For Carpet Systems, the Contractor shall provide a listing of each carpet and carpet cushion product installed in the building, with confirmation that each product complies with the CRI Green Label Plus testing program. For resilient Flooring, the contractor shall provide manufacturer's product data verifying certification under either the Greenguard for Children & Schools or FloorScore indoor emissions testing program. For Engineered Wood Flooring and Bamboo Flooring, the Contractor shall provide Manufacturer's product data verifying certification under either the Greenguard or FloorScore indoor emissions testing program.

1.6.9 Indoor Environmental Quality Credit 4.4 Low Emitting Materials - Composite Wood and Agrifiber Products

Submittals for all composite wood and agrifiber products (including but not limited to particleboard, wheatboard, strawboard, agriboard products, engineered wood components, solid-core wood doors, OSB, MDF, and plywood products) must include manufacturer's product data verifying that these products contain no urea-formaldehyde resins.

PART 2 PRODUCTS

2.1 LOW-EMITTING MATERIALS

2.1.1 Indoor Environmental Quality Credit 4.1 Low Emitting Materials - Adhesives and Sealants

All adhesives and sealants used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) shall comply with the requirements of the following reference standards. Adhesives, sealants, and sealant primers shall comply with South Coast Air Quality Management District (SCAQMD) Rule #1168, effective date of July 1, 2005 and rule amendment date of January 7, 2005. Aerosol adhesives shall comply with Green Seal Standard for Commercial Adhesives GS-36, in effect on October 19, 2000:

Wood Glues: 30 g/L.
Metal-to-Metal Adhesives: 30 g/L.
Adhesives for Porous Materials (Except Wood): 50 g/L.
Subfloor Adhesives: 50 g/L.
Plastic Foam Adhesives: 50 g/L.
Carpet Adhesives: 50 g/L.
Carpet Pad Adhesives: 50 g/L.
VCT and Asphalt Tile Adhesives: 50 g/L.
Cove Base Adhesives: 50 g/L.
Gypsum Board and Panel Adhesives: 50 g/L.
Rubber Floor Adhesives: 60 g/L.
Ceramic Tile Adhesives: 65 g/L.
Multipurpose Construction Adhesives: 70 g/L.
Fiberglass Adhesives: 80 g/L.
Contact Adhesive: 80 g/L.
Structural Glazing Adhesives: 100 g/L.
Wood Flooring Adhesive: 100 g/L.

Structural Wood Member Adhesive: 140 g/L.
Single-Ply Roof Membrane Adhesive: 250 g/L.
Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine-covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
Top and Trim Adhesive: 250 g/L.
Plastic Cement Welding Compounds: 250 g/L.
ABS Welding Compounds: 325 g/L.
CPVC Welding Compounds: 490 g/L.
PVC Welding Compounds: 510 g/L.
Adhesive Primer for Plastic: 550 g/L.
Sheet-Applied Rubber Lining Adhesive: 850 g/L.
Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
Other Adhesives: 250 g/L.
Architectural Sealants: 250 g/L.
Nonmembrane Roof Sealants: 300 g/L.
Single-Ply Roof Membrane Sealants: 450 g/L.
Other Sealants: 420 g/L.
Sealant Primers for Nonporous Substrates: 250 g/L.
Sealant Primers for Porous Substrates: 775 g/L.
Modified Bituminous Sealant Primers: 500 g/L.
Other Sealant Primers: 750 g/L.
All carpet adhesive shall have a maximum VOC content of 50 g/L.

2.1.2 Indoor Environmental Quality Credit 4.2 Low Emitting Materials - Paints and Coatings

All paints and coatings used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) shall comply with the requirements of the following reference standards:

Flat Paints and Coatings: VOC not more than 50 g/L.
Nonflat Paints and Coatings: VOC not more than 150 g/L.
Dry-Fog Coatings: VOC not more than 400 g/L.
Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
Pretreatment Wash Primers: VOC not more than 420 g/L.
Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
Floor Coatings: VOC not more than 100 g/L.
Shellacs, Clear: VOC not more than 730 g/L.
Shellacs, Pigmented: VOC not more than 550 g/L.
Stains: VOC not more than 250 g/L.
Waterproofing Sealers: VOC not more than 250 g/L.
Sanding Sealers: VOC not more than 275 g/L.
All other sealers: VOC not more than 200 g/L.
VOC limits for architectural paints, coatings and primers applied to interior walls and ceilings: Green Seal Standard GS-11, Paints, First Edition, May 20, 1993.
VOC limit for anti-corrosive and anti-rust paints applied to interior ferrous metal substrates: Green Seal Standard GC-03, Anti-Corrosive Paints, Second Edition, January 7, 1997: VOC limit for clear wood finishes, floor coatings, stains, sealers, and shellacs applied to interior elements: South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, in effect on January 1,

2004:

PART 3 EXECUTION

3.1 COORDINATION MEETINGS

There will be on-site LEED coordination meetings to be held every other month for the duration of the construction phase along with three special coordination sessions. The requirements for this meeting may be fulfilled during the coordination and mutual understanding meeting outlined in Section 01 45 00.00 40 QUALITY CONTROL. The second will be a pre-closeout meeting to review LEED NC Documentation Notebook for completeness and identify any outstanding issues relating to final score and documentation requirements. The third is a closeout meeting to review the final LEED NC Documentation Notebook. All meetings shall be attended by Contractor's designated individual responsible for LEED NC documentation, Government representative and Installation representative. At closeout meeting a final score for the project will be determined based on review of project performance and documentation. Contractor shall make a set of contract drawings and specifications available for review at each meeting as well as an updated LEED NC Documentation Notebook.

-- End of Section --

SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS
08/10

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization (e.g. ASTM B564 Standard Specification for Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the standards producing organization should be ordered from the source by title rather than by number.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)
38800 Country Club Drive
Farmington Hills, MI 48331
Ph: 248-848-3700
Fax: 248-848-3701
E-mail: bkstore@concrete.org
Internet: http://www.concrete.org

ACOUSTICAL SOCIETY OF AMERICA (ASA)
2 Huntington Quadrangle, Suite 1NO1
Melville, NY 11747-4502
Ph: 516-576-2360
Fax: 516-576-2377
E-mail: asa@aip.org
Internet: http://asa.aip.org

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)
2800 Shirlington Road, Suite 300
Arlington, VA 22206
Ph: 703-575-4477
Fax: 703-575-4449
E-mail: info@acca.org
Internet: http://www.acca.org

AIR DIFFUSION COUNCIL (ADC)
1901 N. Roselle Road, suite 800
Schaumburg, IL 60195
Ph: 847-706-6750
Fax: 847-706-6751

E-mail: info@flexibleduct.org
Internet: http://www.flexibleduct.org

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)
30 West University Drive
Arlington Heights, IL 60004-1893
Ph: 847-394-0150
Fax: 847-253-0088
E-mail: amca@amca.org
Internet: http://www.amca.org

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)
2111 Wilson Blvd, Suite 500
Arlington, VA 22201
Ph: 703-524-8800
Fax: 703-528-3816
E-mail: fdietz@ahrinet.org
Internet: http://www.ahrinet.org

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)
1200 G Street, NW, Suite 500
Washington, D.C. 20005
Ph: 202-628-6380
Fax: 202-393-5453
E-mail: doccenter@atis.org
Internet: http://www.atis.org

ALUMINUM ASSOCIATION (AA)
National Headquarters
1525 Wilson Boulevard, Suite 600
Arlington, VA 22209
Ph: 703-358-2960
Fax: 703-358-2961
Internet: http://www.aluminum.org

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)
1827 Walden Office Square
Suite 550
Schaumburg, IL 60173-5774
Ph: 847-303-5664
Fax: 847-303-5774
E-mail: webmaster@aamanet.org
Internet: http://www.aamanet.org

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
444 North Capital Street, NW, Suite 249
Washington, DC 20001
Ph: 202-624-5800
Fax: 202-624-5806
E-Mail: info@aashto.org
Internet: http://www.aashto.org

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)
1 Davis Drive
P.O. Box 12215
Research Triangle Park, NC 27709
Ph: 919-549-8141
Fax: 919-549-8933

E-mail: leonardc@aatcc.org
Internet: http://www.aatcc.org

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)
2025 M Street, NW, Suite 800
Washington, DC 20036
Ph: 202-367-1155
Fax: 202-367-2155
E-mail: info@americanbearings.org
Internet: http://www.abma-dc.org

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)
221 Old Courthouse Road Suite 202
Vienna, VA 22182
Ph: 703-356-7171
Fax: 703-356-4543
Internet: http://www.abma.com

AMERICAN BUREAU OF SHIPPING (ABS)
16855 Northcase Drive
Houston, TX 77060 USA
Ph: 1-282-877-5800
Internet: http://www.eagle.org

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)
1303 W. Walnut Hill Lane, Suite 305
Irving, TX 75038-3008
Ph: 972-506-7216
Fax: 972-506-7682
E-mail: info@concrete-pipe.org
Internet: http://www.concrete-pipe.org

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
1330 Kemper Meadow Drive
Cincinnati, OH 45240
Ph: 513-742-2020 or 513-742-6163
Fax: 513-742-3355
E-mail: mail@acgih.org
Internet: http://www.acgih.org

AMERICAN FOREST & PAPER ASSOCIATION (AF&PA)
American Wood Council
ATTN: Publications Department
1111 Nineteenth Street NW, Suite 800
Washington, DC 20036
Ph: 800-890-7732 or 202-463-2766
Fax: 202-463-2791
E-mail: awcpubs@afandpa.org
Internet: http://www.awc.org/

AMERICAN GAS ASSOCIATION (AGA)
400 North Capitol Street N.W.
Suite 450
Washington, D.C. 20001
Ph: 202-824-7000
Fax: 202-824-7115
E-mail: website@aga.org
Internet: http://www.aga.org

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)
1001 N. Fairfax Street, Suite 500
Alexandria, VA 22314-1581
Ph: 703-684-0211
Fax: 703-684-0242
E-mail: websiter@agma.org
Internet: http://www.agma.org

AMERICAN HARDBOARD ASSOCIATION (AHA)
1210 West Northwest Highway
Palatine, IL 60067
Ph: 847-934-8800
Fax: 847-934-8803
E-mail: aha@hardboard.org
Internet: http://domensino/AHA/

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)
3141 Fairview Park Dr, Suite 777
Falls Church, VA 22042
Tel: 703-849-8888
Fax: 703-207-3561
E-mail: infonet@aiha.org
Internet http://www.aiha.org

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)
One East Wacker Drive, Suite 700
Chicago, IL 60601-1802
Ph: 312-670-2400
Fax: 312-670-5403
Publications: 800-644-2400
E-mail: pubs@aisc.org
Internet: http://www.aisc.org

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)
7012 South Revere Parkway, Suite 140
Centennial, CO 80112
Ph: 303-792-9559
Fax: 303-792-0669
E-mail: info@aitc-glulam.org
Internet: http://www.aitc-glulam.org

AMERICAN IRON AND STEEL INSTITUTE (AISI)
1140 Connecticut Avenue, NW, Suite 705
Washington, DC 20036
Ph: 202-452-7100
Fax: 202-463-6577
E-mail: webmaster@steel.org
Internet: http://www.steel.org

AMERICAN LADDER INSTITUTE (ALI/LADDER)
330 North Wabash Avenue, Suite 2000
Chicago, IL 60611
Tel: 202-367-1217
E-mail: info@americanladderinstitute.org
Internet: http://www.americanladderinstitute.org

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)
P.O. Box 210
Germantown, MD 20875-0210

Ph: 301-972-1700
Fax: 301-540-8004
E-mail: alsc@alsc.org
Internet: http://www.alsc.org

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1819 L Street, NW,11th Floor
Washington, DC 20036
Ph: 202-293-8020
Fax: 202-293-9287
E-mail: info@ansi.org
Internet: http://www.ansi.org/

AMERICAN NURSERY & LANDSCAPE ASSOCIATION (ANLA)
1200 G Street NW, Suite 800
Washington, DC 20005
Ph: 202-789-2900
Fax: 202-789-1893
E-mail: aflynn@anla.org
Internet: http://www.anla.org

AMERICAN PETROLEUM INSTITUTE (API)
1220 L Street, NW
Washington, DC 20005-4070
Ph: 202-682-8000
E-mail: greg.kallio@ihs.com
Internet: http://www.api.org

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)
4501 Forbes Blvd., Suite 130
Lanham, MD 20706
Ph: 301-459-3200
Fax: 301-459-8077
Internet: http://www.arema.org

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)
1711 Arlingate Lane
P.O. Box 28518
Columbus, OH 43228-0518
Ph: 800-222-2768; 614-274-6003
Fax: 614-274-6899
E-mail: webmaster@asnt.org
Internet: http://www.asnt.org

AMERICAN SOCIETY FOR QUALITY (ASQ)
600 North Plankinton Avenue
Milwaukee, WI 53203
-or-
P.O. Box 3005
Milwaukee, WI 53201-3005
Ph: 800-935-2231; 414-272-8575
Fax: 414-272-1734
E-mail: help@asq.org
Internet: http://www.asq.org

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)
1801 Alexander Bell Drive
Reston, VA 20191-4400

Ph: 703-295-6300 - 800-548-2723
Fax: 703-295-6333
E-mail: member@asce.org
Internet: http://www.asce.org

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)
1791 Tullie Circle, NE
Atlanta, GA 30329
Ph: 800-527-4723 or 404-636-8400
Fax: 404-321-5478
E-mail: ashrae@ashrae.org
Internet: http://www.ashrae.org

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)
1800 East Oakton Street
Des Plaines, IL 60018-2187
Ph: 847-699-2929
Fax: 847-768-3434
E-mail: customerservice@asse.org
Internet: http://www.asse.org

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)
18927 Hickory Creek Drive, Suite 220
Mokena, IL 60448
Ph: 708-995-3019
Fax: 708-479-6139
E-mail: info@asse-plumbing.org
Internet: http://www.asse-plumbing.org

AMERICAN WATER WORKS ASSOCIATION (AWWA)
6666 West Quincy Avenue
Denver, CO 80235
Ph: 800-926-7337
Fax: 303-347-0804
E-mail: smorrison@awwa.org
Internet: http://www.awwa.org

AMERICAN WELDING SOCIETY (AWS)
8669 NW 36 Street, #130550 N.W. LeJeune Road
Miami, FL 33166-6672
Ph: 800-443-9353 - 305-443-9353
Fax: 305-443-7559
E-mail: info@aws.org or customerservice@awspubs.com
Internet: http://www.aws.org

AMERICAN WOOD COUNCIL (AWC)
222 Catoctin Circle SE Suite 201
Leesburg, VA 20175
Ph: 800-890-7732
Fax: 608-232-9354
E-mail: publications@awc.org
Internet: http://www.awc.org

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)
P.O. Box 361784
Birmingham, AL 35236-1784
Ph: 205-733-4077
Fax: 205-733-4075

E-mail: email@awpa.com
Internet: http://www.awpa.com

APA - THE ENGINEERED WOOD ASSOCIATION (APA)
7011 South 19th St.
Tacoma, WA 98466-5333
Ph: 253-565-6600
Fax: 253-565-7265
E-mail: help@apawood.org
Internet: http://www.apawood.org

ARCHITECTURAL WOODWORK INSTITUTE (AWI)
46179 Westlake Drive, Suite 120
Potomac Falls, VA 20165
Ph: 571-323-3636
Fax: 571-323-3630
E-mail: info@awinet.org
Internet: http://www.awinet.org

ARCNET TRADE ASSOCIATION (ATA)
E-M-mail: info@arcnet.com
Internet: http://www.arcnet.com/index.htm</URL

ASM INTERNATIONAL (ASM)
9639 Kinsman Road
Materials Park, OH 44073-0002
Ph: 440-338-5151
Fax: 440-338-4634
E-mail: memberservicecenter@asminternational.org
Internet:
http://asmcommunity.asminternational.org/portal/site/www/Home/

ASME INTERNATIONAL (ASME)
Three Park Avenue, M/S 10E
New York, NY 10016-5990
Ph: 800-854-7179 or 800-843-2763
Fax: 212-591-7674
E-mail: infocentral@asme.org
Internet: http://www.asme.org

ASPHALT INSTITUTE (AI)
2696 Research Park Drive
Lexington, KY 40511-8480
Ph: 859-288-4960
Fax: 859-288-4999
E-mail: info@asphaltinstitute.org
Internet: http://www.asphaltinstitute.org

ASPHALT ROOFING MANUFACTURER'S ASSOCIATION (ARMA)
529 14th Street, NW
Washington D.C. 20045
Ph: 202-591-2450
Fax: 202-591-2445
Internet: http://www.asphaltroofing.org

ASSOCIATED AIR BALANCE COUNCIL (AABC)
1518 K Street, NW
Washington, DC 20005
Ph: 202-737-0202

Fax: 202-638-4833
E-mail: info@aabc.com
Internet: http://www.aabchq.com

ASSOCIATION FOR THE ADVANCEMENT OF MEDICAL INSTRUMENTATION (AAMI)
4301 N. Fairfax Drive, Suite 301
Arlington, VA 22203-1633
Ph: 800-332-2264 or 703-525-4890
Fax: 703-276-0793
E-mail: customerservice@aami.org
Internet: http://www.aami.org

ASSOCIATION FOR IRON AND STEEL TECHNOLOGY (AIST)
186 Thorn Hill Road
Warrendale, PA 15086-7528
Ph: 724-814-3000
Fax: 724-814-3001
E-Mail: info@aist.org
Internet: http://www.aistech.org

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)
600 North 18th Street
P.O. Box 2641
Birmingham, AL 35291
Ph: 205-257-2530
Fax: 205-257-2540
E-Mail: aeicdir@bellsouth.net
Internet: http://www.aeic.org

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)
1111 19th Street NW, Suite 402
Washington, DC 20036
Ph: 202-872-5955
Fax: 202-872-9354
E-mail: info@aham.org
Internet: http://www.aham.org

ASSOCIATION OF THE WALL AND CEILING INDUSTRIES - INTERNATIONAL (AWCI)
513 West Broad Street, Suite 210
Falls Church, VA 22046
Ph: 703-538-1600
Fax: 703-534-8307
E-mail: info@awci.org
Internet: http://www.awci.org

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9585
Fax: 610-832-9555
E-mail: service@astm.org
Internet: http://www.astm.org

BAY AREA AIR QUALITY MANAGEMENT DISTRICT (Bay Area AQMD)
939 Ellis Street
San Francisco, CA 94109
Ph: 415-771-6000
Fax: 415-928-8560

E-Mail: publicrecords@baaqmd.gov
Internet: http://www.baaqmd.gov/

BIFMA INTERNATIONAL (BIFMA)
678 Front Ave. NW, Suite 150
Grand Rapids, MI 49504-5368
Ph: 616-285-3963
Fax: 616-285-3765
E-mail: email@bifma.org
Internet: http://www.bifma.org

BIOCYCLE, JOURNAL OF COMPOSTING AND RECYCLING (BIOCYCLE)
The JG Press Inc.
419 State Avenue
Emmaus, PA 18049
Ph: 610-967-4135, Ext. 22
E-mail: biocycle@jgpress.com
Internet: http://www.biocycle.net

BRITISH STANDARDS INSTITUTE (BSI)
389 Chiswick High Road
London W4 4AL
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Ph: +44 (0)20 8996 9001
Fax: +44 (0)20 8996 7001
E-mail: cservices@bsi-global.com or info@bsigroup.com
Internet: http://www.bsi-group.com

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)
355 Lexington Avenue
15th Floor
New York, NY 10017
Ph: 212-297-2122
Fax: 212-370-9047
E-mail: assocmgmt@aol.com
Internet: http://www.buildershardware.com

CALIFORNIA ENERGY COMMISSION (CEC)
Media and Public Communications Office
1516 Ninth Street, MS-29
Sacramento, CA 95814-5512
Ph: 916-654-4287
Internet: http://www.energy.ca.gov/

CARPET AND RUG INSTITUTE (CRI)
P.O. Box 2048
Dalton, GA 30722-2048
Ph: 800-882-8846 or 706-278-3176
Fax: 706-278-8835
Internet: http://www.carpet-rug.com

CAST IRON SOIL PIPE INSTITUTE (CISPI)
3008 Preston Station Drive
Hixson, TN 37343
Ph: 423-842-2122
Internet: http://www.cispi.org

CEILINGS & INTERIOR SYSTEMS CONSTRUCTION ASSOCIATION (CISCA)
405 Illinois Ave. Unit 2B

St. Charles, IL 60174
Ph: 630-584-1919
Fax: 866-560-8537
E-mail: cisca@cisca.org
Internet: http://www.cisca.org

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)
1600 Clifton Road
Atlanta, GA 30333
Ph: 404-639-3311 or 800-232-4636
E-mail: cdcinfo@cdc.gov
Internet: http://www.cdc.gov

CHEMICAL FABRICS & FILM ASSOCIATION (CFFA)
1300 Sumner Avenue
Cleveland OH 44115-2851
Ph: 216-241-7333
Fax: 216-241-0105
E-mail: cffa@chemicalfabricsandfilm.com
Internet: http://www.chemicalfabricsandfilm.com/

CHLORINE INSTITUTE (CI)
1300 Wilson Boulevard
Arlington, VA 22209
Ph: 703-741-5760
Fax: 703-741-6068
E-mail: aonna@CL2.com
Internet: http://www.CL2.com

COMPOSITE PANEL ASSOCIATION (CPA)
19465 Deerfield Avenue, Suite 306
Leesburg, VA 20176
Ph: 703-724-1128
Fax: 703-724-1588
Internet: http://www.pbmdf.com

COMPRESSED AIR AND GAS INSTITUTE (CAGI)
1300 Sumner Avenue
Cleveland OH 44115-2851
Ph: 216-241-7333
Fax: 216-241-0105
E-mail: cagi@cagi.org
Internet: http://www.cagi.org/

COMPRESSED GAS ASSOCIATION (CGA)
1451 George Carter Way, Suite 103
Chantilly, VA 20151
Ph: 703-788-2700
Fax: 703-961-1831
E-mail: cga@cganet.com
Internet: http://www.cganet.com

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)
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Fax: 866-418-0232
E-mail: gpoweb@gpo.gov
Internet: http://www.gpoaccess.gov/

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)
FHWA, Office of Safety

1200 New Jersey Ave., SE
Washington, DC 20590-
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Fax: 202-366-2249
E-mail: contactcenter@gpo.gov
Internet: http://www.safety.fhwa.dot.gov
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Fax: 202-512-2104
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Internet: http://www.gpoaccess.gov

U. S. GREEN BUILDING COUNCIL (USGBC)
2101 L St NW, Suite 500
Washington, D.C. 20037
Fax: 202-828-5110
E-mail: info@usgbc.org
Internet: http://www.usgbc.org

U.S. GENERAL SERVICES ADMINISTRATION (GSA)
General Services Administration
1800 F Street, NW
Washington, DC 20405
Ph: 202-501-0800
Internet: www.GSA.gov
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Department of Defense Single Stock Point (DODSSP)
Document Automation and Production Service (DAPS)
Building 4/D
700 Robbins Avenue
Philadelphia, PA 19111-5094
Ph: 215-697-6396 - for account/password issues
Internet: http://assist.daps.dla.mil/online/start/; account registration required

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
8601 Adelphi Road
College Park, MD 20740-6001
Ph: 866-272-6272
Fax: 301-837-0483
E-mail: contactcenter@gpo.gov
Internet: http://www.archives.gov
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Fax: 202-512-2104
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Internet: http://www.gpoaccess.gov

U.S. NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)
1322 Patterson Ave. SE, Suite 1000
Washington Navy Yard, DC 20374
Ph: 757-322-4200
Fax: 757-322-4416
Internet: http://www.navfac.navy.mil

U.S. NAVAL FACILITIES ENGINEERING SERVICE CENTER (NFESC)
401 Industry Road, Suite 500
Louisville, KY 40208
Ph: 502-638-4400
Fax: 502-638-4300
E-mail: contact@nstcenter.com
Internet: http://www.nfesc.navy.mil

U.S. NAVAL SEA SYSTEMS COMMAND (NAVSEA)
Commander Naval Sea Systems Command
1333 Isaac Hull Ave., SE
Washington Navy Yard, DC 20376-1080
Ph: 202-781-0000
E-mail: navsea_publicqueries@navy.mil

WASHINGTON STATE ADMINISTRATIVE CODE (WAC)
Kyle Thiessen, Code Reviser
P.O. Box 40581
Olympia, WA 98504-0466
Ph: 360-782-6777
Fax: 360-786-1529
E-mail: Via internet address and prompt at "Title 1: Code Reviser"
Internet: http://apps.leg.wa.gov/wac

WASHINGTON STATE DEPARTMENT OF ECOLOGY (WSDE)
Washington State Department of Ecology
P.O. Box 447600
Olympia, WA 98504-7600
E-mail: ecypub@ecy.wa.gov
Internet:
https://fortress.wa.gov/ecy/publications/UIPages/Home.aspx

WATER ENVIRONMENT FEDERATION (WEF)
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Alexandria, VA 22314-1994
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Fax: 703-684-2492
E-mail: mrichards@wef.org(Margaret Richards) or subs@wef.org
(Carolyn Chew)
Internet: http://www.wef.org

WATER QUALITY ASSOCIATION (WQA)
4151 Naperville Road
Lisle, IL 60532-3696
Ph: 630-505-0160
Fax: 630-505-9637
E-mail: szrout@wqa.org
Internet: http://www.wqa.org

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)
P.O. Box 23145
Tigard, OR 97281

Ph: 503-639-0651
Fax: 503-684-8928
E-mail: info@wclib.org
Internet: http://www.wclib.org

WESTERN WOOD PRESERVERS INSTITUTE (WWPI)
7017 N.E. Highway 99 Suite 108
Vancouver, WA 98665
Ph: 360-693-9958
Fax: 360-693-9967
E-mail: info@wwpinstitute.org
Internet: http://www.wwpinstitute.org

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)
Yeon Building
522 SW 5th Avenue
Suite 500
Portland, OR 97204-2122
Ph: 503-224-3930
Fax: 503-224-3934
E-mail: info@wwpa.org
Internet: http://www.wwpa.org

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)
401 N. Michigan Ave., Suite 2200
Chicago, IL 60611
Ph: 312-321-6802
Fax: 312-673-6922
E-mail: wdma@wdma.com
Internet: http://www.wdma.com

WIRE ROPE TECHNICAL BOARD (WRTB)
801 North Fairfax Street, Suite 211
Alexandria, VA 22314-1757
Ph: 703-299-8550
Fax: 703-299-9253
E-mail: wrtb@usa.net
Internet: http://www.wireropetechnicalboard.org

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMMPA)
507 First Street
Woodland, CA 95695
Ph: 530-661-9591 or 800-550-7889
Fax: 530-661-9586
E-mail: info@wmmpa.com
Internet: http://www.wmmpa.com

THE WOOLMARK COMPANY (WBI)
The Woolmark Company
1230 Avenue of the Americas, 7th Fl.
New York, NY 10020
Ph: 646-756-2535
internet: http://www.woolmark.com

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

-- End of Section --

SECTION 01 45 00.00 40

QUALITY CONTROL
05/12

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS
Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Quality Control Data

Quality Control Coordinating Actions

Quality Control Training

Inspection Records

Field Tests; G

Factory Tests; G

1.2.1 Quality Assurance (QA) Plan

Address the following within the QA Plan:

a. Description of the authority, responsibilities and coordinating procedures, of on-site/off-site quality assurance personnel, including those QA personnel not under direct control of the Contractor.

b. List personnel designated by the Contractor to accomplish the work required by the contract.

c. Provide an appendix with a copy of each form, report format, or similar record to be used in the QA program.

d. Contractor's organization that handles construction contract activities.

e. Contractor's operational plan for accomplishing and reviewing work controls, fabrication controls, certifications, and documentation of quality control operations, inspections, and test records, including those for subcontractors.

f. Include within these provisions the methods to be used during the procurement cycle (order to delivery) for those materials or equipment that require source inspections, shop fabrications, or similar operations located separately from the work site.

g. Description of on-site personnel training.

h. Certification(s) of personnel, procedures, processes, and equipment.

i. Non-Destructive Testing (NDT) requirements.

j. Identification of independent certifying and testing laboratories.

Refer to Section 01 91 13 Commissioning.

1.2.2 Records

Include all quality control data; factory tests or manufacturer's certifications, quality control coordinating actions; records of quality control training/certifications as well as routine hydrostatic, electrical continuity, grounding, welding, line cleaning, field tests and similar tests. Ensure Quality records are available for examination by the Contracting Officer's Representative.

Furnish legible copies of the test and inspection records to the Contracting Officer's Representative. Ensure records cover work placement traceable to the contract schedule, specifications and drawings, and are verifiable.

1.2.2.1 Narrative Description

Submit for approval, the narrative description of an inspection system which provides for compliance with the quality requirements and technical criteria of the contract within 14 calendar days after notice to proceed.

1.3 QUALITY ASSURANCE

1.3.1 Qualifications of Quality Representative

1.3.2 Quality Control Requirements

Provide a quality control program encompassing: selection of construction materials and sources; suppliers; subcontractors; on-site and off-site fabrication of Contractor-furnished assemblies; on-site and off-site assembly; erection; work procedures; workmanship; inspection; and testing.

1.3.2.1 Management and Organization

Designate an individual within the on-site organization whose sole responsibility is the day-to-day on-site management and direction of the Quality Program.

The Quality Program Manager will report to the Contractor's management and have the necessary authority to discharge contractual responsibilities.

1.3.2.2 Identification and Data Retrieval

Provide an identification and data retrieval system.

Identify all records, drawings, submittals, and equipment by referencing the Contract Number; Contract Specification Number; Contract Drawing Number; Submittal Document Number; Contract Change Number; and the Contractor's Drawing Number System.

1.3.2.3 Procurement

Contractor is responsible for controlling procurement sources and those of his subcontractors to ensure that each purchase meets quality requirements.

1.3.2.4 Receiving Inspection System

Maintain a site receiving inspection system that ensures procured materials and equipment are inspected and tested.

Ensure receiving inspection records accompany each procurement delivery to the construction site. Maintain records of site receiving inspections.

Show defects, discrepancies, dispositions, and waivers, including evidence of Government source inspection within the records.

1.3.2.5 Nonconforming Articles and Material Control

Control nonconformances discovered by the Contractor, subcontractors, suppliers or Government quality representatives to prevent their use and to correct deficient operations.

a. Prepare a "nonconformance" report for each instance comprising:

(1) A unique and traceable number.

(2) Identification of the nonconforming article or material.

(3) A description of the nonconformance and the applicable requirement.

(4) Cause or reason for the nonconformance.

(5) Remedial actions taken or recommended.

(6) Disposition of the nonconforming article or material.

b. Identify and mark each nonconforming article for removal from the work area.

c. Monitor and correct deficient operations.

1.3.2.6 Fabrication, Process, and Work Control

Ensure compliance of requirements in contract specifications and drawings with procedures and controls.

Establish in-process inspections, to ensure compliance with quality requirements.

1.3.2.7 Quality Control Records

Maintain Quality Control records at a central on-site location.

Maintenance of quality control records do not relieve the Contractor from submitting samples, test data, detail drawings, material certificates, or other information required by each section in the specification.

Ensure each record is identified and traceable to specific requirements in

the specifications and drawings.

1.3.2.8 Drawings and Change Control

Maintain drawing-control system to provide revised drawings and ensure continuous removal of obsolete drawings from work areas. Control changes involving interface with other work areas, or affecting materials controlled by others. Integrate this system with the document requirements of the contract.

Clearly annotate and identify drawing changes and associated drawings for implementation that are to be revised accordingly. Use for fabrication and inspection drawings that have been approved, or approved as noted, by the Contracting Officer's Representative.

1.3.3 Quality Inspections

1.3.3.1 Government Inspections

Work performed under this contract will be subject to inspection by the Contracting Officer's Representative. Changes to the specifications or drawings will not be allowed without written authorization of the Contracting Officer's Representative.

Notify Contracting Officer's Representative in writing before placing concrete, backfilling or encasing any underground utility so that work may be inspected. Failure to notify the Contracting Officer's Representative before backfill or encasement occurs will require the work be uncovered at no additional cost to the Government.

Contractor's program is subject to continuous evaluation, review, and verification by the Contracting Officer's Representative.

1.3.3.2 Contractor's Quality Inspections

Implement an inspection system that Documents and indicates quality control through records of inspections, tests, and procedures.

Include the following within the Contractor's Quality Assurance System:

a. Single Contractor's representative responsible for on-site communication and operation of the inspection program.

b. Purchasing control system documenting project procurement to drawings, specifications, and approved submittals.

c. Receiving inspection system documenting inspections for each procurement.

d. Documentation for handling and disposing of nonconforming components and materials.

e. Inspection records for each specific section of the specification and drawings.

f. Identification of test(s) to be performed, test procedures, records, and independent organizations used.

g. Documenting and maintaining certification or re-certification of

procedures.

h. Management of government-furnished equipment, components, and materials.

i. Calibration of gages, tools, measuring instruments, and independent laboratories used.

Establish a system of scheduled or random audits to ensure task completion.

1.3.4 Field Services

1.3.4.1 Responsibility for Inspection and Testing

Contractor is responsible for all inspections and tests, and the accompanying documentation for each inspection and test. Contractor may utilize independent inspection and testing laboratories or services as approved by the Contracting Officer's Representative.

Contractor is also be responsible for tests of construction materials utilizing the services of an approved independent testing laboratory.

1.3.4.2 Inspection and Test Records

Provide on-site records of each inspection and test performed throughout the life of the contract including, but not be limited to, factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved, identification of operators and inspectors, result of inspections or tests, nature of defects, causes for rejection, proposed remedial action, and corrective actions taken.

Ensure all inspection records, test procedures, test results, and associated forms are verified by and provided to the Contracting Officer's Representative. Submit final test data with a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data.

1.4 HANDLING AND STORAGE

Provide controls, procedures and documentation with each shipment, that meet requirements of each section of the specifications.

Include documentation with each shipment that consist of documentation required by the contract along with specifications required to identify, store, preserve, operate, and maintain the items shipped.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 57 20.00 10

ENVIRONMENTAL PROTECTION
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

33 CFR 328	Definitions of Waters of the United States
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 279	Standards for the Management of Used Oil
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
40 CFR 68	Chemical Accident Prevention Provisions
49 CFR 171 - 178	Hazardous Materials Regulations

U.S. ARMY CORPS OF ENGINEERS (USACE)

WETLAND MANUAL	Corps of Engineers Wetlands Delineation Manual Technical Report Y-87-1

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

33 CFR 328	Definitions of Waters of the United States
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 279	Standards for the Management of Used Oil
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
40 CFR 68	Chemical Accident Prevention Provisions
49 CFR 171 - 178	Hazardous Materials Regulations

1.2 DEFINITIONS

1.2.1 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

1.2.2 Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2.3 Contractor Generated Hazardous Waste

Contractor generated hazardous waste means materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of material brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e. methyl ethyl ketone, toluene etc.), waste thinners,excess paints, excess solvents, waste solvents, and excess pesticides, and contaminated pesticide equipment rinse water.

1.2.4 Land Application for Discharge Water

The term "Land Application" for discharge water implies that the Contractor must discharge water at a rate which allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, discharge into defined drainage areas, or discharge into the "waters of the United States" must occur. Land Application must be in compliance with all applicable Federal, State, and local laws and regulations.

1.2.5 Surface Discharge

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers,creeks, and/or "waters of the United States" and would require a permit to discharge water from the governing agency.

1.2.6 Waters of the United States

All waters which are under the jurisdiction of the Clean Water Act, as defined in 33 CFR 328.

1.2.7 Wetlands

Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for

life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs. Official determination of whether or not an area is classified as a wetland must be done in accordance with WETLAND MANUAL.

1.3 GENERAL REQUIREMENTS

Minimize environmental pollution and damage that may occur as the result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work must be protected during the entire duration of this contract. Comply with all applicable environmental Federal, State, and local laws and regulations. Any delays resulting from failure to comply with environmental laws and regulations will be the Contractor's responsibility.

1.4 SUBCONTRACTORS

Ensure compliance with this section by subcontractors.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Environmental Protection Plan; G

SD-11 Closeout Submittals

KSC Form 7-648 NS (02/07); G

1.6 ENVIRONMENTAL PROTECTION PLAN

Prior to commencing construction activities or delivery of materials to the site, submit an Environmental Protection Plan for review and approval by the Contracting Officer. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental issues which the Contractor must address during construction. Issues of concern must be defined within the Environmental Protection Plan as outlined in this section. Address each topic at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but are considered necessary, must be identified and discussed after those items formally identified in this section. Prior to submittal of the Environmental Protection Plan, meet with the Contracting Officer for the purpose of discussing the implementation of the initial Environmental Protection Plan; possible subsequent additions and revisions to the plan including any reporting requirements; and methods for administration of the Contractor's Environmental Plans. The Environmental Protection Plan must be current and maintained onsite by the Contractor.

1.6.1 Compliance

No requirement in this Section will relieve the Contractor of any applicable Federal, State, and local environmental protection laws and regulations. During Construction, the Contractor will be responsible for identifying, implementing, and submitting for approval any additional

requirements to be included in the Environmental Protection Plan.

1.6.2 Contents

Include in the environmental protection plan, but not limit it to, the following:

a. Name(s) of person(s) within the Contractor's organization who is(are) responsible for ensuring adherence to the Environmental Protection Plan.

b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.

c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

d. Description of the Contractor's environmental protection personnel training program.

e. An erosion and sediment control plan which identifies the type and location of the erosion and sediment controls to be provided. The plan must include monitoring and reporting requirements to assure that the control measures are in compliance with the erosion and sediment control plan, Federal, State, and local laws and regulations. A Storm Water Pollution Prevention Plan (SWPPP) may be substituted for this plan.

f. Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on the site.

g. Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan shall include measures to minimize the amount of mud transported onto paved public roads by vehicles or runoff.

h. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.

i. Drawing showing the location of borrow areas.

j. Include in the Spill Control plan the procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance regulated by 40 CFR 68, 40 CFR 302, 40 CFR 355, and/or regulated under State or Local laws and regulations. The Spill Control Plan supplements the requirements of NASA KSC Environmental requirements. Include in this plan, as a minimum:

1). The name of the individual who will report any spills or hazardous substance releases and who will follow up with complete documentation. This individual will immediately notify the Contracting Officer and NASA Environmental. Include in the plan a list of the required reporting channels and telephone numbers.

2). The name and qualifications of the individual who will be responsible for implementing and supervising the containment and cleanup.

3). Training requirements for Contractor's personnel and methods of accomplishing the training.

4). A list of materials and equipment to be immediately available at the job site, tailored to cleanup work of the potential hazard(s) identified.

5). The names and locations of suppliers of containment materials and locations of additional fuel oil recovery, cleanup, restoration, and material-placement equipment available in case of an unforeseen spill emergency.

6). The methods and procedures to be used for expeditious contaminant cleanup.

k. A hazardous waste disposal plan identifying methods and locations for hazardous waste and universal waste collection.

l. A non-hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris and schedules for disposal.

1). Identify any subcontractors responsible for the transportation and disposal of solid waste. Submit licenses or permits for solid waste disposal sites that are not a commercial operating facility.

2). Evidence of the disposal facility's acceptance of the solid waste must be attached to this plan during the construction. Attach a copy of each of the Non-hazardous Solid Waste Diversion Reports to the disposal plan. Submit the report for the previous quarter on the first working day after the first quarter that non-hazardous solid waste has been disposed and/or diverted (e.g. the first working day of January, April, July, and October).

3). Indicate in the report the total amount of waste generated and total amount of waste diverted in cubic yards or tons along with the percent that was diverted.

m. A recycling and solid waste minimization plan with a list of measures to reduce consumption of energy and natural resources. Detail in the plan the Contractor's actions to comply with and to participate in Federal, State, Regional, and local government sponsored recycling programs to reduce the volume of solid waste at the source.

n. An air pollution control plan detailing provisions to assure that dust, debris, materials, trash, etc., do not become air borne and travel off the project site.

o. A contaminant prevention plan that: identifies potentially hazardous substances to be used on the job site; identifies the intended actions to prevent introduction of such materials into the air, water, or ground; and details provisions for compliance with

Federal, State, and local laws and regulations for storage and handling of these materials. A copy of the Material Safety Data Sheets (MSDS) and the maximum quantity of each hazardous material to be onsite at any given time must be included in the contaminant prevention plan. Update the plan as new hazardous materials are brought onsite or removed from the site.

p. A wastewater management plan that identifies the methods and procedures for management and/or discharge of wastewaters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines. If a settling/retention pond is required, the plan must include the design of the pond including drawings, removal plan, and testing requirements for possible pollutants. If land application will be the method of disposal for the wastewater, the plan must include a sketch showing the location for land application along with a description of the pretreatment methods to be implemented. If surface discharge will be the method of disposal, include a copy of the permit and associated documents as an attachment prior to discharging the wastewater. If disposal is to a sanitary sewer, the plan must include documentation that the Wastewater Treatment Plant Operator has approved the flow rate, volume, and type of discharge.

1.6.3 Appendix

Attach to the Environmental Protection Plan, as an appendix, copies of all environmental permits, permit application packages, approvals to construct, notifications, certifications, reports, and termination documents.

1.7 PROTECTION FEATURES

Prior to the start of any onsite construction activities, the Contractor and the Contracting Officer will make a joint condition survey. Immediately following the survey, the Contractor will prepare a brief report including a plan describing the features requiring protection under the provisions of NASA KSC Environmental requirements, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the Contractor's assigned storage area and access route(s), as applicable. This survey report will be signed by both the the Contractor and the Contracting Officer upon mutual agreement as to its accuracy and completeness. The Contractor must protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference which their preservation may cause to the work under the contract.

1.8 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS

Any deviations from the drawings, plans and specifications, requested by the Contractor and which may have an environmental impact, will be subject to approval by the Contracting Officer and may require an extended review, processing, and approval time. The Contracting Officer reserves the right to disapprove alternate methods, even if they are more cost effective, if the Contracting Officer determines that the proposed alternate method will have an adverse environmental impact.

1.9 NOTIFICATION

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with Federal, State or local environmental laws or regulations, permits, and other elements of the Contractor's Environmental Protection plan. After receipt of such notice, the Contractor will inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or equitable adjustments allowed for any such suspensions. This is in addition to any other actions the Contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation or Federal Law.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 LAND RESOURCES

Confine all activities to areas defined by the drawings and specifications. Identify any land resources to be preserved within the work area prior to the beginning of any construction. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without approval, except in areas indicated on the drawings or specified to be cleared. Ropes, cables, or guys will not be fastened to or attached to any trees for anchorage unless specifically authorized. Provide effective protection for land and vegetation resources at all times, as defined in the following subparagraphs. Remove stone, soil, or other materials displaced into uncleared areas.

3.1.1 Work Area Limits

Mark the areas that need not be disturbed under this contract prior to commencing construction activities. Mark or fence isolated areas within the general work area which are not to be disturbed. Protect monuments and markers before construction operations commence. Where construction operations are to be conducted during darkness, any markers must be visible in the dark. The Contractor's personnel must be knowledgeable of the purpose for marking and/or protecting particular objects.

3.1.2 Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved must be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques. Restore landscape features damaged or destroyed during construction operations outside the limits of the approved work area.

3.1.3 Erosion and Sediment Controls

Providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations is the Contractor's responsibility. The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of construction activities. The area of bare soil

exposed at any one time by construction operations should be kept to a minimum. Construct or install temporary and permanent erosion and sediment control best management practices (BMPs) as indicated on the drawings. BMPs may include, but not be limited to, vegetation cover, stream bank stabilization, slope stabilization, silt fences, construction of terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels, and sedimentation basins. The Contractor's best management practices must also be in accordance with the National Pollutant Discharge Elimination System (NPDES) Storm Water Pollution Prevention Plan (SWPPP) which may be reviewed at NASA Environmental . Remove any temporary measures after the area has been stabilized.

3.1.4 Contractor Facilities and Work Areas

Place field offices, staging areas, stockpile storage, and temporary buildings in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities will be made only when approved. Erosion and sediment controls must be provided for onsite borrow and spoil areas to prevent sediment from entering nearby waters. Temporary excavation and embankments for plant and/or work areas must be controlled to protect adjacent areas.

3.2 WATER RESOURCES

Monitor all water areas affected by construction activities to prevent pollution of surface and ground waters. Do not apply toxic or hazardous chemicals to soil or vegetation unless otherwise indicated. For construction activities immediately adjacent to impaired surface waters (as defined by the Florida Department of Environmental Protection), the Contractor must be capable of quantifying sediment or pollutant loading to that surface water when required by State or Federally issued Clean Water Act permits.

3.2.1 Cofferdams, Diversions, and Dewatering Operations

Construction operations for dewatering shall be controlled at all times to maintain compliance with existing State water quality standards and designated uses of the surface water body. Comply with NASA KSC Environmental requirements.

3.2.2 Wetlands

Do not enter, disturb, destroy, or allow discharge of contaminants into any wetlands.

3.3 AIR RESOURCES

Equipment operation, activities, or processes will be in accordance with all Federal and State air emission and performance laws and standards.

3.3.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from asphaltic batch plants; must be controlled at all times, including weekends, holidays and hours when work is not in progress. Maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or

outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. Provide sufficient, competent equipment available to accomplish these tasks. Perform particulate control as the work proceeds and whenever a particulate nuisance or hazard occurs. Comply with all State and local visibility regulations.

3.3.2 Odors

Odors from construction activities must be controlled at all times. The odors must be in compliance with State regulations and/or local ordinances and may not constitute a health hazard.

3.3.3 Sound Intrusions

Keep construction activities under surveillance and control to minimize environment damage by noise. Comply with State regulations and local ordinances.

3.3.4 Burning

Burning is prohibited on the Government premises.

3.4 MATERIALS MANAGEMENT AND WASTE DISPOSAL

Disposal of wastes will be as directed below, unless otherwise specified in other sections and/or shown on the drawings.

3.4.1 Solid Wastes

Solid wastes (excluding clearing debris) shall be handled in accordance with NASA KSC Environmental requirements.

3.4.2 Chemicals and Chemical Wastes

Dispense chemicals ensuring no spillage to the ground or water. Perform and document periodic inspections of dispensing areas to identify leakage and initiate corrective action. This documentation will be periodically reviewed by the Government. Collect chemical waste in corrosion resistant, compatible containers. Collection drums must be monitored and removed to a staging or storage area when contents are within 6 inches of the top. Wastes shall be classified, managed, stored, and disposed of in accordance with NASA KSC Environmental requirements.

3.4.3 Hazardous Materials and Universal Waste/Contractor General Hazardous Wastes

Hazardous wastes are defined in 40 CFR 261, or are as defined by applicable State and local regulations. Hazardous materials are defined in 49 CFR 171 - 178. Manage and store hazardous waste and universal waste in compliance with 40 CFR 262 and NASA KSC Environmental requirements. Take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing.

3.4.4 Fuel and Lubricants

Storage, fueling and lubrication of equipment and motor vehicles must be conducted in a manner that affords the maximum protection against spill and evaporation. Manage and store fuel, lubricants and oil in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded must be stored in marked corrosion-resistant containers and recycled or disposed in accordance with 40 CFR 279, State, and local laws and regulations and NASA KSC Environmental requirements.

3.4.5 Wastewater

Disposal of wastewater will be as specified below.

a. Wastewater from construction activities, such as onsite material processing, concrete curing, foundation and concrete clean-up, water used in concrete trucks, forms, etc. shall be in accordance with NASA KSC Environmental requirements.

b. For discharge of ground water, the Contractor shall land apply on the project site in accordance with all Federal, State, Regional, and/or Local laws and regulations for pumping and land applying ground water as well as NASA KSC Environmental requirements.

c. Water generated from the flushing of lines after disinfection or disinfection in conjunction with hydrostatic testing will be land applied in accordance with all Federal, State, and local laws and regulations for land application.

3.5 RECYCLING AND WASTE MINIMIZATION

Participate in State and local government sponsored recycling programs. The Contractor is further encouraged to minimize solid waste generation throughout the duration of the project. Recycle material in accordance with NASA KSC policy. For further information, please contact the NASA/KSC Recycling Manager.

3.6 NON-HAZARDOUS SOLID WASTE DIVERSION REPORT

Maintain an inventory of non-hazardous solid waste diversion and disposal of construction and demolition debris. Submit a report (KSC Form 7-648 NS (02/07) to NASA Environmental through the Contracting Officer on a monthly basis and keep a log on-site in compliance with direction from the Contracting Officer.

a. Construction and Demolition (C&D) Debris Disposed = _____ in cubic yards or tons, as appropriate.

b. Construction and Demolition (C&D) Debris Recycled = _____ in cubic yards or tons, as appropriate.

c. Total C&D Debris Generated = _____ in cubic yards or tons, as appropriate.

d. Waste Sent to Waste-To-Energy Incineration Plant (This amount should not be included in the recycled amount) = _____ in cubic yards or tons, as appropriate.

e. Metal Recycled = _____ in tons, as appropriate.

3.7 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

Refer to NASA KSC environmental requirements.

3.8 BIOLOGICAL RESOURCES

Minimize interference with, disturbance to, and damage to fish, wildlife, and plants including their habitat. The protection of threatened and endangered animal and plant species, including their habitat, is the Contractor's responsibility in accordance with Federal, State, Regional, and local laws and regulations. Comply with NASA KSC environmental policy. Notify the Contracting Officer to request that NASA Environmental perform a biological survey within 14 days of contract Notice to Proceed. Do not begin land clearing or site disturbance activities before receiving written approval from the Contracting Officer.

3.9 PREVIOUSLY USED EQUIPMENT

Clean all previously used construction equipment prior to bringing it onto the project site. Ensure that the equipment is free from soil residuals, egg deposits from plant pests, noxious weeds, and plant seeds. Consult with the USDA jurisdictional office for additional cleaning requirements.

3.10 MAINTENANCE OF POLLUTION FACILITIES

Maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.11 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel must be trained in all phases of environmental protection and pollution control. Conduct environmental protection/pollution control meetings for all personnel prior to commencing construction activities. Additional meetings must be conducted for new personnel and when site conditions change. Include in the training and meeting agenda: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection/pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, wetlands, and endangered species and their habitat that are known to be in the area.

3.12 POST CONSTRUCTION CLEANUP

The Contractor will clean up all areas used for construction. Unless otherwise instructed in writing by the Contracting Officer, obliterate all signs of temporary construction facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. The disturbed area must be graded, filled and the entire area seeded unless otherwise indicated.

-- End of Section --

SECTION 01 74 19

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT
01/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED GBDC	(2009) LEED Reference Guide for Green Building Design and Construction
LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 GOVERNMENT POLICY

Government policy is to apply sound environmental principles in the design, construction and use of facilities. As part of the implementation of that policy: (1) practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction and demolition waste from landfills and incinerators and to facilitate their recycling or reuse. A minimum of 75 percent by weight of total project solid waste shall be diverted from the landfill.

1.3 MANAGEMENT

Develop and implement a waste management program. Take a pro-active, responsible role in the management of construction and demolition waste and require all subcontractors, vendors, and suppliers to participate in the effort. Construction and demolition waste includes products of demolition or removal, excess or unusable construction materials, packaging materials for construction products, and other materials generated during the construction process but not incorporated into the work. In the management of waste consideration shall be given to the availability of viable markets, the condition of the material, the ability to provide the material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates. The Contractor is responsible for implementation of any special programs involving rebates or similar incentives related to recycling of waste. Revenues or other savings obtained for salvage, or recycling accrue to the Contractor. Appropriately permit firms and facilities used for recycling, reuse, and disposal for the intended use to the extent required by federal, state, and local regulations. Also, provide on-site instruction of appropriate separation, handling, recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Waste Management Plan; (LEED NC)

SD-11 Closeout Submittals

Records; (LEED NC)

1.5 MEETINGS

Conduct Construction Waste Management meetings. After award of the Contract and prior to commencement of work, schedule and conduct a meeting with the Contracting Officer's Representative to discuss the proposed Waste Management Plan and to develop a mutual understanding relative to the details of waste management. The requirements for this meeting may be fulfilled during the coordination and mutual understanding meeting outlined in Section QUALITY CONTROL. At a minimum, environmental and waste management goals and issues shall be discussed at the following additional meetings:

a. Pre-bid meeting.

b. Preconstruction meeting.

c. Regular site meetings.

d. Work safety meetings.

1.6 WASTE MANAGEMENT PLAN

A waste management plan shall be submitted within 15 days after contract award and not less than 10 days before the preconstruction meeting. The plan shall demonstrate how the project waste diversion goal shall be met and shall include the following:

a. Name of individuals on the Contractor's staff responsible for waste prevention and management.

b. Actions that will be taken to reduce solid waste generation, including coordination with subcontractors to ensure awareness and participation.

c. Description of the regular meetings to be held to address waste management.

d. Description of the specific approaches to be used in recycling/reuse of the various materials generated, including the areas on site and equipment to be used for processing, sorting, and temporary storage of wastes.

e. Characterization, including estimated types and quantities, of the waste to be generated.

f. Name of landfill and/or incinerator to be used and the estimated costs for use, assuming that there would be no salvage or recycling on the project.

g. Identification of local and regional reuse programs, including non-profit organizations such as schools, local housing agencies, and organizations that accept used materials such as materials exchange networks and Habitat for Humanity. Include the name, location, and phone number for each reuse facility to be used, and provide a copy of the permit or license for each facility.

h. List of specific waste materials that will be salvaged for resale, salvaged and reused on the current project, salvaged and stored for reuse on a future project, or recycled. Recycling facilities that will be used shall be identified by name, location, and phone number, including a copy of the permit or license for each facility.

i. Identification of materials that cannot be recycled/reused with an explanation or justification, to be approved by the Contracting Officer 's Representative.

j. Description of the means by which any waste materials identified in item (h) above will be protected from contamination.

k. Description of the means of transportation of the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).

l. Anticipated net cost savings determined by subtracting Contractor program management costs and the cost of disposal from the revenue generated by sale of the materials and the incineration and/or landfill cost avoidance.

Revise and resubmit Plan as required by the Contracting Officer's Representative. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations or meeting project cumulative waste diversion requirement. Distribute copies of the Waste Management Plan to each subcontractor, the Quality Control Manager, and the Contracting Officer's Representative.

1.7 RECORDS

Records shall be maintained to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED GBDC and using the LEED NC Letter Template. The records shall be made available to the Contracting Officer's Representative during construction.

1.8 REPORTS

Provide quarterly reports and a final report to Contracting Officer's Representative. Quarterly and final reports shall include project name, information for waste generated this quarter, and cumulative totals for the project. Each report shall include supporting documentation to include manifests, weight tickets, receipts, and invoices specifically identifying the project and waste material. Include timber harvest and demolition

information, if any.

1.9 COLLECTION

Separate, store, protect, and handle at the site identified recyclable and salvageable waste products in a manner that maximizes recyclability and salvagability of identified materials. Provide the necessary containers, bins and storage areas to facilitate effective waste management and clearly and appropriately identify them. Provide materials for barriers and enclosures around recyclable material storage areas which are nonhazardous and recyclable or reusable. Locate out of the way of construction traffic. Provide adequate space for pick-up and delivery and convenience to subcontractors. Recycling and waste bin areas are to be kept neat and clean, and recyclable materials shall be handled to prevent contamination of materials from incompatible products and materials. Clean contaminated materials prior to placing in collection containers. Use cleaning materials that are nonhazardous and biodegradable. Handle hazardous waste and hazardous materials in accordance with applicable regulations and coordinate with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION. Separate materials by one of the following methods:

1.9.1 Source Separated Method.

Waste products and materials that are recyclable shall be separated from trash and sorted as described below into appropriately marked separate containers and then transported to the respective recycling facility for further processing. Deliver materials in accordance with recycling or reuse facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process). Separate materials into the following category types as appropriate to the project waste and to the available recycling and reuse programs in the project area:

a. Land clearing debris.

b. Asphalt.

c. Concrete and masonry.

d. Metal (e.g. banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized, stainless steel, aluminum, copper, zinc, lead brass, bronze).

   (1) Ferrous.

   (2) Non-ferrous.

e. Wood (nails and staples allowed).

f. Debris.

g. Glass (colored glass allowed).

h. Paper.

   (1) Bond.

   (2) Newsprint.

(3) Cardboard and paper packaging materials.

i. Plastic.

(1) Type 1: Polyethylene Terephthalate (PET, PETE).

(2) Type 2: High Density Polyethylene (HDPE).

(3) Type 3: Vinyl (Polyvinyl Chloride or PVC).

(4) Type 4: Low Density Polyethylene (LDPE).

(5) Type 5: Polypropylene (PP).

(6) Type 6: Polystyrene (PS).

(7) Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

j. Gypsum.

k. Non-hazardous paint and paint cans.

l. Carpet.

m. Ceiling tiles.

n. Insulation.

o. Beverage containers.

1.9.2 Co-Mingled Method.

Waste products and recyclable materials shall be placed into a single container and then transported to a recycling facility where the recyclable materials are sorted and processed.

1.9.3 Other Methods.

Other methods proposed by the Contractor may be used when approved by the Contracting Officer's Representative.

1.10 DISPOSAL

Control accumulation of waste materials and trash. Recycle or dispose of collected materials off-site at intervals approved by the Contracting Officer's Representative and in compliance with waste management procedures. Except as otherwise specified in other sections of the specifications, disposal shall be in accordance with the following:

1.10.1 Reuse.

First consideration shall be given to salvage for reuse since little or no re-processing is necessary for this method, and less pollution is created when items are reused in their original form. Coordinate reuse with the Contracting Officer's Representative.

1.10.2 Recycle.

Waste materials not suitable for reuse, but having value as being recyclable, shall be made available for recycling. All fluorescent lamps, HID lamps, and mercury-containing thermostats removed from the site shall be recycled through KSC Waste Management. Arrange for timely pickups from the site or deliveries to recycling facilities in order to prevent contamination of recyclable materials.

1.10.3 Compost

Consider composting on site if a reasonable amount of compostable material will be available. Compostable materials include plant material, sawdust, and certain food scraps.

1.10.4 Waste.

Materials with no practical use or economic benefit shall be disposed at a landfill or incinerator.

1.10.5 Return

Set aside and protect misdelivered and substandard products and materials and return to supplier for credit.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 75 00

STARTING AND ADJUSTING
05/12

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Operation and Maintenance Data

SD-02 Shop Drawings

Drawings, Diagrams and Schedules

Diagrams and Instructions

Coordination Drawings

Design Calculations

SD-03 Product Data

Catalog Cuts; G

Samples of Warranty Language

SD-06 Test Reports

Factory Tests; G

Functional Field Test; G

Final Acceptance Test,; G

Test Procedures; G

SD-09 Manufacturer's Field Reports

Documentation of the Testing and Verification Actions; G

SD-10 Operation and Maintenance Data

Safety and Security Data or Posters

1.2.1 Preconstruction and Pre-Testing Requirements

Deliver equipment and services to meet the requirements and specifications of their respective contract. Ensure all equipment is free of latent manufacturing and installation defects. The Government reserves the option to elect performance of acceptance testing by internal personnel, or a designated third party. Regardless of who performs the acceptance testing, ensure the requirements of acceptance are.

1.2.2 Shop Drawings and Diagrams

Submit the following shop drawings, record drawings, and diagrams as required to correctly execute the installation of the work:

a. Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work

b. Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project

c. Coordination drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated

1.2.3 Product and Design Data

Submit all product data and any design calculations, mix designs, analyses or other data to ensure a complete functional installation; including, but not limited to:

a. Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work

b. Samples of warranty language when the contract requires product warranties

c. Operation and maintenance data provided by the manufacturer to ensure the safe and efficient operation, maintenance and repair of the system or equipment provided

d. Safety and security data or posters provided by the manufacturer to be posted in a conspicuous visible location for operational and maintenance personnel

1.2.4 Tests Required

Perform tests to verify proper functioning of fire protection, fire suppression, HVAC, compressed air, electrical switchgear, protective relaying, fluid and gas systems, pump/motor combinations, boiler systems, hydraulic and pneumatic control, condition/performance monitoring systems, energy control and monitoring systems, and other assemblies and components that need to be tested as an interrelated whole.

1.2.4.1 Factory Tests

Submit certified copies of required tests performed at the factory to verify proper build. These test results will be used in the "Final

Acceptance Test" section to verify no shipping damage and proper installation.

1.2.4.2 Functional Field Test

Perform functional field tests to verify that the system and components have been properly installed and are functioning properly. Perform test(s) in the presence of the Contracting Officer's Representative. Acceptance will be issued when system has performed per other sections and referenced industry standards.

Coordinate and submit documentation of the testing and verification actions taken by manufacturer's representative at the job site, on a portion of the work, during installation, to confirm compliance with manufacturer's standards or instructions.

1.2.4.3 Final Acceptance Test

Perform a formal test with full documentation using the approved recording form. Contracting Officer's Representative will witness this test and issue a written final acceptance. Provide final test data to the Contracting Officer's Representative."

1.2.4.4 Test Procedures

Submit test procedure and recording forms that document the test steps for approval to the Contracting Officer's Representative 21 calendar days prior to the proposed test date. Ensure procedures clearly state step by step instruction to verify system parameters, components, and functions.

1.2.5 Commissioning

Refer to Section 01 91 13 Commissioning.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 78 00

CLOSEOUT SUBMITTALS
08/11

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

As-Built Record of Equipment and Materials
Warranty Management Plan
Warranty Tags
Spare Parts Data

SD-08 Manufacturer's Instructions

Preventative Maintenance
Condition Monitoring (Predictive Testing)
Inspection
Posted Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

SD-11 Closeout Submittals

Record Drawings; G
Certification of EPA Designated Items; G

1.2 PROJECT RECORD DOCUMENTS

1.2.1 Record Drawings

Drawings showing final as-built conditions of the project. This paragraph covers record drawings complete, as a requirement of the contract. The terms "drawings," "contract drawings," "drawing files," "working record drawings" and "final record drawings" refer to contract drawings which are revised to be used for final record drawings showing as-built conditions. The final CAD record drawings must consist of one set of electronic drawing files in the specified format, 2 sets of prints, and one set of the approved working Record drawings.

1.2.1.1 Government Furnished Materials

Two sets of electronic files in the specified software and format (drawing files to have a disc to include in the DRA) revised to reflect all bid amendments will be provided by the Government at the preconstruction conference for projects requiring file record drawings.

1.2.1.2 Working Record and Final Record Drawings

Revise 2 sets of paper drawings by red-line process to show the as-built conditions during the prosecution of the project. Keep these working as-built marked drawings current on a weekly basis and at least one set available on the jobsite at all times. Changes from the contract plans which are made in the work or additional information which might be uncovered in the course of construction must be accurately and neatly recorded as they occur by means of details and notes. Prepare final record (as-built) drawings after the completion of each definable feature of work as listed in the Contractor Quality Control Plan (Foundations, Utilities, Structural Steel, etc., as appropriate for the project). The working as-built marked prints and final record (as-built) drawings will be jointly reviewed for accuracy and completeness by the Contracting Officer's Representative and the Contractor prior to submission of each monthly pay estimate. If the Contractor fails to maintain the working and final record drawings as specified herein, the Contracting Officer's Representative will deduct from the monthly progress payment an amount representing the estimated cost of maintaining the record drawings. This monthly deduction will continue until an agreement can be reached between the Contracting Officer's Representative and the Contractor regarding the accuracy and completeness of updated drawings. Show on the working and final record drawings , but not limited to, the following information:

a. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, show by offset dimensions to two permanently fixed surface features the end of each run including each change in direction on the record drawings. Locate valves, splice boxes and similar appurtenances by dimensioning along the utility run from a reference point. Also record the average depth below the surface of each run.

b. The location and dimensions of any changes within the building structure.

c. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.

d. Changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor; including but not limited to fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment foundations, etc.

e. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.

f. Changes or modifications which result from the final inspection.

g. Where contract drawings or specifications present options, show only the option selected for construction on the final as-built prints.

h. Systems designed or enhanced by the Contractor, such as HVAC controls, fire alarm, fire sprinkler, and irrigation systems.

i. Modifications (include within change order price the cost to change

working and final record drawings to reflect modifications) and compliance with the following procedures.

(1) Follow directions in the modification for posting descriptive changes.

(2) Place a Modification Delta at the location of each deletion.

(3) For new details or sections which are added to a drawing, place a Modification Delta by the detail or section title.

(4) For minor changes, place a Modification Delta by the area changed on the drawing (each location).

(5) For major changes to a drawing, place a Modification Delta by the title of the affected plan, section, or detail at each location.

(6) For changes to schedules or drawings, place a Modification Delta either by the schedule heading or by the change in the schedule.

(7) The Modification Delta size shall be 1/2 inch diameter unless the area where the Delta is to be placed is crowded. Smaller size Delta shall be used for crowded areas.

1.2.1.3 Drawing Preparation

Modify the record drawings as may be necessary to correctly show the features of the project as it has been constructed by bringing the contract set into agreement with approved working as-built prints, and adding such additional drawings as may be necessary. These working as-built marked prints must be neat, legible and accurate. These drawings are part of the permanent records of this project and must be returned to the Contracting Officer's Representative after approval by the Government. Any drawings damaged or lost by the Contractor must be satisfactorily replaced by the Contractor at no expense to the Government.

1.2.1.4 Payment

No separate payment will be made for record drawings required under this contract, and all costs accrued in connection with such drawings are considered a subsidiary obligation of the Contractor.

1.2.2 As-Built Record of Equipment and Materials

Furnish one copy of preliminary record of equipment and materials used on the project 15 days prior to final inspection. This preliminary submittal will be reviewed and returned 2 days after final inspection with Government comments. Submit Two sets of final record of equipment and materials 10 days after final inspection. Key the designations to the related area depicted on the contract drawings. List the following data:

RECORD OF DESIGNATED EQUIPMENT AND MATERIALS DATA				
Description	Specification Section	Manufacturer and Catalog, Model, and Serial Number	Composition and Size	Where Used

1.2.3 Final Approved Shop Drawings

Furnish final approved project shop drawings 30 days after transfer of the completed facility.

1.2.4 Construction Contract Specifications

Furnish final record (as-built) construction contract specifications, including modifications thereto, 30 days after transfer of the completed facility.

1.2.5 Real Property Equipment

Furnish a list of installed equipment furnished under this contract. Include all information usually listed on manufacturer's name plate. In the "EQUIPMENT-IN-PLACE LIST" include, as applicable, the following for each piece of equipment installed: description of item, location (by room number), model number, serial number, capacity, name and address of manufacturer, name and address of equipment supplier, condition, spare parts list, manufacturer's catalog, and warranty. Furnish a draft list at time of transfer. Furnish the final list 30 days after transfer of the completed facility.

1.3 SPARE PARTS DATA

Submit two copies of the Spare Parts Data list.

a. Indicate manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

b. Return any spare material (ceiling tile, carpet, etc.) to Contracting Officer.

1.4 PREVENTATIVE MAINTENANCE

Submit Preventative Maintenance, Condition Monitoring (Predictive Testing) and Inspection schedules with instructions that state when systems should be retested.

a. Define the anticipated length of each test, test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements within the schedule. Provide a signoff blank for the Contractor and Contracting Officer's Representative for each test feature; e.g., gpm, rpm, psi. Include a remarks column for the testing validation procedure referencing operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Delineate procedures for preventative maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

b. Repair requirements must inform operators how to check out, troubleshoot, repair, and replace components of the system. Include electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting of the system after acceptance.

1.5 CERTIFICATION OF EPA DESIGNATED ITEMS

Submit the Certification of EPA Designated Items as required by FAR 52.223-9, "Certification and Estimate of Percentage of Recovered Material Content for EPA Designated Items". Include on the certification form the following information: project name, project number, Contractor name, license number, Contractor address, and certification. Record each product used in the project that has a requirement or option of containing recycled content in accordance with Section 01 33 29 LEED(TM) Documentation, noting total price, total value of post-industrial recycled content, total value of post-consumer recycled content and comments. Recycled content values may be determined by weight or volume percent, but must be consistent throughout.

1.6 WARRANTY MANAGEMENT

1.6.1 Warranty Management Plan

At least 30 days before the planned pre-warranty conference, submit one set of the warranty management plan. Include within the warranty management plan all required actions and documents to assure that the Government receives all warranties to which it is entitled. The plan must be in narrative form and contain sufficient detail to render it suitable for use by future maintenance and repair personnel, whether tradesmen, or of engineering background, not necessarily familiar with this contract. The term "status" as indicated below must include due date and whether item has been submitted or was accomplished. Warranty information made available during the construction phase must be submitted to the Contracting Officer's Representative for approval prior to each monthly pay estimate. Assemble approved information in a binder and turn over to the Government upon acceptance of the work. The construction warranty period will begin on the date of project acceptance and continue for the full product warranty period. A joint 4 month and 9 month warranty inspection will be conducted, measured from time of acceptance, by the Contractor, Contracting Officer's Representative and the Customer Representative. Include within the warranty management plan , but not limited to, the following:

a. Roles and responsibilities of all personnel associated with the warranty process, including points of contact and telephone numbers within the organizations of the Contractors, subContractors, manufacturers or suppliers involved.

b. Furnish with each warranty the name, address, and telephone number of each of the guarantor's representatives nearest to the project location.

c. Listing and status of delivery of all Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, transformers, and for all commissioned systems such as fire protection and alarm systems, sprinkler systems, lightning protection systems, etc.

d. A list for each warranted equipment, item, feature of construction or system indicating:

   (1) Name of item.
   (2) Model and serial numbers.

(3) Location where installed.
(4) Name and phone numbers of manufacturers or suppliers.
(5) Names, addresses and telephone numbers of sources of spare parts.
(6) Warranties and terms of warranty. Include one-year overall warranty of construction, including the starting date of warranty of construction. Items which have extended warranties must be indicated with separate warranty expiration dates.
(7) Cross-reference to warranty certificates as applicable.
(8) Starting point and duration of warranty period.
(9) Summary of maintenance procedures required to continue the warranty in force.
(10) Cross-reference to specific pertinent Operation and Maintenance manuals.
(11) Organization, names and phone numbers of persons to call for warranty service.
(12) Typical response time and repair time expected for various warranted equipment.

e. The Contractor's plans for attendance at the 4 and 9 month post-construction warranty inspections conducted by the Government.

f. Procedure and status of tagging of all equipment covered by extended warranties.

g. Copies of instructions to be posted near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

1.6.2 Pre-Warranty Conference

Prior to contract completion, and at a time designated by the Contracting Officer's Representative, meet with the Contracting Officer's Representative to develop a mutual understanding with respect to the requirements of this section. Communication procedures for Contractor notification of construction warranty defects, priorities with respect to the type of defect, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer's Representative for the execution of the construction warranty will be established/reviewed at this meeting. In connection with these requirements and at the time of the Contractor's quality control completion inspection, furnish the name, telephone number and address of a licensed and bonded company which is authorized to initiate and pursue construction warranty work action on behalf of the Contractor. This point of contact will be located within the local service area of the warranted construction, be continuously available, and be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of its responsibilities in connection with other portions of this provision.

1.6.3 Warranty Tags

At the time of installation, tag each warranted item with a durable, oil and water resistant tag approved by the Contracting Officer's Representative. Attach each tag with a copper wire and spray with a silicone waterproof coating. Also, submit two record copies of the warranty tags showing the layout and design. The date of acceptance and the QC signature must remain blank until the project is accepted for beneficial occupancy. Show the following information on the tag.

Type of product/material	
Model number	
Serial number	
Contract number	
Warranty period from/to	
Inspector's signature	
Construction Contractor	
Address	
Telephone number	
Warranty contact	
Address	
Telephone number	
Warranty response time priority code	
WARNING - PROJECT PERSONNEL TO PERFORM ONLY OPERATIONAL MAINTENANCE DURING THE WARRANTY PERIOD.	

1.7 COMMISSIONING

1.7.1 Building Commissioning

All contract requirements for building commissioning shall be completed prior to contract completion.

1.7.2 HVAC Commissioning

All contract requirements of Section 01 91 13 COMMISSIONING must be fully completed, including all testing concurrent with Building Commissioning. All contract requirements of Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC must be fully completed, including testing and inspection, prior to HVAC commissioning, except as noted otherwise in Section 23 05 93. All contract requirements of Section 23 09 33.13 98 ELECTRIC AND ELECTRONIC CONTROL SYSTEMS FOR HVAC and 23 09 23.13 20 PROGRAMMABLE LOGIC CONTROL (PLC) SYSTEMS FOR HVAC must be fully completed, including all testing, prior to HVAC commissioning. The time required to complete all work and testing as prescribed by Sections 01 91 13, 23 09 33.13 98 and 23 09 23.13 20 is included in the allotted calendar days for completion.

1.8 OPERATION AND MAINTENANCE MANUALS

Submit 6 copies of the project operation and maintenance manuals 30

calendar days prior to testing the system involved. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

1.8.1 Configuration

Operation and Maintenance Manuals must be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Bind information in manual format and grouped by technical sections. Test data must be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals must have 0.3937-inch holes and be bound in 3-ring, loose-leaf binders. Organize data by separate index and tabbed sheets, in a loose-leaf binder. Binder must lie flat with printed sheets that are easy to read. Caution and warning indications must be clearly labeled.

1.8.2 Training and Instruction

Submit classroom and field instructions in the operation and maintenance of systems equipment where required by the technical provisions. These services must be directed by the Contractor, using the manufacturer's factory-trained personnel or qualified representatives. Contracting Officer's Representative will be given 7 calendar days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor, such as lists, static exhibits, and visual aids, must be made available to the Contracting Officer's Representative.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA
07/06

PART 1 GENERAL

1.1 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system, stressing and enhancing the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation. The subcontractors must compile and prepare data and deliver to the Contractor prior to the training of Government personnel. The Contractor must compile and prepare aggregate O&M data including clarifying and updating the original sequences of operation to as-built conditions. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section and Section 01 33 00 SUBMITTAL PROCEDURES.

1.1.1 Package Quality

Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted.

1.1.2 Package Content

Comply with the data package requirements specified in the individual technical sections, including the content of the packages and addressing each product, component, and system designated for data package submission.

1.1.3 Changes to Submittals

Manufacturer-originated changes or revisions to submitted data must be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Submit changes, additions, or revisions required by the Contracting Officer's Representative for final acceptance of submitted data within 30 calendar days of the notification of this change requirement.

1.1.4 Review and Approval

The Government's Commissioning Authority (CA) must review the commissioned systems and equipment submittals for completeness and applicability as described in 01 91 13. The Government must verify that the systems and equipment provided meet the requirements of the Contract documents and design intent, particularly as they relate to functionality, energy performance, water performance, maintainability, sustainability, system cost, indoor environmental quality, and local environmental impacts. The CA must communicate deficiencies to the Contracting Officer's Representative. Upon a successful review of the corrections, the CA must recommend approval and acceptance of these O&M manuals to the Contracting Officer's Representative. This work is in addition to the normal review procedures for O&M data.

1.2 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

1.2.1 Operating Instructions

Include specific instructions, procedures, and illustrations for the following phases of operation for the installed model and features of each system:

1.2.1.1 Safety Precautions

List personnel hazards and equipment or product safety precautions for all operating conditions.

1.2.1.2 Operator Prestart

Include procedures required to install, set up, and prepare each system for use.

1.2.1.3 Startup, Shutdown, and Post-Shutdown Procedures

Provide narrative description for Startup, Shutdown and Post-shutdown operating procedures including the control sequence for each procedure.

1.2.1.4 Normal Operations

Provide narrative description of Normal Operating Procedures. Include Control Diagrams with data to explain operation and control of systems and specific equipment.

1.2.1.5 Emergency Operations

Include Emergency Procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include Emergency Shutdown Instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance and procedures for emergency operation of all utility systems including required valve positions, valve locations and zones or portions of systems controlled.

1.2.1.6 Operator Service Requirements

Include instructions for services to be performed by the operator such as lubrication, adjustment, inspection, and recording gage readings.

1.2.1.7 Environmental Conditions

Include a list of Environmental Conditions (temperature, humidity, and other relevant data) that are best suited for the operation of each product, component or system. Describe conditions under which the item equipment should not be allowed to run.

1.2.2 Preventive Maintenance

Include the following information for preventive and scheduled maintenance to minimize corrective maintenance and repair for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.2.2.1 Lubrication Data

Include preventative maintenance lubrication data, in addition to instructions for lubrication provided under paragraph titled "Operator Service Requirements":

a. A table showing recommended lubricants for specific temperature ranges and applications.

b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.

c. A Lubrication Schedule showing service interval frequency.

1.2.2.2 Preventive Maintenance Plan and Schedule

Include manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation and to minimize corrective maintenance. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

1.2.3 Corrective Maintenance (Repair)

Include manufacturer's recommended procedures and instructions for correcting problems and making repairs.

1.2.3.1 Troubleshooting Guides and Diagnostic Techniques

Include step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

1.2.3.2 Wiring Diagrams and Control Diagrams

Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation configuration and numbering.

1.2.3.3 Maintenance and Repair Procedures

Include instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards.

1.2.3.4 Removal and Replacement Instructions

Include step-by-step procedures and a list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions shall include a combination of text and illustrations.

1.2.3.5 Spare Parts and Supply Lists

Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead-time to obtain.

1.2.4 Corrective Maintenance Work-Hours

Include manufacturer's projection of corrective maintenance work-hours including requirements by type of craft. Corrective maintenance that requires completion or participation of the equipment manufacturer shall be identified and tabulated separately.

1.2.5 Appendices

Provide information required below and information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Include the following:

1.2.5.1 Product Submittal Data

Provide a copy of all SD-03 Product Data submittals required in the applicable technical sections.

1.2.5.2 Manufacturer's Instructions

Provide a copy of all SD-08 Manufacturer's Instructions submittals required in the applicable technical sections.

1.2.5.3 O&M Submittal Data

Provide a copy of all SD-10 Operation and Maintenance Data submittals required in the applicable technical sections.

1.2.5.4 Parts Identification

Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies in accordance with the manufacturer's standard practice. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as typically shown in a master parts catalog

1.2.5.5 Warranty Information

List and explain the various warranties and clearly identify the servicing and technical precautions prescribed by the manufacturers or contract documents in order to keep warranties in force. Include warranty information for primary components such as the compressor of air conditioning system.

1.2.5.6 Personnel Training Requirements

Provide information available from the manufacturers that is needed for use in training designated personnel to properly operate and maintain the equipment and systems.

1.2.5.7 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.2.5.8 Testing and Performance Data

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms.

1.2.5.9 Contractor Information

Provide a list that includes the name, address, and telephone number of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name address and telephone number of the manufacturer's representative and service organization that can provide replacements most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

1.3 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Furnish the O&M data packages specified in individual technical sections. The required information for each O&M data package is as follows:

1.3.1 Data Package 1

a. Safety precautions

b. Cleaning recommendations

c. Maintenance and repair procedures

d. Warranty information

e. Contractor information

f. Spare parts and supply list

1.3.2 Data Package 2

a. Safety precautions

b. Normal operations

c. Environmental conditions

d. Lubrication data

e. Preventive maintenance plan and schedule

f. Cleaning recommendations

g. Maintenance and repair procedures

h. Removal and replacement instructions

i. Spare parts and supply list

j. Parts identification

k. Warranty information

l. Contractor information

1.3.3 Data Package 3

a. Safety precautions

b. Operator prestart

c. Startup, shutdown, and post-shutdown procedures

d. Normal operations

e. Emergency operations

f. Environmental conditions

g. Lubrication data

h. Preventive maintenance plan and schedule

i. Cleaning recommendations

j. Troubleshooting guides and diagnostic techniques

k. Wiring diagrams and control diagrams

l. Maintenance and repair procedures

m. Removal and replacement instructions

n. Spare parts and supply list

o. Product submittal data

p. O&M submittal data

q. Parts identification

r. Warranty information

s. Testing equipment and special tool information

t. Testing and performance data

u. Contractor information

1.3.4 Data Package 4

a. Safety precautions

b. Operator prestart

c. Startup, shutdown, and post-shutdown procedures

d. Normal operations

e. Emergency operations

f. Operator service requirements

g. Environmental conditions

h. Lubrication data

i. Preventive maintenance plan and schedule

j. Cleaning recommendations

k. Troubleshooting guides and diagnostic techniques

l. Wiring diagrams and control diagrams

m. Maintenance and repair procedures

n. Removal and replacement instructions

o. Spare parts and supply list

p. Corrective maintenance man-hours

q. Product submittal data

r. O&M submittal data

s. Parts identification

t. Warranty information

u. Personnel training requirements

v. Testing equipment and special tool information

w. Testing and performance data

x. Contractor information

1.3.5 Data Package 5

a. Safety precautions

b. Operator prestart

c. Start-up, shutdown, and post-shutdown procedures

d. Normal operations

e. Environmental conditions

f. Preventive maintenance plan and schedule

g. Troubleshooting guides and diagnostic techniques

h. Wiring and control diagrams

i. Maintenance and repair procedures

j. Removal and replacement instructions

k. Spare parts and supply list

l. Product submittal data

m. Manufacturer's instructions

n. O&M submittal data

o. Parts identification

p. Testing equipment and special tool information

q. Warranty information

r. Testing and performance data

s. Contractor information

1.4 COMMISSIONING

Refer to Section 01 91 13 Commissioning.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

01 91 13

COMMISSIONING

PART 1 GENERAL

The requirements of this Section apply to, and are a component part of, each section of the specifications.

This Section includes:

a. Building commissioning of the following systems:

(1) HVAC components and equipment, including air handling units, fans, boilers, heat exchangers, chilled beams, pumps, piping, ductwork, terminal equipment, and fuel oil systems

(2) Building Automation System (BAS) and Programmable Logic Controllers (PLC): control hardware and software, sequence of operations, integration of factory controls with BAS/PLC, and integration of BAS and PLC

(3) Lighting Controls

(4) Domestic hot water systems, including water heaters, pumps, piping, and accessories

(5) Fire Protection systems, including wet pipe sprinkler and clean agent suppression systems

(6) Electrical Power Distribution systems, including emergency generators, transfer switches, switchgear, panelboards, transformers, Uninterruptible Power Supplies (UPS), raceway, busducts, and wiring

(7) Fire Alarm System

(8) Security System

(9) Building Exterior Enclosure, including roofing, exterior walls, glazing, foundation damproofing/waterproofing, and air barriers

b. Building commissioning activities and documentation in support of the U.S. Green Building Council (USGBC) LEED™ rating program. Commissioning activities and documentation include the section on "Energy and Atmosphere" prerequisite of "Fundamental Building Systems Commissioning" and the section on "Enhanced Commissioning."

The Government, Architect/Engineer, nor Commissioning Agent are not responsible for construction means, methods, job safety, or management function related to commissioning on the job site.

The commissioning process does not take away from or reduce the responsibility of the system designers or installing Contractors to provide a finished and fully functioning product.

The following Sections are an integral part of this project Commissioning:

a. Section 01 45 00.00 40 QUALITY CONTROL

b. Section 01 75 00 STARTING AND ADJUSTING

c. Section 01 78 23 OPERATION AND MAINTENANCE DATA

d. Section 07 27 00.45 10 BUILDING AIR BARRIER SYSTEM

e. Section 07 27 26 FLUID-APPLIED MEMBRANE AIR BARRIERS

f. Section 07 52 00 MODIFIED BITUMINOUS MEMBRANE ROOFING

g. Section 08 44 00 CURTAIN WALL AND GLAZED ASSEMBLIES

f. Section 22 00 00 PLUMBING, GENERAL PURPOSE

g. Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS

h. Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS

i. Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

j. Section 23 09 23.13 20 PROGRAMMABLE LOGIC CONROL (PLC) SYSTEMS FOR HVAC

k. Section 23 09 33.13 98 ELECTRIC AND ELECTRONIC CONTROL SYSTEMS FOR HVAC

l. Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS

m. Section 26 08 00 APPARATUS INSPECTION AND TESTING

1.1 DEFINITIONS

a. Basis of Design - The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the Project Requirements. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the Project Requirements may be included.

b. Commissioning - Commissioning is a comprehensive and systematic process to verify that the building systems perform as designed to meet the requirements. Commissioning during the construction, acceptance, and warranty phases intends to achieve the following specific objectives:

(1) Verify and document that equipment is installed and started per manufacturer's recommendations, industry accepted minimum standards, and the Contract Documents.

(2) Verify and document that equipment and systems receive complete operational checkout by the installing Contractors.

(3) Verify and document equipment and system performance.

(4) Verify the completeness of Operations and Maintenance materials.

(5) Ensure that the operating personnel are adequately trained on the

operation and maintenance of the building equipment.

c. Commissioning Agent - the designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process.

d. Commissioning Plan - an overall plan that provides the structure, schedule and coordination planning for the commissioning process.

e. Deficiency - a condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents, does not perform properly, or is not complying with the Project Requirements.

f. Project Requirements - a dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the Government. It is initially the outcome of the programming and conceptual design phases.

g. Functional Performance Test - test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word.

h. Integrated System Test: A test to verify functionality of all commissioned systems simultaneously, including interactions between systems, and dynamic responses between systems to various actions and loads.

i. Manual Test - using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").

j. Monitoring - the recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of control systems.

k. Pre-functional Checklist - a list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the Commissioning Agent to the Contractor. Pre-functional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some pre-functional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The word "pre-functional" refers to before functional testing. Pre-functional checklists augment and are combined with the manufacturer's start-up checklist.

l. Seasonal Performance Tests - Functional Performance Test that are deferred until the system(s) will experience conditions closer to their design conditions.

m. Warranty Period - warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

1.2 Administrative Requirements

Expedite the commissiong process and minimize unnecessary delays, while not compromising the integrity of the procedures. The commissioning requires cooperation of the Contractor, Subcontractors, vendors, Architect/Engineer, Commissioning Agent, Green Consultant, and Contracting Officer.

1.2.1 Co-ordination

The Commissioning Agent will be an independent consultant of the Government. The Contractor shall coordinate with the Commissioning Agent for overall co-ordination and management of the commissioning program. The commissioning team comprises the following groups:

a. Contractors Project Manager, Superintendent and Test Engineer

b. Sub-Contractor for the System being Commissioned

c. Suppliers and Installers for the System being Commissioned

d. Commissioning Agents Project Manager and Project Engineers

e. Contracting Officers Representative

f. Green Consultant

g. Architect/Engineer and Specialty Consultant

1.2.2 Commissioning Meetings

Plan and co-ordinate periodic commissioning meetings as required to monitor construction and commissioning progress of the work. An initial Scoping/Kickoff meeting will be conducted early in the construction phase to discuss the commissioning process with the commissioning team. Periodic commissioning meetings shall include regular commissioning progress meetings as well as special meetings where needed. Notify the Contracting Officer of construction job-site meetings to address co-ordination, deficiency resolution and planning issues.

1.2.3 Functional Testing Co-ordination

Do **not** "temporarily" start equipment for commissioning. Do not conduct functional performance testing until a pre-functional, start-up and TAB is completed for a given system. Do not functionally test the controls system and equipment it controls until all points have been calibrated and the pre-functional checklists are completed.

1.3 SUBMITTALS

a. Provide one copy of each submittal for equipment related to commissioned systems to the Commissioning Agent at the time it is submitted to the Architect. The Contractor shall include all information necessary to prepare startup checklists and functional performance test procedures, including performance data, sequences of operation, and manufacturer's startup checklists. The Commissioning Agent will forward any submittal comments to the Architect prior to the submittals being returned to the Contractor. The Commissioning Agent may request additional submittal information from the Contractor needed to complete the commissioning process. The Contractor shall gather the requested information and resubmit it to the Commissioning Agent

b. Submit results and reports from all factory, manufacturer startup or special field-testing services within seven days of completion.

c. Government approval is required for submittals with a "G" designtation; submittals not having a "G" designtation are for the Commissioning Agent only. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

c. CERTIFICATES OF READINESS: Contractor shall submit Certificates of Readiness (see form at the end of this section).

1.4 SCHEDULE

Include all key commissioning activities and prerequisite construction activities in the overall construction schedule, including logic ties and durations. Coordinate with the Commissioning Agent to identify items to incorporate into schedule. The schedule shall allow sufficient time to complete the functional and integrated system testing, including resolution of any deficiencies and retesting, prior to Substantial Completion.

1.6 NOTIFICATIONS

Notify Commissionign Agent at least seven (7) days in advance of all of the following activities:

a. Duct or pipe pressure/leak testing

b. Pipe flushing

c. Field Testing of electrical equipment, wiring, etc.

d. Equipment Startup

e. Exterior enclosure testing

PART 2 PRODUCTS

Provide all standard testing equipment required for performing startup and initial checkout and required functional performance testing for the system. Datalogging equipment or software required to test equipment will be provided by the Commissioning Agent.

PART 3 EXECUTION

3.1 COMMISSIONING PROCESS

The Commissioning Agent coordinates all activities. The following activities outline the commissioning tasks and the general order in which they occur.

a. Commissioning Scoping/Kickoff Meeting

b. Commissioning Plan and Guidelines

c. Submittals Review

d. Periodic site visits to observe construction and related testing, flushing, etc. The Commissioning Agent will issue written field reports after each site visit. The Contractor shall provide written responses to each field report item within seven (7) days. Any items that require interpretation by the Architect/Engineer shall be transmitted to the Architect for review.

e. Start-Up/Pre-Functional Checklists

f. Functional Performance Testing

g. Integrated System Testing

h. Short-Term Diagnostic Testing and Trending

i. Correction of Deficiencies and any Restesting

j. Operations and Maintenance Training

k. Record Documents Review

l. Final Commissioning Report and LEED™ Documentation

m. Deferred testing due to unforeseen deferred tests, seasonal testing and end of Warranty review.

3.2 FUNCTIONAL PERFORMANCE TESTING

3.2.1 Prerequisites for Testing

Confirm that the system to be tested is complete and ready for testing, and submit a Certificate of Readiness (form supplied at end of this section) to the Commissioning Agent, who will verify the system is ready for functional testing.

Specifically verify the following have been completed:

a. All pressure and leak testing and pipe flushing are complete

b. All component level testing specified in other specification sections is complete, with reports submitted to the Commissioning Agent

c. Manufacturer startup and/or field testing completed, with reports submitted to the Commissioning Agent

d. For HVAC systems, Test and Balance is complete and report submitted to Commissioning Agent

e. For controls systems, all sensors have been field-calibrated, all point-to-point checks completed, all sequences checked, all devices checked, and graphical user interfaces implemented.

f. Contractor has checked system for proper function

3.2.2 Test Methods

Methods for functional performance testing and verification include direct manipulation of system inputs (i.e. heating or cooling sensors), manipulation of system inputs with the building automation system (i.e. software override of sensor inputs), trend logs of system inputs and outputs using the building automation system, or short-term monitoring of system inputs and outputs using stand alone data loggers. The Commissioning Agent determines which method, or combination of methods, is most appropriate. The Commissioning Agent will develop written functional test procedures for each commissioned system once all submittals have been approved. The commissioning agent will send copies of all test procedures to the contractor for review in advance of testing.

3.2.3 Setup

Perform each test procedure under conditions that simulate normal operating conditions as closely as possible. Where equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met, have functional performance test procedures demonstrate the actual performance of safety shutoffs in a real or closely-simulated conditions of failure.

3.2.4 Direction

The Commissioning Agent shall witness and direct all functional testing. Contractor shall provide responsible parties from the applicable system to be tested, including subcontractors and vendors/installers.

3.2.5 Functional Performance Testing Basic Scope

Coordinate, observe and record the results of the functional performance testing. Coordinate retesting as necessary until satisfactory performance is verified. Verify the intended operation of individual components and system interactions under various conditions and modes of operation.

a. HVAC and Controls:

(1) Verify calibration of all sensors (temperature, pressure, humidity, etc.).

(2) Verify operation of all devices (valves, dampers, etc.).

(3) Verify correct communication and data point mapping between equipment controls (e.g. chillers) and BAS.

(4) Verify correct communication with remote facilities.

(5) Test all operating modes, interlocks, control responses,

responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

(6) Verify proper responses to component failures for each component (e.g. pumps, air handling units, control panels, sensors, etc.).

(7) Verify functionality of HVAC systems during integrated systems testing, including ability to maintain space temperature and humidity within limits under design loa.

(8) Verify correct communication and data point mapping between equipment controls and BAS.

(9) Verify correct communication with remote facilities.

(10) Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

b. Plumbing:

(1) Testing scope shall include central equipment for water heating through distribution systems to each fixture. It shall include measuring capacities and effectiveness of operational and control functions.

(2) Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of system controllers and sensors.

(3) Verify correct communication and interface with BAS.

c. Electrical:

(1) Commissioning Agent will witness Contractor-provided testing such as load bank testing, impedance testing, infrared thermography, etc.

(2) Commissioning Agent will witness Contractor-provided Integrated Power System Test specified in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

(3) Verify functionality of electrical power distribution systems during integrated systems testing.

(3) Test emergency power system for functionality of all components and automatic transfer upon loss of normal power, and verify all equipment in building on emergency power continues to operate.

(4) Test all lighting controls for proper programming, setpoints, function, and operation, including manual switches, occupancy/vacancy sensors, timers, daylight-responsive controls, programmed controls, and interfaces with the building automation system.

(5) Commissioning Agent will witness fire alarm system testing performed by the Contractor and Owner.

(6) Commissioning Agent will witness security alarm system testing

performed by the Contractor and Owner.

d. Fire Protection:

(1) Commissioning Agent will witness fire protection system testing performed by the Contractor and Owner.

e. Exterior Enclosure:

(1) CA will witness air barrier testing performed under Section 07 27 00.45 10. Acceptable leakage shall be no more than .25 CFM/SF of exterior envelope. Contractor shall investigate source of air leakage if testing does not meet this criteria, seal any leaks found, and retesting shall be performed until accepted.

(2) Perform spray testing of exterior walls, storefronts, and curtainwalls to verify no water penetration through assemblies.

(3) Perform hose testing of roofs to verify no water penetration.

(4) Commissioning Agent will provide spray nozzles for testing. Contractor shall provide water source connection and ¾" hoses of sufficient length to test all areas of building.

(5) Contractor shall correct any leakage points found, and retest will be performed.

(6) Commissioning Agent will perform infrared thermography examination of roof and exterior walls to identify any potential thermal or moisture issues.

3.3 SHORT-TERM DIAGNOSTIC TESTING/TRENDING

After initial occupancy, perform short-term diagnostic testing, using the building automation system to record system operation over a four week period.

The HVAC controls subcontractor shall setup all trend points at the direction of the Commissioning Agent, and ensure that sufficient storage exists to store trend data.

The Contractor shall retrieve all trend data files at the end of the diagnostic period in a format suitable for direct import to Microsoft Excel, and send to the Commissioning Agenet.

The Commissioning Agent will review the trend data and identify any indications of potential issues with the commissioned systems. Potential issues may require further investigation or testing.

3.4 DEFICIENCY REPORT AND RESOLUTION RECORD

Document items of non-compliance in materials, installation or operation.

3.4.1 Non-Conformance

Immediately address observed non-conformance and deficiencies in terms of notification to responsible parties, and provide recommended actions to correct deficiencies.

Corrections of minor deficiencies identified may be made during the tests at the discretion of the Commissioning Agent. In such cases document the deficiency and resolution on the procedure form.

3.4.1.1 Identified Deficiencies Correction Procedure

If there is no dispute on the deficiency and the responsibility to correct it:

a. The Commissioning Agent documents the deficiency and the adjustments or alterations required to correct it. The Contractor corrects the deficiency and notifies the Commissioning Agent that the equipment is ready to be retested.

b. The Commissioning Agent reschedules the test and the test is repeated.

If there is a dispute about a deficiency or who is responsible:

a. The deficiency is documented on the non-compliance form and a copy given to the Design Team.

b. Resolutions are made at the lowest management level possible. Additional parties are brought into the discussions as needed. Contractor has responsibility for resolving construction deficiencies. If a design revision is deemed necessary and approved by the Contracting Officer, the Architect/Engineer has responsibility for providing a design revision.

c. The Commissioning Agent documents the resolution process.

d. Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency and notifies the Commissioning Agent that the equipment is ready to be retested. The Commissioning Agent reschedules the test and the test is repeated until satisfactory performance is achieved.

The Contractor is responsible for retesting costs.

3.5 OPERATIONS AND MAINTENANCE TRAINING

a. The Contractor shall develop a schedule for training. All training shall be conducted during normal working hours (Monday through Friday between 9:00AM and 5:00PM) and shall involve Owner's staff and consultants. Notification shall occur no later than seven business days before day of training..

b. Training Preparation Conference: Before operation and maintenance training, CxA shall convene a training preparation conference to include Owner's operation and maintenance personnel, Contractor, and subcontractors. Perform the following:

1. Review the OPR and BoD.
2. Review installed systems, subsystems, and equipment.
3. Review instructor qualifications.
4. Review instructional methods and procedures.
5. Review training module outlines and contents.
6. Review course materials (including operation and maintenance manuals).
7. Inspect and discuss locations and other facilities required for instruction.

8. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

c. Training Modules: The commissioning team shall jointly develop an instruction program that includes individual training modules for each system, subsystem, and equipment. The Contractor shall provide manufacturer's representatives for each of the following pieces of equipment to conduct training for the Owner's staff:

1. Generators
2. UPS
3. Switchgear
4. Air Handling Units
5. Chillers
6. Building Automation System

d. Training materials shall be sent to Owner at last seven business days in advance of training so that Owner can review materials in advance of training. Submit five (5) hard copies and one (1) electronic copy of all materials. Materials shall include, at a minimum, equipment catalog data, operating and maintenance manuals, preventive maintenance requirements, warranty information, and project-specific data pertinent to each piece of equipment such as settings, sequences of operation, etc.

3.6 FINAL COMMISSIONING REPORT AND LEED™ DOCUMENTATION

The Commissioning Agent will compile and submit a Final Commissioning Report. Summarize all of the tasks, findings, conclusions, and recommendations of the commissioning process.

3.7 DEFERRED AND SEASONAL TESTING

3.7 Unforeseen Deferred Tests

If a test cannot be completed due to the building structure, required occupancy condition, or other deficiency, the functional testing may be delayed upon recommendation of the Commissioning Agent and the approval of the Contracting Officer. Conduct these tests in the same manner as the seasonal tests as soon as possible.

3.8 Deferred Tests

Schedule, coordinate, observe, and document additional testing for seasonal variation in operations and control strategies during the opposite season to verify performance of the HVAC system and controls. Complete testing during the warranty period to fully test all sequences of operation.

3.7.3 End-of-Warranty Review

Conduct end of warranty review prior to the end of the warranty period. Review the current building operation with the facility maintenance staff. Include in the review all outstanding issues from original or seasonal testing. Interview facility staff to identify concerns with

building operation. Provide suggestions for improvements and assist Contracting Officer in developing reports or documentation to remedy problems.

Update O&M manuals and Record Documents as necessary due to the testing.

3.9 CERTIFICATES OF READINESS

CERTIFICATES OF READINESS
Contractor has verified that the following prerequisite items have been completed in preparation for the functional testing phase of the commissioning process.
System to Be Commissioned: _____

The system to be commissioned, including all equipment, ductwork, piping, electrical, plumbing, and interfaces to other systems is complete, installed per the Contract Documents, and any issues previously identified by the Commissioning Team have been addressed.

All equipment has been properly started up by qualified personnel. Where specified, the startup was conducted by the manufacturer. Startup procedures and reports have been documented and provided to the CxA.

For HVAC systems, all duct pressure testing, duct cleaning, pipe pressure testing, and pipe flushing has been completed according to the Contract Documents.

For HVAC systems, the Test and Balance work is complete, all issues have been corrected, and a final (draft) report has been provided to the CxA.

For electrical systems, all specified testing of components, cables, instruments, etc. has been completed and reports have been provided to the CxA.

For Building Automation system (BAS), the BAS contractor has completed their own checkout procedures, including but not limited to the following:

" Calibration of all sensors.
" Point-to-Point checks of all sensors and devices.
" Checks of all devices (dampers, control valves, etc.) for proper operation, fail position, and verification of no leakage.
" Programming of all sequences of operations, alarms, and setpoints.
" Completion and check of all graphics.
" Interface with other systems (lighting, plumbing, metering, etc.).

All equipment and systems are online and operating with no restrictions for testing.

All necessary notifications, coordination and scheduling have been considered that might be required for functional testing of this system (e.g. Owner, Fire Marshall, Occupants, etc.).

Attach a list any known exceptions or outstanding issues related to the above statements.

List name, title, company, date:

_____

I have verified that the above statements are true and that the system is

ready for functional testing by the CxA, except for those items noted as attached. I understand that if it is found that the system has not been properly prepared as per the above, necessitating one or more return site visits by the CxA, the Construction Team may be charged by the Owner for the CxA's additional time, including travel time plus travel expenses.

Signature: _____

-- End of Section --

SECTION 02 41 00

DEMOLITION
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.6	(2006) Safety Requirements for Demolition Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2008; Errata 1-2010; Changes 1-3 2010; Changes 4-6 2011; Change 7 2012) Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61	National Emission Standards for Hazardous Air Pollutants

1.2 PROJECT DESCRIPTION

1.2.1 Demolition/Deconstruction Plan

Demolition of existing facilities shall be in accordance with these Contract Documents. Please refer to Demolition Plans for details.

1.2.2 General Requirements

Do not begin demolition until authorization is received from the Contracting Officer. The work includes demolition and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer. In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections.

1.3 ITEMS TO REMAIN IN PLACE

Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government. Repair or replace damaged items as approved by the Contracting Officer. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements and/or pavements to remain. Provide new

supports and reinforcement for existing construction weakened by demolition or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

1.3.1 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove dust, dirt, and debris from work areas daily.

1.3.2 Trees

Protect trees within the project site which might be damaged during demolition and which are indicated to be left in place, by a 6 foot high fence. Erect and secure fence a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Contracting Officer.

1.3.3 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition operations. Prior to start of work, utilities serving each area of alteration or removal will be shut off by the Government and disconnected and sealed by the Contractor.

1.3.4 Facilities

Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Contracting Officer. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.4 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Construction Survey and Photographs

SD-11 Closeout Submittals

Receipts

1.6 QUALITY ASSURANCE

Notify the State's environmental protection agency and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSE/SAFE A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives will not be permitted.

1.6.1 Dust and Debris Control

Prevent the spread of dust and debris to occupied portions of the project site and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. Sweep pavements as often as necessary to control the spread of debris.

1.7 PROTECTION

1.7.1 Traffic Control Signs

a. Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Notify the Contracting Officer prior to beginning such work.

1.8 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Repair or replace items to be relocated which are damaged by the Contractor with new undamaged items as approved by the Contracting Officer.

1.9 EXISTING CONDITIONS

Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs sized 4 inch will be acceptable as a record of existing conditions. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to before starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit pre-construction survey and photographs.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures onsite for reuse. Existing construction scheduled to be removed for reuse shall be disassembled. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Materials shall be designated for reuse onsite whenever possible.

3.1.1 Utilities and Related Equipment

3.1.1.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.1.2 Disconnecting Existing Utilities

Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer. When utility lines are encountered but are not indicated on the drawings, notify the Contracting Officer prior to further work in that area. Remove meters and related equipment and deliver to a location in accordance with instructions of the Contracting Officer.

3.1.2 Chain Link Fencing

Remove chain link fencing, gates and other related salvaged items scheduled for removal and transport to designated areas. Remove gates as whole units. Cut chain link fabric to 25 foot lengths and store in rolls off the ground.

3.1.3 Paving and Slabs

Remove concrete and asphaltic concrete paving and slabs as indicated. Provide neat sawcuts at limits of pavement removal as indicated.

3.1.4 Items With Unique/Regulated Disposal Requirements

Remove and dispose of items with unique or regulated disposal requirements in the manner dictated by law or in the most environmentally responsible manner.

3.2 CONCURRENT EARTH-MOVING OPERATIONS

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition work in areas occupied until all demolition

in the area has been completed and debris removed. Fill holes and other hazardous openings.

3.3 DISPOSITION OF MATERIAL

3.3.1 Title to Materials

Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, shall become the property of the Contractor and shall be removed from Government property. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition and removal procedures, and authorization by the Contracting Officer to begin demolition. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited. Submit receipts or bills of lading for materials removed and disposed of from the project site.

3.4 CLEANUP

Remove debris and rubbish from the project site. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from demolition operations in accordance with all applicable federal, state and local regulations.

3.5.2 Burning on Government Property

Burning of materials removed from demolished facilities.

3.5.3 Removal from Government Property

Transport waste materials removed from demolished structures, except waste soil, from Government property for legal disposal. Dispose of waste soil as directed by the Contracting Officer.

-- End of Section --

SECTION 03 01 30.71

CONCRETE REHABILITATION
04/06

PART 1 GENERAL

This specification section is provided in the event that existing concrete is damaged and rehabilitation is required.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 31/C 31M	(2009) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 39/C 39M	(2009a) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

1.2 DEFINITIONS

1.2.1 Epoxy Resin Binder

A two-component epoxy bonding system in low and medium viscosities used by itself as a primer or for producing epoxy concrete or mortars when mixed with aggregate.

1.2.2 Epoxy Concrete

A combination of epoxy resin binder and fine and coarse aggregate.

1.2.3 Epoxy Mortar

A combination of epoxy resin binder and fine aggregate used in the surface repair of non-structural cracks and filling of saw kerfs.

1.2.4 Non-Pressure Epoxy Grout

A combination of epoxy resin binder, a mineral filler and a thixotropic agent used in cementing dowels in place and the repair of non-structural cracks.

1.2.5 Pressure Grouting Epoxy

A low viscosity epoxy resin system pumped under pressure.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-05 Design Data

Job mix formula

SD-07 Certificates

Epoxy resin binder

Epoxy grout

SD-08 Manufacturer's Instructions

Epoxy resin binder for concrete and mortar

Non-pressure epoxy grout

Crack sealer for pressure grouting

Crack surface sealer for pressure grouting

1.4 QUALITY ASSURANCE

1.4.1 Design Data

1.4.1.1 Job Mix Formula

Submit at least 15 days before work commences, a job-mix formula for each use of epoxy concrete or epoxy mortar. Test reports shall accompany the mix design. Identify the proposed source of the materials and state the proportions of aggregates and epoxy resin. When determining job mix, use samples of materials to be used on the job.

a. Trial batches: Perform a minimum of three trial batchings in a certified testing laboratory. Try different aggregate-resin proportions to obtain satisfactory placing and finishing characteristics but keep the proportion by weight of aggregate to epoxy resin binder at least five to one. When mixing, add the fine aggregates first, and then the coarse aggregates. The final trial batch should be sufficiently wet so that some fines will "bleed" to the surface during finishing operations.

b. Supporting criteria: Include in the submittal the following data for each trial batch:

(1) Proportions by weight

(2) Unit weights and specific gravities of constituents
(3) Batch weights

(4) Compressive strengths of 3 by 6 inch cylinders, made in accordance with ASTM C 31/C 31M, air cured for 7 days and tested in accordance with ASTM C 39/C 39M. Compressive strength shall be

a minimum of 7000 psi.

(5) Curing time

1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to site for damage, unload and store with a minimum of handling. Deliver epoxy resin components and aggregate materials in original sealed containers and store in dry covered areas at temperatures below 90 degrees F. Remove from job site unused mixed materials which have reached end of working or pot life.

1.6 WEATHER LIMITATIONS

Halt work when weather conditions detrimentally affect the quality of patching or bonding concrete. Apply epoxy resin materials only when the contact surfaces are completely dry and if the atmospheric and surface temperature ranges are suitable for the specified epoxy material. Follow manufacturer's instructions for weather conditions and temperature ranges.

1.7 EQUIPMENT

Use a container recommended by the epoxy manufacturer as the mixing vessel. Use a power drive (air or spark-proof) propeller type blade for mixing except that hand mixing may be used for small batches. Use equipment specified by epoxy manufacturer for field mixing of aggregates and epoxy resin.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Epoxy

2.1.1.1 Epoxy Resin Binder for Concrete and Mortar

ASTM C 881/C 881M, Type III, Grade 1, Class B or C without mineral filler. For walls and ceilings use ASTM C 881/C 881M, Type III, Grade 3, Class B or C with filler.

2.1.1.2 Non-Pressure Epoxy Grout

ASTM C 881/C 881M Type IV, Grade 2, Class B or C with or without mineral filler.

2.1.1.3 Crack Sealer for Pressure Grouting

ASTM C 881/C 881M, Type IV, Grade 1, Class B or C without filler.

2.1.1.4 Crack Surface Sealer for Pressure Grouting

ASTM C 881/C 881M, Type IV, Grade 3, Class B or C with mineral filler.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Epoxy Concrete

3.1.1.1 Patch Areas

Remove loose concrete from the spalled areas indicated. Inspect the cavity for remaining defective concrete by tapping with a hammer or steel rod and listening for dull or hollow sounds. In areas where tapping does not produce a solid tone, remove additional concrete until testing produces a solid tone. Make the entire cavity at least one inch deep. Sawcut edges of cavity to avoid feather edging. Prepare surface of cavity by sandblasting, grinding, or water blasting. Remove dust, dirt, and loosely bonded material resulting from cleaning. Ensure cavity surfaces are dry.

3.1.1.2 Spalls at Joints and Cracks

For spalls to be repaired that are adjacent to joints and working cracks insert preformed joint filler to the working faces of the spall. Trim filler to fit shape of the working faces of joint or crack so epoxy material is prevented from bypassing filler. Where practicable, extend filler horizontally and vertically into joint or crack opening. Secure filler strip in place prior to and during placement of epoxy concrete. Apply a bond breaker to working faces at keyed joints. Keep bond breaker off of concrete surface to be bonded. After the epoxy concrete has completely cured, saw out the top inch of the preformed joint filler and install liquid joint sealer.

3.1.2 Epoxy Mortar for Cracks and Saw Kerfs

Use epoxy mortar to repair cracks and saw kerfs that have loose or unsound materials. Prepare surfaces by sandblasting, scarifying or waterblasting. Remove dust, dirt, and loosely bonded material resulting from cleaning. Ensure surfaces are dry before application of epoxy mortar.

3.1.3 Epoxy Grout for Cracks

Use epoxy grout to repair cracks and saw kerfs that are free of loose or unsound materials. Prepare surfaces by sandblasting, scarifying or waterblasting. Remove dust, dirt, and loosely bonded material resulting from cleaning. Ensure surfaces are dry before application of epoxy grout.

3.2 MIXING MATERIALS

Make batches small enough to ensure placement before binder sets. Mix materials in accordance with manufacturer's recommendations.

3.3 PLACEMENT

3.3.1 Epoxy Concrete

Prime dry cavity surfaces with epoxy resin using a stiff bristle brush. Make coating approximately 20 mils thick. Place epoxy concrete while primer is still tacky and in layers not exceeding one inch thick. Use vibratory floats, plates, or hand tampers to consolidate the concrete. Level each layer and screed the final surface to match the adjoining

surfaces. Remove excess epoxy concrete on adjacent surfaces before the concrete hardens. Do not feather epoxy concrete out onto adjacent surfaces.

3.3.2 Epoxy Mortar

Prime surfaces with epoxy resin binder. Scrub prime coat into surface with a stiff bristle brush. Make coating approximately 20 mils thick. Place epoxy mortar while primer is still tacky. Apply at a thickness recommended by the manufacturer. Work mortar into place and consolidate thoroughly so that contact surfaces are wetted by the mortar. Finish surface of mortar to the required texture. Do not feather edge epoxy mortar onto adjacent surfaces.

3.3.3 Non-Pressure Epoxy Grout

3.3.3.1 Cementing Dowels

Immediately prior to placing the dowel, clean hole of dust and other deleterious material with a high pressure air hose. Fill hole halfway with grout. Insert dowel in hole by rotating it at least one complete turn while tapping it down. If necessary add more grout to fill hole.

3.3.3.2 Epoxy Grout for Cracks

Apply epoxy grout at a thickness recommended by the manufacturer. Work grout into place and consolidate thoroughly so that contact surfaces are wetted by the grout. Finish surface of grout to the required texture. Do not feather edge epoxy grout onto adjacent surfaces.

3.3.4 Pressure Grouting of Cracks

Clean each crack of dust, dirt, loose concrete and unsound material. Insert a valve at both ends of each crack, at the junction of two cracks, and along the length of each crack at 16 to 20 inch intervals. Fill crack between valves with crack surface sealer. After crack surface sealer has hardened and cured, pump crack sealer into valve at one end of crack. For vertical surfaces start at lowest valve and work upwards. As crack sealer appears at next valve, pinch closed pumping valve and move to next valve and commence pumping. Continue procedure until other end of crack is reached. Avoid delays in pumping operation. After crack sealer has hardened and cured grind valves off flush with concrete surface. Coat areas of valves with crack surface sealer and allow to harden and cure.

3.4 CURING

Cure epoxy materials in accordance with manufacturer's recommendations.

3.5 FIELD QUALITY CONTROL

3.5.1 Sampling

As soon as epoxy resin and aggregate materials are available for sampling, obtain by random selection a sample of each batch. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use and quantity involved.

3.5.2 Inspection

Check each repaired area for cracks, spalls, popouts and loss of bond between repaired area and surrounding concrete. Check each repaired area for voids by tapping with a hammer or steel rod and listening for dull or hollow sounds. Immediately repair defects.

-- End of Section --

SECTION 03 11 13.00 10

STRUCTURAL CAST-IN-PLACE CONCRETE FORMING
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 347	(2004; Errata 2008; Errata 2012) Guide to Formwork for Concrete

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood

ASTM INTERNATIONAL (ASTM)

ASTM C1074	(2011) Standard Practice for Estimating Concrete Strength by the Maturity Method
ASTM C1077	(2013b) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C31/C31M	(2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39/C39M	(2012) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 SYSTEM DESCRIPTION

The design, engineering, and construction of the formwork is the responsibility of the Contractor. Design formwork in accordance with methodology of ACI 347 for anticipated loads, lateral pressures, and stresses, and capable of withstanding the pressures resulting from placement and vibration of concrete. Comply with the tolerances specified in Section , paragraph CONSTRUCTION TOLERANCES. However, for surfaces with an ACI Class A surface designation, limit the allowable deflection

for facing material between studs, for studs between walers and walers between bracing to 0.0025 times the span. Design the formwork as a complete system with consideration given to the effects of cementitious materials and mixture additives such as fly ash, cement type, plasticizers, accelerators, retarders, air entrainment, and others. Monitor the adequacy of formwork design and construction prior to and during concrete placement as part of the Contractor's approved Quality Control Plan. Submit design analysis and calculations for form design and methodology used in the design at least 30 days either before fabrication on site or before delivery of prefabricated forms.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Formwork; G

Formwork Drawings: Formwork drawings, prepared under the supervision and sealed by the formwork design engineer, shall be submitted for Owners record and shall be reviewed by the Engineer for conformance to structural layout only. Such shop drawings shall indicate types of materials, sizes, lengths, connection details, design allowance for construction loads, anchors, form ties, shores, braces, construction joints, reveals, camber, openings, formwork coatings and all other pertinent information.

SD-03 Product Data

Design
Form Materials; (LEED NC)
Form Releasing Agents
Chamfer Strips

SD-04 Samples

Sample Panels; G

SD-06 Test Reports

Inspection

SD-07 Certificates

SD-11 Closeout Submittals

Local / Regional Materials (LEED NC)
Certified Wood

1.5 QUALITY ASSURANCE

Sample Panels shall be of sufficient size to contain joints and shall be not less than 6 feet long and 4 feet wide. The panels shall be of

typical wall thickness and constructed containing the full allocation of reinforcing steel that will be used in the structure, with the forming system that duplicates in every detail the one that will be used in construction of the structure. Use the same concrete mixture proportion and materials, the same placement techniques and equipment, and the same finishing techniques and timing that are planned for the structure. Construction of Class A finish will not be permitted until sample panels have been approved. Protect sample panels from construction operations in a manner to protect approved finish, and are not to be removed until all Class A finish concrete has been accepted. After shop drawings have been reviewed, submit sample panels for Class A finish with applied architectural treatment; panels shall be built on the project site where directed.

1.6 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 Form Materials

Submit manufacturer's data, including literature describing form materials, accessories, and form releasing agents.

2.1.1 Forms For Class A Finish (ALL CONCRETE EXPOSED TO VIEW)

Forms for Class A finished surfaces shall be plywood panels conforming to APA L870, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type.

2.1.2 Forms For Class B Finish (ALL CONCRETE TO RECEIVE PLASTER OR STUCCO)

This class of finish shall apply to all surfaces except those specified to receive Class A, Class C, Class D. Forms for Class B finished surfaces shall be plywood panels conforming to APA L870, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type. Steel lining on wood sheathing will not be permitted.

2.1.3 Forms For Class C Finish (ALL OTHER CONCRETE UNLESS NOTED OTHERWISE)

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to APA L870, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used. Forms for round columns may have one vertical seam.

2.1.4 Forms For Class D Finish (FOUNDATIONS)

Forms for Class D finished surfaces, except where concrete is placed against earth, shall be wood or steel or other approved concrete form material.

2.1.5 Retain-In-Place Metal Forms

Retain-in-place metal forms for concrete slabs and roofs shall be as specified in Section 05 30 00 STEEL DECKS.

2.1.6 Pan-Form Units

Pan-form units for one-way joist and slab construction shall be factory-fabricated units, of the approximate section indicated. Units shall consist of either steel that is free of dents, irregularities, sag and rust or of glass-fiber reinforced plastic that is molded under pressure with matched dies. Pan forms allowing warped surfaces, leakage of concrete at joints, and uneven surfaces beyond tolerance levels will not be acceptable.. Closure units shall be furnished as required.

Subject to pan tolerance and the surface finish required by the Surface Finish Class SF-1.0 as shown on the drawings, pan forms may be either new pans or reconditioned pans at Contractor's option. Forms may be "long forms", "flange forms", "long flange forms", or "adjustable forms" at Contractor's option. Pan splices may be lapped, reinforced butt jointed, or semi-butt jointed (using end caps welded back-to-back with 2" maximum distance between pan ends).

2.1.7 FORM-FACING MATERIALS

2.1.7.1 Smooth-Formed Finished Concrete

Unless otherwise specified, formwork for exposed concrete surfaces as defined by the Surface Finish Class noted on the drawings, shall consist of plywood, metal, metal framed plywood, or other acceptable surface. Formwork shall provide a continuous straight and smooth surface conforming to the joint system as specified on the Architect's drawings. Form material shall have sufficient thickness to withstand pressure of concrete without bow or deflection. Plywood shall be exterior grade plywood panels (High Density Overlay (100/30 min. rating) on Hardwood Face, Class 1or better), suitable for concrete forms, complying with U.S. Product Standard PS-1, each piece bearing a legible inspection trademark, and as follows

2.1.7.2 Non-specific formed concrete

Unless otherwise specified, the default finish for formed surfaces shall be rough-form finish constructed with plywood, lumber, metal or other acceptable material. Lumber shall be dressed on at least two edges and one side for tight fit. The minimum grade shall be B-C, exterior grade.

2.1.7.3 Textured-form finished concrete

For exposed surfaces as noted on the drawings provide units of form face design, size, arrangement and configuration that matches Architect's control sample. Provide solid backing and form supports to ensure stability of textured form liners. See Architect's drawings, specifications and control sample for special form textured finish concrete.

2.1.8 CYLINDRICAL COLUMNS AND SUPPORTS

Round section members shall be formed with metal, fiberglass, reinforced plastic, paper, or fiber tubes, unless otherwise specified. Paper or

fiber tubes shall be constructed of laminated plies using water-resistant adhesive with wax impregnated exterior for weather and moisture protection. Units shall have sufficient wall thickness to resist loads imposed by wet concrete without detrimental deformation.

2.1.9 NAILS AND FASTENERS

Use only galvanized nails and fasteners for securing formwork in structures exposed to weather or unconditioned spaces such as garages, canopies and porte-cocheres

2.1.10 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Provide solid backing for each tie. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 1/4 inch nor more than 1 inch deep and not more than 1 inch in diameter. Terminate the embedded portion of metal ties not less that 2 inches from any concrete surface exposed to water. Removable tie rods shall be not more than 1-1/2 inches in diameter. Plastic snap ties may be used in locations where the surface will not be exposed to view.

2.1.11 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. If special form liners are to be used, follow the recommendation of the form coating manufacturer. Submit manufacturer's recommendation on method and rate of application of form releasing agents. Provide a product that has a maximum VOC (Volatile Organic Compounds) of 50 g/l but not greater than that permitted by the local government agency having jurisdiction in the area where the project is located

2.1.12 Chamfer Strips

Provide wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

2.2 NOT USED

2.2.1 NOT USED

2.2.2 NOT USED

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Formwork

Design, erect, support, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic construction loads that might be applied until the concrete structure can support such loads. Forms shall be constructed true to the structural design and required alignment.

The formwork design engineer shall design the concrete formwork, formwork removal, shoring, reshoring, and backshoring

Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures to produce concrete surfaces meeting the surface requirements specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and conforming to construction tolerance given in TABLE 1.

Continuously monitor the alignment and stability of the forms during all phases to assure the finished product will meet the required surface classes specified. Failure of any supporting surface either due to surface texture, deflection or form collapse shall be the responsibility of the Contractor as will the replacement or correction of unsatisfactory surfaces. Where concrete surfaces are to have a Class A or Class B finish, joints in form panels shall be arranged as approved. When forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be re-used if there is any evidence of defects which would impair the quality of the resulting concrete surface. All surfaces of used forms shall be cleaned of mortar and any other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker. Submit drawings showing details of formwork, including dimensions of joints, supports, studding and shoring, and sequence of form and shoring removal at least 30 days either before fabrication onsite or before delivery of prefabricated forms. If reshoring is permitted, submit the method, including location, order, and time of erection and removal.

Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of concrete mortar.

Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal

Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds

Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and patch forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations

3.1.2 Provisions for Other Trades

Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items

built into forms.

3.1.3 Pan Form Fabrication and Construction

Factory fabricate pan form units to specified sizes and shapes as indicated on the drawings. Units shall be designed for easy removal without damaging placed concrete. Units shall be shored properly and adjoining pan units shall be blocked if required to prevent lateral or vertical deflection of formwork during concrete placement

Provide load distribution ribs at least 5" wide for all pans 30" wide and narrower and elsewhere where indicated on the drawings. Minimum rib spacing shall be: none in spans less than 20 feet, one near the center of spans 20 to 30 feet and two near the third points of spans over 30 feet. Discontinue ribs between two adjacent joists or beams that have differences in span larger than 33%, between a joist and an adjacent parallel wall, and between a joist and an adjacent parallel beam that is 1 ½ or more times wider than the joist

3.2 CHAMFERING

All exposed joints, edges and external corners shall be chamfered by molding placed in the forms unless the drawings specifically state that chamfering is to be omitted or as otherwise specified. Chamfered joints shall not be permitted where earth or rockfill is placed in contact with concrete surfaces. Chamfered joints shall be terminated twelve inches outside the limit of the earth or rockfill so that the end of the chamfers will be clearly visible.

3.3 COATING

Forms for Class A and Class B finished surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for Class C and D finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.4 SHORES AND SUPPORTS

Comply with requirements of ACI 301 for shoring, reshoring and backshoring in concrete construction and as herein specified where more stringent

3.4.1 Design

Shores and reshores or backshores must be designed to carry all loads transmitted to them. A rational analysis should be used to determine the number of floors to be shored, reshored, or backshored, subject to the minimums stated in the following paragraph, and to determine the loads transmitted to the floors, shores and reshores or backshores as a result of the construction sequence. The analysis should consider, but should not necessarily be limited to, the following:

a. Structural design load of the slab or member including live load, partition loads, and other loads for which the engineer designed the slab. The live load reduction method for the design of certain members

is shown on the structural drawings. The reduced live load and an allowance for construction loads shall be taken into consideration when performing the analysis

b. Dead load weight of the concrete and formwork
c. Construction live loads, such as placing crews and equipment or stored materials
d. Design strength of concrete specified
e. Cycle time between placement of successive floors
f. Strength of concrete at time it is required to support shoring loads from above
g. The distribution of loads between floors, shores, and reshores or backshores at the time of placing concrete, stripping formwork, and removal of reshoring or backshoring
h. Span of slab or structural member between permanent supports
i. Type of formwork systems, i.e., span of horizontal formwork components, individual shore loads, etc.
j. Minimum age of concrete where appropriate
k. Alignment of shores: Where possible, shores for any floor shall be placed directly above previously placed shores so that load will be transferred directly to such shores. Where shores are not vertically aligned, calculations shall include verification that the structure can support the reaction

3.5 FORM REMOVAL

Forms shall not be removed without approval. The Contractor's registered professional engineer shall determine and submit for Owner's record the time and sequence of formwork and shore removal subject to the criteria as specified below. The submittal shall clearly distinguish between reshoring and backshoring procedures. The minimal time required for concrete to reach a strength adequate for removal of formwork without risking the safety of workers or the quality of the concrete depends on a number of factors including, but not limited to, ambient temperature, concrete lift heights, type and amount of concrete admixture, and type and amount of cementitious material in the concrete. It is the responsibility of the Contractor to consider all applicable factors and leave the forms in place until it is safe to remove them but not before 24 hours after concrete placement. In any case forms shall not be removed unless the minimum compressive strength requirements below are met, except as otherwise directed or specifically authorized. When conditions are such as to justify the requirement, forms will be required to remain in place for a longer period. All removal shall be accomplished in a manner which will prevent damage to the concrete and ensure the complete safety of the structure. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements. Form removal shall be scheduled so that all necessary repairs can be performed as specified in Section 03 01 30.71 . Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be prepared and tested in accordance with ASTM C31/C31M and ASTM C39/C39M at the expense of the Contractor by an independent laboratory that complies with ASTM C1077 and shall be tested within 4 hours after removal from the site. After obtaining approval, the Contractor may use maturity instrumentation instead of control cylinders to determine the compressive strength of the concrete. ASTM C1074

procedures shall be used for estimating concrete strength by means of the maturity method. All expenses associated with instrumenting the concrete and evaluating the strength using maturity relationships shall be the responsibility of the Contractor.

3.5.1 Records of Weather Conditions

The Contractor shall be responsible for keeping records of weather conditions to be used in the decision on when to remove forms

3.5.2 Formwork Not Supporting Weight of Concrete

Formwork for walls, columns, sides of beams, gravity structures, and other vertical type formwork not supporting the weight of concrete shall not be removed in less than 24 hours after concrete placement is completed. Form removal before 24 hours will be allowed for simple floor slab, sidewalks, and driveways provided the ambient temperature during this period has not fallen below 50 degrees F at any time since placement for at least 12 hours after placing concrete provided the concrete is sufficiently hard so as not to be damaged by form removal operations and provided curing and protection operations are maintained. If ambient air temperatures remain below 50°F, if retarding agents are used, or if Type II and Type V Portland cement is used, then this specified minimum period shall be increased as required to safely remove the forms without damage to the concrete.and evidence from compressive tests on field-cured concrete control cylinders or maturity instrumentation indicates that the concrete has attained a compressive strength of at least 2000 psi. Control cylinders shall be prepared for each set of forms to be removed before 24 hours. The stability of the concrete shall be evaluated by a structural engineer prior to removal of the forms. If forms are to be removed in less than 24 hours on formwork not supporting the weight of concrete, submit the evaluation and results of the control cylinder tests or maturity instrumentation shall be submitted to and approved before the forms are removed.

3.5.3 Formwork Supporting Weight of Concrete

Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected. As a minimum, forms shall be left in place until control concrete test cylinders or maturity instrumentation indicate evidence the concrete has attained at least 70 percent of the compressive strength required for the structure in accordance with the quality and location requirements but not less than 3000 psi.

3.5.4 Placing Reshores and Backshores

a. All shoring operations shall be carried out in accordance with a planned sequence as determined by the Contractor's shoring engineer
b. Shoring operations shall be performed so that at no time will areas of new construction be required to support combined dead and construction loads in excess of the available strength as determined by the design loads (as specified in the General Notes) and the developed concrete strength (as determined by field cured cylinders or maturity method) at the time of stripping and reshoring or backshoring
c. Shores (backshores or reshores) shall not be removed until the

structural member supported has sufficient strength to support all applied loads

d. For backshoring operations, the forms shall be removed in such a manner that individual structural members are not allowed to deflect and carry load
e. Reshoring operations require that the structural members be strong enough to safely support their own weight before stripping of formwork
f. For reshoring operations, no structural member shall be overstressed under its own dead weight plus the weight of the floors above and construction loads assigned to the structural member by a rational analysis that accounts for the relative stiffness of each floor with due consideration of concrete age and strength. While reshoring is underway, no construction loads shall be permitted on the new construction unless it can safely support the construction loads
g. Where possible, shores shall be located in the same position on each floor so that they will be continuous in their support from floor to floor

3.6 CLEANING AND TIGHTENING

Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and all other debris just prior to concrete placement. Retighten forms and bracing prior to concrete placement as required to prevent concrete mortar leaks and maintain proper alignment

3.7 CLEANING AND RE-USE OF FORMS

Forms reused in the work shall be repaired and cleaned. Split, frayed, delaminated, or otherwise damaged facing material will not be acceptable for exposed surfaces. Forms intended for successive concrete placement shall have surfaces cleaned, fins and laitance removed, and joints tightened to avoid surface offsets. New form coating compound shall be applied to reused forms. Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable

3.8 INSPECTION

Forms and embedded items shall be inspected in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing. Submit field inspection reports for concrete forms and embedded items.

3.8.1 Shallow Foundation Elements

a. Verify element width, length, depth, and elevation
b. Verify that forms are plumb and straight, braced against movement, and lubricated for removal
c. Verify that carton forms, if any, are dry and neatly formed around piers

3.8.2 Slabs-on-Grade

a. Verify formwork at turndowns and slab edges is plumb and straight, braced against movement and lubricated for removal

3.8.3 Columns and Walls

a. Verify that forms are plumb and straight, braced against movement, lubricated for removal, and conform to approved shop drawings
b. Verify proper dimensions and orientation
c. Verify top of column elevation is set in form and that it is 1/2 inch below the future slab soffit

3.8.4 Suspended Floors (General)

a. Verify that formwork conforms to signed and sealed shop drawings
b. Verify that shoring layout conforms to signed and sealed shop drawings
c. Verify that reshores at all levels conform to signed and sealed shop drawings
d. Verify that forms are plumb and straight, braced against movement, and lubricated for removal
e. Verify that the forms used for exposed finish surfaces are of the type specified and provide a joint system as shown on the Architect's drawings
f. Verify the proper dimensions of girders, beams, and joists
g. Verify that the slab thickness and top of slab elevation is correct
h. Verify the top of columns are 1/2 inch below the deck soffit

3.8.5 Pan Form Slabs

a. Verify that pans used are of the type specified and are free of dents, surface irregularities, sags, rust, or stains
b. Verify that the discontinuities that will be created in the slab soffit at the splice points of the pans do not exceed the value specified

3.8.6 Tilt-Up Concrete

a. Verify that the formwork complies with the shop drawings

3.8.7 Tolerances for Formed Surfaces

TABLE 1 TOLERANCES FOR FORMED SURFACES	
1. Variations from the plumb:	
a. In the lines and surfaces of columns, piers, walls and in arises	1/4 inch in any 10 feet of length Maximum for entire length -- 1 inch
b. For exposed corner columns, control-joint grooves, and other conspicuous lines	1/4 inch in any 20 feet of length Maximum for entire length -- 1/2 inch

TABLE 1 TOLERANCES FOR FORMED SURFACES	
2. Variation for the level or from the grades indicated on the drawings:	
a. In slab soffits, ceilings beam soffits, and in arises,measured before removal of supporting shores	1/4 inch in any 10 feet of length 3/8 inch in any bay or in any 20 feet of length Maximum for entire length -- 3/4 inch
b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	1/4 inch in any bay or in any 20 feet of length Maximum for entire length -- 1/2 inch
3. Variation of the linear building lines from established position in plan	1/2 inch in any 10 feet 1 inch maximum
4. Variation of distance between walls, columns, partitions	1/4 inch per 10 feet of distance, but not more than 1/2 inch in any one bay, and not more than 1 inch total variation
5. Variation in the sizes and locations of sleeves, floor openings, and wall opening	Minus 1/4 inch, Plus 1/2 inch
6. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus 1/4 inch, Plus 1/2 inch
7. Footings:	
a. Variation of dimensions in plan	Minus 1/2 inch, plus 2 inches when formed or plus 3 inches when placed against unformed excavation
b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than 2 inches
c. Reduction in thickness	Minus 5 percent of the specified thickness
8. Variation in steps:	
a. In a flight of stairs	Riser -- 1/8 inch Tread -- 1/4 inch

TABLE 1 TOLERANCES FOR FORMED SURFACES	
b. In consecutive steps	Riser -- 1/16 inch Tread -- 1/8 inch

-- End of Section --

SECTION 03 15 00.00 10

CONCRETE ACCESSORIES
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 111	(2011) Standard Method of Test for Mineral Matter or Ash in Asphalt Materials

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

ASTM INTERNATIONAL (ASTM)

ASTM A1011/A1011M	(2012b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability and Ultra-High Strength
ASTM A109/A109M	(2008) Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A480/A480M	(2013) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM B152/B152M	(2013) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C919	(2012) Use of Sealants in Acoustical Applications
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants

ASTM D1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D2628	(1991; R 2011) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D2835	(1989; R 2012) Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D4	(1986; R 2010) Bitumen Content
ASTM D412	(2006a; R 2013) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2012a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D5249	(2010) Backer Material for Use with Cold-and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
ASTM D6/D6M	(1995; E 2011; R 2011) Loss on Heating of Oil and Asphaltic Compounds

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Waterstops; G

SD-03 Product Data

Preformed Expansion Joint Filler
Sealant; (LEED NC)
Waterstops

SD-04 Samples

Lubricant for Preformed Compression Seals
Field-Molded Type
Non-metallic Materials
Waterstops

SD-07 Certificates

Preformed Expansion Joint Filler
Sealant
Waterstops; (LEED NC)

SD-11 Closeout Submittals

Low Emitting Materials - Adhesives and Sealants

1.4 DELIVERY, STORAGE, AND HANDLING

Protect material delivered and placed in storage off the ground from moisture, dirt, and other contaminants. Deliver sealants in the manufacturer's original unopened containers. Remove sealants from the site whose shelf life has expired.

PART 2 PRODUCTS

2.1 CONTRACTION JOINT STRIPS

Contraction joint strips shall be 1/8 inch thick tempered hardboard conforming to AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) or high impact polystyrene (HIPS) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips shall have removable top section.

2.2 PREFORMED EXPANSION JOINT FILLER

Expansion joint filler shall be preformed material conforming to ASTM D1751 or ASTM D1752. Unless otherwise indicated, filler material shall be 3/8 inch thick and of a width applicable for the joint formed. Backer material, when required, shall conform to ASTM D5249.

2.3 SEALANT

Joint sealant shall conform to the following:

2.3.1 Preformed Polychloroprene Elastomeric Type

ASTM D2628.

2.3.2 Lubricant for Preformed Compression Seals

ASTM D2835. Submit a piece not less than 9 ft of 1 inch nominal width or

wider seal or a piece not less than 12 ft of compression seal less than 1 inch nominal width. Provide one quart of lubricant.

2.3.3 Field-Molded Type

ASTM C920. Sealant shall be Type M, Grade P or NS, Class 25, Use T for horizontal joints subject to vehicular and pedestrian traffic. Use NT for horizontal joints not subject to traffic for horizontal joints. Type M, Grade NS, Class 25, Use NT for vertical joints. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, non-shrink, nonreactive with sealant, and non-absorptive material type such as extruded butyl or polychloroprene rubber. Submit One gallon of field-molded sealant and one quart of primer (when primer is recommended by the sealant manufacturer) identified to indicate manufacturer, type of material, quantity, and shipment or lot represented.

2.4 WATERSTOPS

Shop fabricate intersection and change of direction waterstops. Submit a sample of each material consisting of a piece not less than 12 inches long cut from each 200 feet of finished waterstop furnished, but not less than a total of 4 linear feet of each type and size furnished. For spliced segments of waterstops to be installed in the work, furnish one spliced sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site for inspection and testing. Make the spliced samples using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each spliced sample shall be not less than 12 inches long. Submit waterstop materials and splice samples for inspection and testing identified to indicate manufacturer, type of material, size and quantity of material and shipment represented.

2.4.1 Flexible Metal

Copper waterstops shall conform to ASTM B152/B152M and ASTM B370, O60 soft anneal temper and 20 oz mass per sq ft sheet thickness. Stainless steel waterstops shall conform to ASTM A167 and ASTM A480/A480M, UNS S30453 (Type 304L), and 0.0375 inch (20 gauge) thick strip.

2.4.2 Rigid Metal

Flat steel waterstops shall conform to ASTM A109/A109M, No. 2 (half hard) temper, No. 2 edge, No. 1 (matte or dull) finish or ASTM A1011/A1011M, Grade 40.

2.4.3 Non-Metallic Materials

Non-metallic waterstops shall be manufactured from a prime virgin resin; reclaimed material is not acceptable. The compound shall contain plasticizers, stabilizers, and other additives to meet specified requirements. Rubber waterstops shall conform to COE CRD-C 513. Polyvinylchloride waterstops shall conform to COE CRD-C 572. Thermoplastic elastomeric rubber waterstops shall conform to ASTM D471. Submit a piece not less than 12 inch long cut from each 200 ft of finished waterstop furnished, but not less than a total of 4 ft of each type, size, and lot furnished. One splice sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site. Make the splice samples using straight run pieces with the splice located

at the mid-length of the sample and finished as required for the installed waterstop. The total length of each splice shall be not less than 12 inches long.

2.4.4 Non-Metallic Hydrophilic

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water shall conform to ASTM D412 as follows: Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum. Hardness shall be 50 minimum on the type A durometer and the volumetric expansion ratio in distilled water at 70 degrees F shall be 3 to 1 minimum.

2.4.5 Preformed Elastic Adhesive

Produce preformed plastic adhesive waterstops from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, containing no solvents, asbestos, irritating fumes or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength.

2.4.5.1 Chemical Composition

Meet the chemical composition of the sealing compound requirements shown below:

PERCENT BY WEIGHT			
COMPONENT	MINIMUM	MAXIMUM	TEST
Bitumen (Hydrocarbon plastic)	50	70	ASTM D4
Inert Mineral Filler	30	50	AASHTO T 111
Volatile Matter		2	ASTM D6/D6M

2.4.5.2 Adhesion Under Hydrostatic Pressure

The sealing compound shall not leak at the joints for a period of 24 hours under a vertical 6 foot head pressure. In a separate test, the sealing compound shall not leak under a horizontal pressure of 10 psi which is reached by slowly applying increments of 2 psi every minute.

2.4.5.3 Sag of Flow Resistance

Sagging shall not be detected when tested as follows: Fill a wooden form 1 inch wide and 6 inches long flush with sealing compound and place in an oven at 135 degrees F in a vertical position for 5 days.

2.4.5.4 Chemical Resistance

The sealing compound when immersed separately in a 5% solution of caustic potash, a 5% solution of hydrochloric acid, 5% solution of sulfuric acid and a saturated hydrogen sulfide solution for 30 days at ambient room temperature shall show no visible deterioration.

PART 3 EXECUTION

3.1 INSTALLATION

Joint locations and details, including materials and methods of installation of joint fillers and waterstops, shall be as specified and indicated. In no case shall any fixed metal be continuous through an expansion or contraction joint.

3.1.1 Contraction Joints

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC or HIPS insert strips into the plastic concrete using a steel parting bar, when necessary, or by cutting the concrete with a saw after concrete has set. Make joints 1/8 inch to 3/16 inch wide and extend into the slab one-fourth the slab thickness, minimum, but not less than 1 inch. Cut to a depth of 1/3 slab thickness for slabs reinforced with steel fibers or synthetic fibers

3.1.1.1 Joint Strips

Provide strips of the required dimensions and as long as practicable. After the first floating, groove the concrete with a tool at the joint locations. Insert the strips in the groove and depress them until the top edge of the vertical surface is flush with the surface of the slab. Float and finish the slab as specified. Working of the concrete adjacent to the joint shall be the minimum necessary to fill voids and consolidate the concrete. Tool slab edges round on each side of insert after the curing period to form a recess for sealer. Discard the removable section of PVC or HIPS strips and leave the insert in place. Maintain true alignment of the strips during insertion.

3.1.1.2 Sawed Joints

Saw joints early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent raveling of the edges of the saw cut. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking. Use concrete sawing machines that are adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Cut joints to true alignment and in sequence of concrete placement. Remove sludge and cutting debris. Form reservoir for joint sealant.

3.1.2 Expansion Joints

Use preformed expansion joint filler in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. Extend the filler to the full slab depth, unless otherwise indicated. neatly finish the edges of the joint with an edging tool of 1/8 inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess to the size shown on the drawings. Remove the wood strip after the concrete has set. Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. Thoroughly clean the groove of laitance, curing compound,

foreign materials, protrusions of hardened concrete, and any dust. If blowing out the groove use oil-free compressed air.

3.1.3 Joint Sealant

Fill sawed contraction joints and expansion joints in slabs with joint sealant, unless otherwise shown. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Apply joint sealant as recommended by the manufacturer of the sealant.

3.1.3.1 Joints With Preformed Compression Seals

Install compression seals with equipment capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal or concrete and with no more than 5 percent stretching of the seal. Cover the sides of the joint and, if necessary, the sides of the compression seal with a coating of lubricant. Coat butt joints with liberal applications of lubricant.

3.1.3.2 Joints With Field-Molded Sealant

Do not seal joints when the sealant material, ambient air, or concrete temperature is less than 40 degrees F. When the sealants are meant to reduce the sound transmission characteristics of interior walls, ceilings, and floors the guidance provided in ASTM C919 shall be followed. Coat joints requiring a bond breaker with curing compound or with bituminous paint. Install bond breaker and back-up material where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

3.2 WATERSTOPS, INSTALLATION AND SPLICES

Install waterstops at all construction joints and other joints in all foundation walls below grade and at the locations shown to form a continuous water-tight diaphragm. Make adequate provision to support and completely protect the waterstops during the progress of the work. Repair or replace any waterstop punctured or damaged. Protect exposed waterstops during application of form release agents to avoid being coated. Provide suitable guards to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued. Accomplish splices with certified trained personnel using approved equipment and procedures.

3.2.1 Copper And Stainless Steel

Splices in copper waterstops shall be lap joints made by brazing. Splices in stainless steel waterstops shall be welded using a TIG or MIG process utilizing a weld rod to match the stainless. All welds shall not be annealed to maintain physical properties. Do not use carbon flame in the annealing process. Damaged waterstops shall be repaired by removing damaged portions and patching. Patches shall overlap a minimum of 1 inch onto undamaged portion of the waterstop.

3.2.2 Flat Steel

Splices in flat steel waterstops shall be properly aligned, butt welded, and cleaned of excessive material.

3.2.3 Non-Metallic

Fittings shall be shop made using a machine specifically designed to mechanically weld the waterstop. A miter guide, proper fixturing (profile dependant), and portable power saw shall be used to miter cut the ends to be joined to ensure good alignment and contact between joined surfaces. The splicing of straight lengths shall be done by squaring the ends to be joined. Maintain continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions, etc.) across the splice.

3.2.3.1 Rubber Waterstop

Splices shall be vulcanized or shall be made using cold bond adhesive as recommended by the manufacturer. Splices for TPE-R shall be as specified for PVC.

3.2.3.2 Polyvinyl Chloride Waterstop

Make splices by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. Use the correct temperature to sufficiently melt without charring the plastic. Reform waterstops at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled, shall show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

3.2.3.3 Quality Assurance

Edge welding will not be permitted. Compress or close centerbulbs when welding to non-centerbulb type. Waterstop splicing defects which are unacceptable include, but are not limited to the following: 1) Tensile strength less than 80 percent of parent section. 2) Free lap joints. 3) Misalignment of centerbulb, ribs, and end bulbs greater than 1/16 inch. 4) Misalignment which reduces waterstop cross section more than 15 percent. 5) Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness. 6) Misalignment of waterstop splice resulting in misalignment of waterstop in excess of 1/2 inch in 10 feet. 7) Visible porosity in the weld area, including pin holes. 8) Charred or burnt material. 9) Bubbles or inadequate bonding. 10) Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.

3.2.4 Non-Metallic Hydrophilic Waterstop Installation

Miter cut ends to be joined with sharp knife or shears. The ends shall be adhered with cyanacryiate (super glue) adhesive. When joining hydrophilic type waterstop to PVC waterstop, the hydrophilic waterstop shall be positioned as shown on the drawings. Apply a liberal amount of a single component hydrophilic sealant to the junction to complete the transition.

3.2.5 Preformed Plastic Adhesive Installation

The installation of preformed plastic adhesive waterstops shall be a prime, peel, place and pour procedure. Joint surfaces shall be clean and dry before priming and just prior to placing the sealing strips. The end of each strip shall be spliced to the next strip with a 1 inch overlap; the overlap shall be pressed firmly to release trapped air. During damp or cold conditions the joint surface shall be flashed with a safe, direct

flame to warm and dry the surface adequately; the sealing strips shall be dipped in warm water to soften the material to achieve maximum bond to the concrete surface.

3.3 CONSTRUCTION JOINTS

Treat construction joints coinciding with expansion and contraction joints as expansion or contraction joints as applicable.

-- End of Section --

SECTION 03 20 00.00 10

CONCRETE REINFORCING
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 318	(2011; Errata 1 2011; Errata 2 2012; Errata 3-4 2013) Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1035/A1035M	(2013a) Standard Specification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement
ASTM A184/A184M	(2006; E2011) Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A496/A496M	(2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A497/A497M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A615/A615M	(2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A675/A675M	(2003; R 2009) Standard Specification for

	Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A706/A706M	(2009b) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A767/A767M	(2009) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A82/A82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A884/A884M	(2012) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934/A934M	(2013) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM C1116/C1116M	(2010a) Standard Specification for Fiber-Reinforced Concrete

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2009; 28th Ed) Manual of Standard Practice

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections apply to work of this section.

1.4 DESCRIPTION OF WORK

The work of this section includes labor, materials, hardware, equipment, transportation and services required to fabricate and place all reinforcement for cast-in-place concrete including bars, welded wire fabric, ties and supports shown on the drawings and as specified. Prestressing reinforcement is specified in Precast Concrete sections of the specifications.

1.5 ENVIRONMENTAL OBJECTIVES

Refer to 01 33 29 LEED(TM) DOCUMENTATION

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcing Steel; G

SD-03 Product Data

Product Data Sheets
Welding
Reinforcing Steel; (LEED NC)

SD-07 Certificates

Mill Certificates
Qualification of Steel Bar Butt-Splicers
International Code Council (ICC) Evaluation Service Reports

SD-11 Closeout Submittals

Local / Regional Material; (LEED NC)
Recycled Content

1.6.1 Shop Drawings

Submit shop drawings for all Reinforcing Steel and related accessories for the Engineer's approval. Shop drawings shall show arrangement and layout, bending and assembly diagrams, bar schedules, stirrup spacing, splicing and laps of bars and shall be prepared in accordance with CRSI Standards

1.6.2 Mill Certificates

Submit, for record, mill certificates and/or test results signed by Contractor and Producer, for all reinforcement

1.6.3 Product Data Sheets

Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including mechanical splices, hooked anchorage systems, large-headed stud punching shear reinforcement, dowel bar substitute systems, and dowel bar sleeves

1.6.4 International Code Council (ICC) Evaluation Service Reports

Submit evaluation service reports of approval from ICC Evaluation Service, Inc. for mechanical splice, hooked anchorage systems, large-headed stud punching shear reinforcement and dowel bar substitute systems

1.7 QUALITY ASSURANCE

1.7.1 Welding Qualifications

Welders shall be qualified in accordance with AWS D1.4/D1.4M. Qualification test shall be performed at the worksite and notify the Contracting Officer 24 hours prior to conducting tests. Special welding

procedures and welders qualified by others may be accepted as permitted by AWS D1.4/D1.4M. Submit a list of qualified welders names.

1.7.2 Qualification of Steel Bar Butt-Splicers

Qualification of steel bar butt-splicers shall be certified to have satisfactorily completed a course of instruction in the proposed method of butt-splicing or have satisfactorily performed such work within the preceding year. Submit certificates on the Qualifications of Steel Bar Butt-Splicers prior to commencing butt-splicing.

1.7.3 Qualification of Butt-Splicing Procedure

As a condition of approval of the butt-splicing procedure, make three test butt-splices of steel bars of each size to be spliced using the proposed butt-splicing method, in the presence of the Contracting Officer. These test butt-splices and unspliced bars of the same size shall be tension tested to destruction with stress-strain curves plotted for each test. Test results shall show that the butt-splices meet the specified strength and deformation requirements in order for the splicing procedure to be approved.

1.7.4 Testing and Inspection by NASA and/or Designated Representative

1.7.4.1 Inspections

Steel reinforcement placement. Inspect 100% of reinforcement before each concrete pour to verify the information noted below:

a. Primary and secondary, longitudinal reinforcement has correct size and number in proper layers.
b. Longitudinal reinforcement has correct length and lap.
c. Ties and stirrups are of correct size, spacing, and number and have the proper termination-hook geometry.
d. Unscheduled face reinforcement in beams are provided and are of correct size, number and spacing and have the proper end terminations.
e. Proper hooks are provided at bar ends as detailed.
f. Reinforcement is properly supported and braced to formwork to prevent movement during concreting operation.
g. Reinforcement has proper cover.
h. Sufficient spacing between reinforcement for concrete placement.
i. Dowel reinforcement is of proper size, at proper spacing, and has proper lap length and embedment length.
j. Welded wire reinforcement is composed of flat sheets, has proper wire gage and spacing, is properly supported, and is properly lapped.
k. Proper Construction/Contraction/Expansion joint spacing and reinforcement
l. Reinforcement around embedded items is installed according to details.
m. Proper installation of flat-slab shear-head reinforcement

1.7.4.2 Testing

1.7.4.2.1 Mechanical Tension Splices

The Owner's Testing Laboratory shall conduct monotonic tension tests in accordance with ASTM A 1034 of mechanical tension splices of the type as specified on the structural drawings. It is not necessary that the specimens to be tested are production splices, however, the specimens to be tested shall have been made by the Contractor's personnel under field

conditions. The rate of testing shall be as follows

a. Two specimens for the first 50 splices (or fraction thereof) at the beginning of the project. Splices not meeting tension requirements shall be retested at Contractor's expense until all splices meet the tension requirements
b. One specimen for every 100 (or fraction thereof) additional splices occurring on the project. Any splices not meeting tension requirements shall be retested at Contractors expense until all splices have passed the test
c. A minimum of one test specimen shall also be selected from transition splices (splices of one bar size to another bar size), if any

The Laboratory shall provide 100% visual inspection of mechanical tension splices on the project and consult with the manufacturer regarding recommendations for installation. Inspection shall verify compliance with specifications and conformance with the manufacturer's recommendations for installation. The manufacturer shall be present for the first installation of the splice on the project

1.7.4.2.2 End-Bearing Compression Splices

The Owner's Testing Laboratory shall provide 100% visual inspection of compression butt splices on the project. Inspection shall verify splice conformance with the specified requirements above as well as the manufacturer's instructions

1.8 DELIVERY, STORAGE, AND HANDLING

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports. Reinforcing materials shall be delivered from the mill in bundles that are identified as to heat number and manufacturer and accompanied with mill and analysis test reports and an affidavit from the supplier stating that the material conforms to the requirements of the governing ASTM specification listed herein. Deformed bar material that is not identifiable according to the criteria listed above shall be tested for tensile strength and bend tests according to ASTM A 615 on a sample of 2 bars for each ten tons or fraction thereof of unidentified material for each bar size. The bars shall be a minimum of 24 inches long

PART 2 PRODUCTS

2.1 DOWELS

Dowels shall conform to ASTM A675/A675M, Grade 80. Steel pipe conforming to ASTM A53/A53M, Schedule 80, may be used as dowels provided the ends are closed with metal or plastic inserts or with mortar.

2.1.1 Joint Dowel Bars

Smooth bars used to dowel across slab-on-grade construction joints shall conform to ASTM A 615, Grade 40 or ASTM A 36, plain-steel bars. Cut bars true to length with ends square and free of burrs

2.1.2 Dowel Bar Sleeves

Plastic or gage metal (26 gauge min.) sleeves with an inside diameter of 1/16 inch greater than the dowel bar that it encases, that have the strength, durability, and design to provide free movement of the dowel

relative to the concrete slab and that are specifically manufactured for this purpose

2.1.3 Alternate Slab-on-Grade Joint Load Transfer Systems

A system that consists of flat, ASTM A 36 plate that is saw cut into a square or rectangular shape and is embedded into or encased by a plastic sleeve that allows movement in both lateral directions but not in the vertical direction.

2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A184/A184M.

2.3 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A615/A615M, ASTM A706/A706M, or ASTM A1035/A1035M grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A82/A82M. In highly corrosive environments or when directed by the Contracting Officer, reinforcing steel shall conform to ASTM A767/A767M, ASTM A1035/A1035M or ASTM A934/A934M as appropriate.

Submit certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

2.3.1 Zinc-Coated (Galvanized) Bars

Zinc-coated (galvanized) bars shall comply with the requirements of ASTM A767/A767M, Class II (2.0 oz. zinc PSF coating, galvanized after fabrication and bending.

2.3.2 Weldable Reinforcing Bars

All reinforcing bars noted on the drawings as being required to be welded shall conform to ASTM A 706.

2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to ASTM A185/A185M ASTM A496/A496M ASTM A497/A497M. When directed by the Contracting Officer for special applications, welded wire fabric shall conform to ASTM A884/A884M.

2.5 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire. Ties for zinc-coated bars shall be zinc-coated. Tie wire in architecturally exposed concrete shall be plastic coated or stainless steel

2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI 10MSP and shall be steel or precast concrete blocks. Precast concrete blocks shall have wire ties and shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or

where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be galvanized, plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

a. Slabs-on-Grade: Use precast concrete bar supports (dobies) or supports with sand plates or horizontal runners designed for use on ground
b. Spread Footing Bottom Reinforcement: Use precast concrete bar supports (dobies) or chairs designed for soil-supported slabs
c. Mat Foundation: Use precast concrete bar supports (dobies), chairs designed for soil-supported slabs, or poured-in-place concrete curbs
d. Exposed to View Concrete: Provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2)
e. Support of Epoxy-Coated Reinforcement: Provide epoxy-coated or other dielectric-polymer-coated wire bar supports to support epoxy-coated reinforcement
f. Support of Galvanized Reinforcement: Provide galvanized wire bar supports to support galvanized reinforcement

2.7 Coating Repair Materials

Repair damaged areas of epoxy-coated or galvanized reinforcement using the following products

a. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating compatible with epoxy coating on reinforcement and complying with ASTM A 775
b. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc shall be used to repair damaged areas of galvanized reinforcement

2.8 SYNTHETIC FIBER REINFORCEMENT

Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 2 inches.

PART 3 EXECUTION

3.1 Reinforcing Steel

Reinforcement steel and accessories shall be fabricated and placed as specified and shown and approved shop drawings. Fabrication and placement details of steel and accessories not specified or shown shall be in accordance with ACI SP-66 and ACI 318. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Zinc-Coated and epoxy-coated bars shall be mill-bent prior to coating. All steel shall be bent cold unless authorized. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms. Submit detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other

deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318 and CRSI 10MSPat locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.1.1.1 Support of Spread Footing Reinforcing Steel

a. Bottom Steel: Support bottom reinforcing mat to provide the specified clearance to the bars. Spacing between supports shall not exceed 4'-0" centers each way
b. Top Steel: Support top reinforcing on steel angle frames braced in both directions or on special standee support bars. Spacing between supports shall not exceed 4'-0" centers each way. The depth of the supports shall provide the specified clearance from the bars to the top of the concrete. The design of the support steel shall be the responsibility of the Contractor

3.1.1.2 Support of Mat Foundation Reinforcing Steel

a. Bottom Steel: Support bottom reinforcing mat to provide the specified clearance to the bars. Spacing between supports shall not exceed 4'-0" centers each way
b. Top Steel: Support top reinforcing on steel angle frames braced in both directions or on special standee support bars. Spacing between supports shall not exceed 4'-0" centers each way. The depth of the supports shall provide the specified clearance from the bars to the top of the concrete. The design of the support steel shall be the responsibility of the Contractor

3.1.2 Splicing

Splices of reinforcement shall conform to ACI 318 and shall be made only as required or indicated. Unauthorized or unscheduled splices not approved by the Engineer in writing will not be accepted. Splicing shall be by lapping or by mechanical or welded butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Welding shall conform to AWS D1.4/D1.4M. Welded butt splices shall be full penetration butt welds. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6 inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

Manufacturer of mechanical tension splice shall be present for first day's installation

3.1.2.1 Reinforcing Steel Placement in Mat Foundations

Provide Class B tension lap splices for all bars #11 and smaller. Stagger splices as shown in the typical details

3.2 WELDED-WIRE FABRIC PLACEMENT

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Fabric placement at joints shall be as indicated. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.3 DOWEL INSTALLATION

Support slab-on-grade joint dowel bars independently of support for slab reinforcement on soil supported slab bolsters or specially manufactured cradles such that dowel bar remains parallel to slab surface and at right angles to joint during concreting operations. Lightly coat the exposed end of the dowel with a paraffin-base lubricant, asphalt emulsion, form oil, or grease or use a dowel bar sleeve.

3.4 Alternate Slab-on-Grade Joint Load Transfer Systems

Install the alternate load transfer system in accordance with the manufacturer's instructions such that the largest plane of the flat plate is parallel to the plane of the subgrade on which the slab is bearing

3.5 Additional Reinforcement at Sleeves and Openings

Provide and place additional reinforcing steel at all sleeves and openings in beams, slabs and walls as specified on the drawings. Where sleeves or openings not shown on the drawings interrupt the reinforcement, consult with Engineer for instructions for placing and splicing of bars. Provide required additional reinforcing steel at no additional cost to the Owner

3.6 SYNTHETIC FIBER REINFORCED CONCRETE

Fiber reinforcement shall be added to the concrete mix in accordance with the applicable sections of ASTM C1116/C1116M and the recommendations of the manufacturer, and in an amount of 0.1 percent by volume.

3.7 SHRINKAGE AND TEMPERATURE REINFORCEMENT

Provide shrinkage and temperature reinforcement as indicated on the drawings at right angles to main top and bottom bars for all structural slabs unless detailed otherwise on the drawings

3.8 REINFORCEMENT IN JOIST DISTRIBUTION RIBS

Provide reinforcement in ribs, minimum one - #5 continuous top and bottom unless indicated otherwise on the drawings

3.9 REINFORCEMENT IN COMPOSITE STEEL DECK SLAB

a. Composite steel deck slabs shall be reinforced as indicated on the

drawings

b. Extra Reinforcement over Girders: Provide additional reinforcing steel over interior girders as shown on the drawings

c. Placement of Slab Reinforcement: Provide bolsters, high chairs, and/or additional reinforcing as shown in details on the drawings to support the reinforcing with the clear cover shown on the drawings

d. Fiber-Reinforced Concrete in Composite Steel Deck Slabs:

Provide fibers of the type and at the dosage rate shown on the drawings in concrete cast over composite metal deck.

The fiber-reinforced concrete shall be produced in accordance with ASTM C1116/C1116M and have a residual strength of 80 psi.

3.10 REINFORCEMENT AROUND OPENINGS IN COMPOSITE STEEL DECK SLABS

For all openings in steel deck not framed with structural steel and greater than 10" in width in either direction, provide additional reinforcing steel as shown in details on the drawings

3.11 REINFORCEMENT IN PAN-FORMED BEAM SLABS

Provide reinforcing in pan-formed beam slabs as shown on the drawings. Provide required bar supports and additional reinforcing as shown in details on the drawings to support slab reinforcing with the clear cover shown on the drawings

3.12 REINFORCEMENT IN GRADE BEAMS

Provide reinforcing in grade beams as shown on the drawings. Grade beam bottom steel shall be supported at 5'-0" maximum centers using beam bolsters that provide 3" bottom cover to the reinforcing steel. Beam bolsters used shall be designed and manufactured for support on soil

3.13 REINFORCEMENT IN TOPPING SLABS

Provide welded smooth wire reinforcement minimum 6 x 6 W1.4 x W1.4 in all topping slabs unless specified otherwise on the drawings

3.14 REINFORCEMENT IN HOUSEKEEPING PADS

Provide welded smooth wire reinforcement 6 x 6 W2.9 x W2.9 minimum in all housekeeping pads supporting mechanical equipment unless detailed otherwise on the drawings

3.15 3.14 REINFORCEMENT IN SIDEWALKS

Provide welded smooth wire reinforcement minimum 6 x 6 W1.4 x W1.4 in all sidewalks unless detailed otherwise on the Architectural, Civil, or Structural Drawings

3.16 MECHANICAL AND PLUMBING REQUIREMENTS

Refer to Mechanical and Plumbing Drawings for concrete requiring reinforcing steel. Such reinforcement shall be furnished as part of the work of this section

-- End of Section --

SECTION 03 30 00

CAST-IN-PLACE CONCRETE
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 301	(2010; Errata 2011) Specifications for Structural Concrete
ACI 304.2R	(1996; R 2008) Placing Concrete by Pumping Methods
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305.1	(2006) Specification for Hot Weather Concreting
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 306R	(2010) Guide to Cold Weather Concreting
ACI 308.1	(2011) Specification for Curing Concrete
ACI 308R	(2001; R 2008) Guide to Curing Concrete
ACI 318	(2011; Errata 1 2011; Errata 2 2012; Errata 3-4 2013) Building Code

	Requirements for Structural Concrete and Commentary
ACI 347	(2004; Errata 2008; Errata 2012) Guide to Formwork for Concrete

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A775/A775M	(2007b) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A934/A934M	(2013) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM C1017/C1017M	(2007) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1107/C1107M	(2013) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1116/C1116M	(2010a) Standard Specification for Fiber-Reinforced Concrete
ASTM C1240	(2012) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C143/C143M	(2012) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C156	(2011) Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

ASTM C171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C192/C192M	(2013) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C233/C233M	(2011) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2012) Petrographic Examination of Aggregates for Concrete
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C311	(2011b) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C33/C33M	(2013) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2012) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2013) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C494/C494M	(2013) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881/C881M	(2010) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM C932	(2006; R 2013) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering

ASTM C94/C94M	(2013a) Standard Specification for Ready-Mixed Concrete
ASTM C989/C989M	(2012a) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C990	(2009) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM D1557	(2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D2628	(1991; R 2011) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D5759	(2012) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM D6690	(2012) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM E1155	(1996; R 2008) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E1745	(2011) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
ASTM E329	(2013a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2000) Principles and Criteria for Forest Stewardship

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1	(2009) DOC Voluntary Product Standard PS

1-07, Structural Plywood

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

U.S. DEPARTMENT OF COMMERCE (DOC)

DOC/NIST PS1	(1995) Construction and Industrial Plywood with Typical APA Trademarks

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-200	(Rev E; Am 1; Notice 1) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 DEFINITIONS

a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, ground granulated blast-furnace slag, and silica fume.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings for concrete formwork must be submitted by the Contractor in accordance with paragraph entitled, "Shop Drawings," of this section, to include the following:

Formwork
Column Forms
Wall Forms
Floor Forms
Ceiling Forms
Special Construction

Reinforcing steel; G

Reproductions of contract drawings are unacceptable.

Provide erection drawings for concrete Formwork that show placement of reinforcement and accessories, with reference to the contract drawings.

SD-03 Product Data

Materials for curing concrete
Joint sealants; (LEED NC)

Submit manufacturer's product data, indicating VOC content. Manufacturer's catalog data for the following items must include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders, waterstops, and liquid chemical floor hardeners.

Joint filler; (LEED NC)
Plastic Forms

Recycled Aggregate Materials; (LEED NC)
Cement; (LEED NC)
Portland Cement
Ready-Mix Concrete; (LEED NC)
Vapor retarder
Bonding Materials
Floor Finish Materials
Concrete Curing Materials

Reinforcement Materials
Liquid Chemical Floor Hardener; (LEED NC)

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

Vapor retarder

Epoxy bonding compound

Waterstops

Wood Forms

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

Biodegradable Form Release Agent

Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.

SD-04 Samples

Slab finish sample

Submit the following samples:

Three samples of each type waterstop, 1/2 inch long.

Dumbbell Type
Rubber
Polyvinylchloride (PVC)

SD-05 Design Data

Concrete mix design; G

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, silica fume, ground slag polypropylene fibers, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which produce a range of strength encompassing those required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submit copies of the fly ash, silica fume, polypropylene fibers and pozzolan test results, in addition. The approval of fly ash, silica fume, pozzolan , and polypropylene fibers test results must be within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement.

Calculations

SD-06 Test Reports

Concrete mix design; G

Fly ash

Pozzolan

Ground granulated blast-furnace slag

Aggregates

Fiber-reinforced concrete

Tolerance report

Compressive strength tests

Slump

Air Entrainment

SD-07 Certificates

Curing concrete elements

Pumping concrete

Silica fume manufacturer's representative

Form removal schedule

Biodegradable Form Release Agent

VOC Content for form release agents, curing compounds, and concrete penetrating sealers

Forest Stewardship Council (FSC) Certification

SD-08 Manufacturer's Instructions

Fly ash

Ground granulated blast-furnace slag

Welding Procedures must be in accordance with AWS D1.4/D1.4M.

Provide certificates for concrete that are in accordance with the paragraph entitled, "Classification and Quality of Concrete," of this section. Provide certificates that contain project name and number, date, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer, brand name of manufactured materials, material name, values as specified for each material, and test results. Provide

certificates for Welder Qualifications that are in accordance with the paragraph entitled, "Qualifications for Welding Work," of this section.

Welding Procedures

SD-11 Closeout Submittals
Local / Regional Materials; (LEED NC)
Redcycled Content
Low Emitting Materials - Adhesive Sealants

1.5 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.6 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor retarder, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.6.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.7 QUALITY ASSURANCE

1.7.1 Design Data

1.7.1.1 Formwork Calculations

. Include design calculations indicating arrangement of forms, sizes and grades of supports (lumber), panels, and related components in conformance with ACI 347. Furnish drawings and calculations of shoring and re-shoring methods proposed for floor and roof slabs, spandrel beams, and other horizontal concrete members.

1.7.2 Drawings

1.7.2.1 Shop Drawings

Fabrication Drawings for concrete formwork for Reinforcement Materials, Column Forms, Wall Forms, Floor Forms, Ceiling Forms and for Special Construction must indicate concrete pressure calculations with both live and dead loads, along with material types. Provide all design calculations in accordance with ACI 347.

1.7.2.2 Formwork

Drawings showing details of formwork including, but not limited to; joints, supports, studding and shoring, and sequence of form and shoring removal. Reproductions of contract drawings are unacceptable.

Design, fabricate, erect, support, brace, and maintain formwork so that it is capable of supporting without failure all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.

1.7.2.3 Reinforcing Steel

Reference 03 20 00.00 10 for detailing of reinforcement

1.7.3 Control Submittals

1.7.3.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.7.3.2 Pumping Concrete

Submit proposed materials and methods for pumping concrete. Submittal must include mix designs, pumping equipment including type of pump and size and material for pipe, and maximum length and height concrete is to be pumped.

1.7.3.3 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative must be present at mix plant to ensure proper mix, including high range water reducer, and batching methods during the first 3 days of concrete mix preparation and placement. After which the manufacturer's representative must designate a representative at the concrete producer's plant to ensure the concrete mix procedures meet the silica fume manufacturer's recommendations. Representative to attend and advise at finishing of sample slab.

1.7.3.4 Form Removal Schedule

Submit schedule for form removal indicating element and minimum length of time for form removal.

1.7.3.5 VOC Content for form release agents, curing compounds, and concrete penetrating sealers

Submit certification for the form release agent, curing compounds, and concrete penetrating sealers that indicate the VOC content of each product.

1.7.4 Test Reports

1.7.4.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. Include mill test and all other test for cement, silica fume, aggregates, and admixtures in the laboratory test reports. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the

concrete mix design. Obtain approval before concrete placement.

1.7.4.2 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on fly ash use in concrete.

1.7.4.3 Ground Granulated Blast-Furnace Slag

Submit test results in accordance with ASTM C989/C989M for ground granulated blast-furnace slag. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on slag use in concrete.

1.7.4.4 Fiber-Reinforced Concrete

Test to determine flexural toughness index I5 in accordance with ASTM C1116/C1116M.

1.7.5 Field Samples

1.7.5.1 Slab Finish Sample

Install minimum of 10 foot by 10 foot slab. Finish as required by specification. Silica fume manufacturer's representative must attend and advise.

1.7.6 Special Finisher Qualifications

For 35 percent or more fly ash content as a percentage of cementitious materials, finisher must have a minimum of 3 years' experience finishing high-volume fly ash concrete.

1.8 ENVIRONMENTAL REQUIREMENTS

Provide space ventilation according to manufacturer recommendations, at a minimum, during and following installation of concrete curing compound and sealer. Maintain one of the following ventilation conditions during the curing compound/sealer curing period or for 72 hours after installation:

a. Supply 100 percent outside air 24 hours a day.

b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 84 degrees F and humidity is between 30 percent and 60 percent.

c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.8.1 Submittals for Environmental Performance

a. Provide data indication the percentage of post-industrial pozzolan (fly ash, blast furnace slag) cement substitution as a percentage of the full product composite by weight.

b. Provide data indicating the percentage of post-industrial and post-consumer recycled content aggregate.

c. Provide product data indicating the percentage of post-consumer recycled steel content in each type of steel reinforcement as a percentage of the full product composite by weight.

d. Provide product data stating the location where all products were manufactured

e. For projects using FSC certified formwork, provide chain-of-custody documentation for all certified wood products.

f. For projects using reusable formwork, provide data showing how formwork is reused.

g. Provide MSDS product information data showing that form release agents meet any environmental performance goals such as using vegetable and soy based products.

h. Provide MSDS product information data showing that concrete adhesives meet any environmental performance goals including low emitting, low volatile organic compound products.

1.9 SUSTAINABLE DESIGN REQUIREMENTS

1.9.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Concrete materials may be locally available.

1.9.2 Forest Stewardship Council (FSC) Certification

Use FSC-certified wood where specified. Provide letter of certification signed by lumber supplier. Indicate compliance with FSC STD 01 001 and identify certifying organization. Submit FSC certification numbers; identify each certified product on a line-item basis. Submit copies of invoices bearing the FSC certification numbers.

1.10 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Perform concrete testing by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency must meet the requirements of ASTM E329.

1.11 QUALIFICATIONS FOR WELDING WORK

Section 05 05 23 WELDING, STRUCTURAL applies to work specified in this section.

Welding procedures must be in accordance with AWS D1.4/D1.4M.

Verify that Welder qualifications are in accordance with AWS D1.4/D1.4M or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

1.12 CONCRETE SAMPLING AND TESTING

Testing by the Contractor must include sampling and testing concrete materials proposed for use in the work and testing the design mix for each class of concrete. Perform quality control testing during construction.

Sample and test concrete aggregate materials proposed for use in the work in accordance with ASTM C33/C33M.

Sample and test portland cement in accordance with ASTM C150/C150M.

Sample and test air-entraining admixtures in accordance with ASTM C233/C233M.

Testing must be performed by a Grade I Testing Technician.

PART 2 PRODUCTS

2.1 MATERIALS FOR FORMS

Provide wood, plywood, plastic, carton, or steel. Use plywood or steel forms where a smooth form finish is required.

2.1.1 Wood Forms

Use lumber as specified in Section 06 10 00 ROUGH CARPENTRY and as follows. Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with DOC/NIST PS1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining. Submit data verifying that composite wood products contain no urea formaldehyde resins. Virgin wood used must be FSC-certified.

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to NIST PS 1, B-B, high density form overlay, not less than 5/8-inch thick.

2.1.2 Plastic Forms

Plastic lumber as specified in Section 06 10 00 ROUGH CARPENTRY. Provide plastic forms that contain a minimum of 50 percent post-consumer recycled content, or a minimum of 50 percent post-industrial recycled content.

2.1.3 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.2 FORM TIES AND ACCESSORIES

The use of wire alone is prohibited. Provide form ties and accessories that do not reduce the effective cover of the reinforcement.

2.2.1 Polyvinylchloride Waterstops

COE CRD-C 572.

2.2.2 Dovetail Anchor Slot

Preformed metal slot approximately 1 by 1 inch of not less than 22 gage galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

2.3 CONCRETE

2.3.1 Contractor-Furnished Mix Design

Indicate the compressive strength (f'c) of the concrete for each portion of the structure(s) and as specified in the Class of Concrete Matrix.

Maximum slump shown in the Class of Concrete Matrix may be increased 1 inch for methods of consolidation other than vibration. Slump may be increased to 8 inches when superplasticizers are used. The water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days must not exceed 0.5% chloride ions by weight of the admixture. For concrete exposed to sulfate exposure class S2 or S3 as noted on the drawings, admixtures must be completely free of chloride ions.

Proportion concrete mixes for strength at 28 days and56 days as indicated.

2.3.1.1 Mix Proportions for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified are the responsibility of the Contractor. Base mixture proportions on compressive strength as determined by test specimens fabricated in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M. Samples of all materials used in mixture proportioning studies must be representative of those proposed for use in the project and must be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Base trial mixtures having proportions, consistencies, and air content suitable for the work on methodology described in ACI 211.1. In the trial mixture, use at least three different water-cement ratios for each type of mixture, which must produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratio required must be based on equivalent water-cement ratio calculations as determined by the conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast-furnace slag by weight equivalency method. Design laboratory trial mixture for maximum permitted slump and air content. Each combination of material proposed for use must have separate trial mixture, except for accelerator or retarder use can be provided without separate trial mixture. Report the temperature of concrete in each trial batch. For each water-cement ratio, at least three test cylinders for each test age must be made and cured in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M for 7 and 28 days. From these results, plot a curve showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, plot a curve showing the relationship between 7 and 28 day strengths.

2.3.1.2 Required Average Strength of Mix Design

The selected mixture must produce an average compressive strength exceeding the specified strength by the amount indicated in ACI 214R, ACI 301 and ACI 318. When a concrete production facility has a record of at least 15 consecutive tests, the standard deviation must be calculated and the required average compressive strength must be determined in accordance with ACI 214R. When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength must follow ACI 214R requirements.

2.3.2 Ready-Mix Concrete LEED NC

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94/C94M:

Type and brand cement

Cement content in 94-pound bags per cubic yard of concrete

Maximum size of aggregate

Amount and brand name of admixtures

Total water content expressed by water/cement ratio

2.3.3 Concrete Curing Materials

2.3.3.1 Absorptive Cover

Provide burlap, cotton mats, and other absorbent materials for curing concrete, as described in ACI 308R.

2.3.3.2 Moisture-Retaining Cover

Provide waterproof paper cover for curing concrete conforming to ASTM C171, regular or white, or polyethylene sheeting conforming to ASTM C171, or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap must conform to ASTM C171, Class 3, and polyethylene film must conform to ASTM C171. When tested for water retention in accordance with ASTM C156, weight of water lost 72 hours after application of moisture retaining covering material must not exceed 0.039 gram per square centimeter of the mortar specimen surface.

2.3.3.3 Membrane-Forming Curing Compound

Provide liquid type compound conforming to ASTM C309, Type 1, clear, Type 1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

2.4 MATERIALS

2.4.1 Cement

ASTM C150/C150M, Type II. Provide blended cement that consists of a

mixture of ASTM C150/C150M, Type II, cement and one of the following materials: ASTM C618 pozzolan or fly ash, ASTM C989/C989M ground granulated blast-furnace slag. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. Supplier must certify that no hazardous waste is used in the fuel mix or raw materials. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

2.4.1.1 Fly Ash and Pozzolan

ASTM C618, Type F, or C, except that the maximum allowable loss on ignition must be 6 percent for Type F. Add with cement. Fly ash content must be a minimum of 15 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311. Evaluate and classify fly ash in accordance with ASTM D5759.

High contents of supplementary cementitious materials can have some detrimental effects on the concrete properties, such as slowing excessively the strength gain rate, and delaying and increasing the difficulty of finishing. The recommended maximum content (by weight of the total cementitious material) for these materials are:

1. For GGBF slag: 50 percent

2. For fly ash or natural pozzolan: 40 percent (25 percent in cold climates)

3. For silica fume: 10 percent

2.4.1.2 Ground Granulated Blast-Furnace Slag

ASTM C989/C989M, Grade 100 OR120. Slag content in combination with fly ash shall not exceed the limits noted in section 2.8.1 as a percent by weight of cementitious material.

2.4.1.3 Silica Fume
ASTM C1240, provide silica fume that is a by-product of silicon or ferrosilicon productionwhere noted on the drawings. Provide 7 percent by weight of the total cementitious material.

2.4.1.4 Portland Cement

Provide cement that conforms to ASTM C150/C150M, Type II, or IIA. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.4.2 Water

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementitious materials (cement plus pozzolans), and in general, improve workability by adjusting the grading rather than by adding water. Water must be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.4.3 Aggregates

ASTM C33/C33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement.

Fine and coarse aggregates must show expansions less than 0.08 percent at 16 days after casting when testing in accordance with ASTM C1260. Should the test data indicate an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1567 using the Contractor's proposed mix design. In this case, include the mix design low alkali portland cement and one of the following supplementary cementitious materials:

1. GGBF slag at a minimum of 40 percent of total cementitious

2. Fly ash or natural pozzolan at a minimum of total cementitious of
   a. 30 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 65 percent or more,
   b. 25 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 70 percent or more,
   c. 20 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 80 percent or more,
   d. 15 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 90 percent or more.

3. Silica fume at a minimum of 7 percent of total cementitious.

If a combination of these materials is chosen, the minimum amount must be a linear combination of the minimum amounts above. Include these materials in sufficient proportion to show less than 0.08 percent expansion at 16 days after casting when tested in accordance with ASTM C1567.

Aggregates must not possess properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C295/C295M.

2.4.3.1 Aggregates/Combined Aggregate Gradation (Floor Slabs Only)

ASTM C33/C33M, uniformly graded and as follows: Nominal maximum aggregate size of 1 inch. A combined sieve analysis must indicate a well graded aggregate from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3mm). Provide sand that is at least 50 percent natural sand.

2.4.3.2 Recycled Aggregate Materials

Use a minimum of 25 percent recycled aggregate, depending on local availability and conforming to requirements of the mix design. Recycled aggregate to include: recovered concrete recovered stone that meets the aggregate requirements specified. Submit recycled material request with the aggregate certification submittals and do not use until approved by the Contracting Officer.

2.4.4 Nonshrink Grout

ASTM C1107/C1107M.

2.4.5 Admixtures

ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures.

2.4.5.1 High Range Water Reducer (HRWR) (Superplasticizers)

ASTM C494/C494M, Type F and Type G (HRWR retarding admixture) and ASTM C1017/C1017M. Silica fume and HRWR must come from the same manufacturer.

2.4.5.2 Pozzolan

Provide fly ash or other pozzolans used as admixtures that conform to ASTM C618.

2.4.6 Vapor Retarder

ASTM E1745 Class A polyolefin sheeting, minimum 15 mil thickness or other equivalent material.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.4.7 Materials for Curing Concrete

Use water-based curing compounds, sealers, and coatings with zero VOC content.

Consider the use of water based or vegetable or soy based curing agents in lieu of petroleum based products. Consider agents that are not toxic and emit low or no Volatile Organic Compounds (VOC). Consider the use of admixtures that offer high performance to increase durability of the finish product but also have low toxicity and are made from bio-based materials such as soy, and emit low levels of Volatile Organic Compounds (VOC).

2.4.7.1 Impervious Sheeting

ASTM C171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.4.7.2 Pervious Sheeting

AASHTO M 182.

2.4.7.3 Liquid Membrane-Forming Compound

ASTM C309, white-pigmented, Type 2, Class B.

2.4.8 Liquid Chemical Sealer-Hardener Compound

Provide surface treatments containing certain chemicals, including sodium silicate and the fluosilicates of magnesium and zinc. Provide compound that does not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.4.9 Expansion/Contraction Joint Filler

ASTM D1751, ASTM D1752, cork or 100 percent post-consumer paper meeting ASTM D1752 (subparagraphs 5.1 to 5.4). Material must be 1/2 inch thick, unless otherwise indicated.

2.4.9.1 Preformed Joint Filler Strips

Provide nonextruding and resilient bituminous type filler strips conforming to ASTM D1751.

2.4.10 Joint Sealants

Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content.

2.4.10.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D6690 or ASTM C920, Type M, Class 25, Use T.

2.4.10.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C920, Type M, Grade NS, Class 25, Use T.

2.4.10.3 Waterstops

Provide waterstops that are flat dumbbell type, not less than 3/16 inch for widths up to 5 inches, and not less than 3/8 inch for widths 5 inches and over.

Provide waterstops made of rubber and that conform to ASTM D1752.

Provide waterstops made of polyvinylchloride (PVC) and that conform to ASTM C990ASTM D2628.

2.4.10.4 Joint Sealant Compound

Provide cold-applied, two-component, elastomeric polymer type compound conforming to FS SS-S-200.

2.4.11 Epoxy Bonding Compound

ASTM C881/C881M. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if placement temperature is below 40 degrees F; Class B if placement temperature is between 40 and 60 degrees F; or Class C if placement temperature is above 60 degrees F.

2.4.12 Biodegradable Form Release Agent

Provide form release agent that is colorless, biodegradable, and water-based, with zero VOC content. A minimum of 85 percent of the total product must be biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils,

waxes, or kerosene.

2.5 BONDING MATERIALS

2.5.1 Concrete Bonding Agent

Provide aqueous-phase, film-forming, nonoxidizing, freeze and thaw-resistant compound agent suitable for brush or spray application conforming to ASTM C932.

2.5.2 Epoxy-Resin Adhesive Binder

Provide two-component, epoxy-polysulfide polymer type binder with an amine-type curing-agent conforming to ASTM C881/C881M.

2.6 FLOOR FINISH MATERIALS

2.6.1 Liquid Chemical Floor Hardener

Hardener must be a colorless aqueous solution containing a blend of magnesium fluorosilicate and zinc fluorosilicate combined with a wetting agent. Solution must contain not less than 1/2 pounds of fluorosilicates per gallon. An approved proprietary chemical hardener may be used provided hardener is delivered ready for use in manufacturer's original containers.

2.6.2 Abrasive Aggregate for Nonslip Aggregate Finish

Aggregate must be packaged, factory-graded fused aluminum oxide grits, or it may be crushed emery containing not less than 40-percent aluminum oxide and not less than 25-percent ferric oxide. Aggregate must be rust proof and nonglazing and must be unaffected by freezing, moisture, and cleaning materials.

Aggregate must be packaged, factory-graded, silicon carbide grits. Aggregate must be rust proof and must be unaffected by freezing, moisture, and cleaning materials.

Aggregate must be well-graded in size from particles retained on No. 30 sieve (0.0236 inch) to particles passing No. 8 sieve (0.0929 inch).

2.6.3 NOT USED

2.7 CLASSIFICATION AND QUALITY OF CONCRETE

2.7.1 Concrete Classes and Usage

Provide concrete classes, compressive strength, requirements for air entrainment, and usage as indicated in the Class of Concrete Matrix as noted in the construction documents General Notes sheet:

2.7.2 Limits for Concrete Proportions

Provide limits for maximum water/cement ratio and minimum cement content for each concrete class as indicated in the Class of Concrete Matrix as noted in the construction documents General Notes sheet:

2.7.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, must be as indicated in the Class of Concrete Matrix as noted in the construction documents General Notes sheet:

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

Specify gradation of aggregates for separate floor topping.

2.7.4 Slump

Provide slump for concrete at time and in location of placement as follows:

TYPE OF CONSTRUCTION	SLUMP
Footings, unreinforced walls	Not less than 1 inch nor more than 3 inches
Columns, beams, reinforced walls, monolithic slabs	Not less than 1 inch nor more than 4 inches
Ramps and other sloping surfaces	0 nor more than 3 inches

2.7.5 Total Air Content

Air content of exposed concrete and interior concrete must be in accordance with ASTM C260/C260M and/or as indicated in the Class of Concrete Matrix as noted in the construction documents General Notes sheet:

PART 3 EXECUTION

3.1 EXAMINATION

Do not begin installation until substrates have been properly constructed; verify that substrates are plumb and true.

If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before processing.

Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Architect/Engineer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water and other deleterious substances before start of concrete placing.

Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder; this may also be used over semiporous, dry subgrade material instead of water sprinkling.

3.2.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

Previously constructed subgrade or fill must be cleaned of foreign materials and inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 12 inches of subgrade soil material-in-place must not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D1557.

SOIL MATERIAL	PERCENT MAXIMUM DENSITY
Capillary water barrier	100
Cohesionless soil material	100
Cohesive soil material	95

Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

Prepare subgrade or fill surface under exterior slabs on ground as specified for subgrade under foundations and footings.

3.2.4 Formwork

Complete and approve formwork. Remove debris and foreign material from interior of forms before start of concrete placing.

3.2.5 Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.6 Reinforcement and Other Embedded Items

Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

3.3 FORMS

Reference section 03 11 13.00 10.

3.4 WATERSTOP SPLICES

Fusion weld in the field.

3.5 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

Reference section 03 20 00.00 10

3.5.1 General

Provide details of reinforcement that are in accordance with section 03 20 00.00 10 and as specified.

3.5.2 Vapor Retarder

Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tape or cement joints. Remove torn, punctured, or damaged vapor retarder and vapor barrier material and provide with new vapor retarder and vapor barrier prior to placing concrete. Concrete placement must not damage vapor retarder material.

3.5.3 Reinforcement Supports

Place reinforcement and secure in accordance with section 03 20 00.00 10.

ASTM A934/A934M. ASTM A775/A775M. Rest epoxy-coated reinforcing bars supported from formwork on coated wire bar supports, or on bar supports made of dielectric material or other acceptable material. Coat wire bar supports with dielectric material, compatible with concrete, for a minimum distance of 2 inches from the point of contact with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars must be epoxy coated. Spreader bars, where used, must be epoxy coated. Make proprietary combination bar clips and spreaders used in construction with epoxy-coated reinforcing bars corrosion resistant or coated with dielectric material. Tie epoxy-coated bars with plastic-coated tie wire; or other materials acceptable to the Contracting Officer.

3.5.4 Splicing

Reference section 03 20 00.00 10 ASTM A780/A780M.

3.5.5 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.5.6 Cover

Reference structural drawings typical details for minimum coverage, unless otherwise indicated.

3.5.7 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.5.8 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.5.9 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.5.10 Fabrication

Shop fabricate reinforcing bars in accordance with section 03 20 00.00 10

3.5.11 Placing Reinforcement

Place reinforcement in accordance with section 03 20 00.00 10.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire fabric on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than 1 inch from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 3-1/2 by 3-1/2 inches, and of thickness equal to

that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Contractor must cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor must notify the Contracting Officer so that conflicts may be reconciled before placing concrete. Anchors and embedded items must be positioned and supported with appropriate accessories.

Handle epoxy-coated reinforcing bars carefully to prevent damage to the coating. Use plastic-coated tie wire and supports of a type to prevent damage to the reinforcing bars.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Provide supports for reinforcing bars that are sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI 318. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

Equip supports on ground and similar surfaces with sand-plates.

Support welded wire fabric as required for reinforcing bars.

Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

With the exception of temperature reinforcement, tied to main steel approximately 24 inches on center, reinforcement must be accurately placed, securely tied at intersections with 18-gage annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to ACI 318.

Bending of reinforcing bars partially embedded in concrete is permitted only as specified in section 03 20 00.00 10.

3.5.12 Spacing of Reinforcing Bars

Spacing must be as indicated. If not indicated, spacing must be in accordance with the ACI 318.

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to approval.

3.5.13 Concrete Protection for Reinforcement

Concrete protection must be in accordance with the structural drawings and ACI 318.

3.5.14 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.6 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ACI 318, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.6.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

3.6.2 Mixing

ACI 304R Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.6.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.7 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris and water from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

3.7.1 General Placing Requirements

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section

cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation.

Concrete to receive other construction must be screeded to proper level to avoid excessive skimming or grouting.

Do not use concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Use of retempered concrete is permitted. Remove rejected concrete from the site.

3.7.2 Vibration

Reference ACI 304.2R and ASTM A775/A775M. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Penetrate the previously placed lift with the vibrator when more than one lift is required. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

3.7.3 Application of Epoxy Bonding Compound

Apply a thin coat of compound to dry, clean surfaces. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is stringy. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

3.7.4 Pumping

Reference ACI 304.2R. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.7.5 Cold Weather

Reference ACI 306R and ACI 306.1. Do not allow concrete temperature to decrease below 50 degrees F. Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the

rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

3.7.6 Hot Weather

Maintain required concrete temperature using Figure 2.1.5 in Reference ACI 305R and ACI 305.1 to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.7.7 Follow-up

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

3.7.8 Placing Concrete in Forms

Deposit concrete placed in forms in horizontal layers not exceeding 24 inches.

Remove temporary spreaders in forms when concrete placing has reached elevation of spreaders.

Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Provide vibrating equipment adequate in number of units and power of each unit to properly consolidate concrete. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Do not insert vibrator into lower courses of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Do not start placing of concrete in supporting elements until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

3.7.9 Placing Concrete Slabs

Place and consolidate concrete for slabs in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, consolidate concrete by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Consolidate concrete placed in

beams and girders of supported slabs and against bulkheads of slabs on ground by mechanical vibrators as specified. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other approved method. Limit consolidation operations to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated must be as dry as practical and surfaces thereof must not be manipulated prior to finishing operations. Bring concrete correct level with a straightedge and struck-off. Use bull floats or darbies to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface is not permitted.

Provide finish of slabs as specified.

3.7.10 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Apply such bonding material to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

3.8 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.8.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 1 square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of

corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI 117-06. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise specified.

3.8.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

3.8.3 Formed Surfaces

3.8.3.1 Tolerances

Reference ACI 117 and as indicated.

3.8.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch these holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 0.25 inch in height.

3.8.3.3 Standard Smooth Finish

Finish must be as-cast concrete surface as obtained with form facing material for standard smooth finish. Repair and patch defective areas as specified, by grinding, filling or other approved methods; remove other projections on surface.

3.8.4 NOT USED

3.8.5 Surface Finish Samples

Provide a minimum of three sample concrete panels for each finish for each mix design, 3 by 3 feet, 3 inches thick. Use the approved concrete mix design(s). Provide sample panels on-site at locations directed. Once approved, each set of panels must be representative of each of the finishes specified and of the workmanship and finish(es) required. Do not remove or destroy samples until directed by the Contracting Officer.

3.8.6 Grout Finish

Provide finish that is standard, smooth coated with grout as specified.

Give finish to interior and exterior concrete vertical surfaces that are to be exposed to view.

Grout is required consisting of one part portland cement to 1-1/2 parts fine aggregate by volume, mixed with water to produce a consistency of thick paint. Portland cement portion must be a blend of standard portland cement and white portland cement, proportioned as determined by trial mixes so that final color of grout when dry approximates color of surrounding concrete. Fine aggregate must pass No. 30 mesh sieve.

Surface of concrete is required to be wetted, and grout must be applied immediately to wetted surfaces. Spread grout over surface with clean burlap pads or sponge-rubber floats to fill pits, air bubbles, and surface holes. Remove excess grout by scraping, then rubbing surface with clean burlap to remove visible grout film. Keep grout damp by means of fog

spray during setting period. Complete finish the day it is started, and make limits of a finished area at natural breaks in finished surface.

3.9 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

Reference ACI 117, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Depress the concrete base slab where quarry tile, ceramic tile are indicated. Steel trowel and fine-broom finish concrete slabs that are to receive quarry tile, ceramic tile, or paver tile . Where straightedge measurements are specified, Contractor must provide straightedge.

3.9.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.9.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. After the concrete has been placed, consolidated, struck off, and leveled to a Class C tolerance as defined below,roughen the surface with stiff brushes of rakes before final set.

3.9.1.2 Floated

Use for surfaces to receive roofing, waterproofing membranes, sand bed terrazzo and exterior slabs where not otherwise specified. After the concrete has been placed, consolidated, struck off, and leveled, do not work the concrete further, until ready for floating. Whether floating with a wood, magnesium, or composite hand float, with a bladed power trowel equipped with float shoes, or with a powered disc, float must begin when the surface has stiffened sufficiently to permit the operation. During or after the first floating, check surface with a 10 foot straightedge applied at no less than two different angles, one of which is perpendicular to the direction of strike off. Cut down high spots and fill low spots during this procedure to produce a surface level within 1/4 inch in 10 feet.

3.9.1.3 Concrete Containing Silica Fume

Finish using magnesium floats or darbies. Finish using techniques demonstrated in the sample installation.

3.9.1.4 Steel Troweled

Use for floors intended as walking surfaces and for reception of floor coverings. First, provide a floated finish. Next, the finish must be power troweled three times, and finally hand troweled. The first troweling after floating needs to produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings done by hand after the surface has hardened sufficiently. The final troweling is done when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate the surface by the hand troweling operations. The finished surface must

be essentially free of trowel marks and uniform in texture and appearance. The finished surface must produce a surface level to within 1/4 inch in 10 feet. On surfaces intended to support floor coverings, remove any defects of sufficient magnitude to show through the floor covering by grinding.

3.9.1.5 Nonslip Finish

Use on surfaces of exterior platforms, steps, and landings; and on exterior and interior pedestrian ramps. Apply dry shake aggregate of ceramically bonded aluminum oxide to the surface at a minimum rate of 25 pounds per 100 square feet. Blend approximately two-thirds of the aggregate with portland cement as recommended by the manufacturer and apply to the surface evenly and without segregation. After blended material has been embedded by floating, apply the remainder of the blended material to the surface at right angles to the previous application. Apply blended material heavier in any areas not sufficiently covered by the first application. Perform a second floating immediately following the first. After the selected material has been embedded by the two floatings, complete the operation with a broomed finish.

3.9.1.6 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.9.1.7 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by belting. Lay belt flat on the concrete surface and advance with a sawing motion; continue until a uniform but gritty nonslip surface is obtained. Round edges and joints with an edger having a radius of 1/8 inch.

3.9.1.8 Concrete Toppings Placement

The following requirements apply to the placement of toppings of concrete on base slabs that are either freshly placed and still plastic, or on hardened base slabs.

a. Placing on a Fresh Base: Screed and bull float the base slab. As soon as the water sheen has disappeared, lightly rake the surface of the base slab with a stiff bristle broom to produce a bonding surface for the topping. Immediately spread the topping mixture evenly over the roughened base before final set takes place. Give the topping the finish specified on the architectural drawings.

b. Bonding to a Hardened Base: When the topping is to be bonded to a floated or troweled hardened base, roughen the base by scarifying, grit-blasting, scabbling, planing, flame cleaning, or acid-etching to lightly expose aggregate and provide a bonding surface. Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the clean base wet for a period of 12 hours preceding the application

of the topping. Remove excess water and apply a 1:1:1/2 cement-sand-water grout, and brush into the surface of the base slab. Do not allow the cement grout to dry, and spread it only short distances ahead of the topping placement. Do not allow the temperature differential between the completed base and the topping mixture to exceed 41 degrees F at the time of placing. Place the topping and finish aswhere indicated in the construction documents .

3.9.1.9 Chemical-Hardener Treatment

Apply liquid-chemical floor hardener where indicated after curing and drying concrete surface. Dilute liquid hardener with water and apply in three coats. First coat must be one-third strength, second coat one-half strength, and third coat two-thirds strength. Apply each coat evenly and allow to dry 24 hours between coats.

Approved proprietary chemical hardeners must be applied in accordance with manufacturer's printed directions.

3.9.1.10 NOT USED

3.9.1.11 NOT USED

3.9.2 Flat Floor Finishes

Construct in accordance with one of the methods recommended in Table 7.15.3, "Typical Composite Ff/FL Values for Various Construction Methods." ACI 117 for tolerance tested by ASTM E1155.

a. Specified Conventional Value for slabs in non-public areas, mechanical rooms, surfaces to receive raised computer flooring, surfaces to have a thick-set tile or a topping.:

Floor Flatness (Ff) 20 13 minimum
Floor Levelness (FL) 15 10 minimum

b. Specified Industrial:

Floor Flatness (Ff) 30 15 minimum
Floor Levelness (FL) 20 10 minimum

c. Specified Moderately Flat for carpeted areas:
Floor Flatness (Ff) 25 15 minimum
Floor Levelness (FL) 20 13 minimum

c. Specified Flat for exposed slabs in public spaces and slabs to receive a thin-set flooring:
Floor Flatness (Ff) 35 21 minimum
Floor Levelness (FL) 25 15 minimum

3.9.2.1 Measurement of Floor Tolerances

Test slab within 24 hours of the final troweling. Provide tests to Contracting Officer within 12 hours after collecting the data. Floor flatness inspector is required to provide a tolerance report which must

include:

a. Key plan showing location of data collected.

b. Results required by ASTM E1155.

3.9.2.2 Remedies for Out of Tolerance Work

Contractor is required to repair and retest any floors not meeting specified tolerances. Prior to repair, Contractor must submit and receive approval for the proposed repair, including product data from any materials proposed. Repairs must not result in damage to structural integrity of the floor. For floors exposed to public view, repairs must prevent any uneven or unusual coloring of the surface.

3.9.3 Concrete Walks

Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints one inch deep with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.

3.9.4 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.9.5 Curbs

Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.

3.9.6 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, and must be 24 inches long, 12 inches wide and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

3.10 CURING AND PROTECTION

Reference ACI 308.1 and ACI 308R unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing

period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.10.1 General

Protect freshly placed concrete from premature drying and cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Start initial curing as soon as free water has disappeared from surface of concrete after placing and finishing. Keep concrete moist for minimum 72 hours.

Final curing must immediately follow initial curing and before concrete has dried. Continue final curing until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 50 degrees F has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Prevent rapid drying at end of final curing period.

3.10.2 Moist Curing

Remove water without erosion or damage to the structure. Prevent water run-off.

3.10.2.1 Ponding or Immersion

Continually immerse the concrete throughout the curing period. Water must not be more than 50 degrees F less than the temperature of the concrete. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.10.2.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.10.2.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6 inches over adjacent sheeting. Provide sheeting that is at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3.10.2.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12

inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.10.3 Liquid Membrane-Forming Curing Compound

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where hot weather conditions can cause an evaporation rate exceeding 0.2 pound of water per square foot per hour.

3.10.3.1 Application

Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has a dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats must be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound must form a uniform, continuous, coherent film that does not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Re-spray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.10.3.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.10.4 Liquid Chemical Sealer-Hardener

Apply sealer-hardener to interior floors not receiving floor covering and floors located under access flooring. Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. Do not apply the sealer hardener until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.10.5 NOT USED

3.10.6 Curing Periods

Reference ACI 308.1 and ACI 308R except 10 days for retaining walls, pavement or chimneys, 21 days for concrete that is in full-time or intermittent contact with seawater, salt spray, alkali soil or waters. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period

necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.10.7 Curing Methods

Accomplish curing by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified.

Moist curing:

Accomplish moisture curing by any of the following methods:

Keeping surface of concrete wet by covering with water

Continuous water spraying

Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Place absorptive cover to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Accomplish moisture-retaining cover curing by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Place cover directly on concrete in widest practical width, with sides and ends lapped at least 3 inches. Weight cover to prevent displacement; immediately repair tears or holes appearing during curing period by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Accomplish membrane curing by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Apply curing compound uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Apply second coat in a direction at right angles to direction of first coat. Total coverage for two coats must be not more than 200 square feet per gallon of curing compound. Respray concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied by method and at rate specified. Maintain continuity of coating for entire curing period and immediately repair damage to coating during this period.

Membrane-curing compounds must not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, painting, and other coatings and finish materials.

3.10.8 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of

formed surfaces by any of the curing methods specified above, as applicable.

3.10.9 Curing Unformed Surfaces

Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

Unless otherwise specified, accomplish final curing of unformed surfaces by any of curing methods specified above, as applicable.

Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.10.10 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.10.11 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.10.12 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.11 FIELD QUALITY CONTROL

3.11.1 Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

3.11.2 Testing

3.11.2.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders

are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

3.11.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.11.2.3 Compressive Strength Tests

ASTM C39/C39M. Make five test cylinders for each set of tests in accordance with ASTM C31/C31M. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. Take samples for strength tests of each mix design of concrete placed each day not less than once a day, nor less than once for each 160 cubic yards of concrete, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 450 psi, take a minimum of three ASTM C42/C42M core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core test is considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Retest locations represented by erratic core strengths. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.11.2.4 Strength of Concrete Structure

Compliance with the following is considered deficient if it fails to meet the requirements which control strength of structure in place, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

3.11.2.5 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does

not meet specification requirements, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C42/C42M, and as follows:

Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

Test cores after moisture conditioning in accordance with ASTM C42/C42M if concrete they represent is more than superficially wet under service.

Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.12 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows.

3.12.1 Mixing Equipment

Before concrete pours, designate Company-owned site meeting environmental standards or on-site area to be paved later in project for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.12.2 Hardened, Cured Waste Concrete

Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement.

3.12.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.12.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material.

3.13 JOINTS

3.13.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Locate construction joints as follows:

a. In walls at not more than 60 feet in any horizontal direction; at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall

b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier

c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

d. In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

Joints must be perpendicular to main reinforcement. Reinforcement must be continued across construction joints.

3.13.2 Waterstops

Provide waterstops in construction joints as indicated.

Install waterstops to form a continuous diaphragm in each joint. Make adequate provisions to support and protect waterstops during progress of work. Make field joints in waterstops in accordance with waterstop manufacturer's printed instructions, as approved. Protect waterstops protruding from joints from damage.

3.13.3 Isolation Joints in Slabs on Ground

Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inchin depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

3.13.4 Control Joints in Slabs on Ground

Provide joints to form panels as indicated.

Under and on exact line of each control joint, cut 50 percent of welded wire fabric reinforcement before placing concrete.

Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface or by cutting the concrete with a saw after the concrete has set. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.

In Hawaii, sawcutting will be limited to within 12 hours after set and at 1/4 slab depth.

3.13.5 Sealing Joints in Slabs on Ground

Isolation and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

Sealing is not required for isolation and control joints to be covered with finish flooring material. Groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.14 INSTALLATION OF ANCHORAGE DEVICES

3.14.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, set and build in cast-in-place concrete as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

3.14.2 Placing Anchorage Devices

Anchorage devices and embedded items must be positioned accurately and supported against displacement. Fill openings in anchorage devices such as slots and threaded holes with an approved, removable material to prevent entry of concrete into openings.

3.15 CONCRETE CONVEYING

3.15.1 Transfer of Concrete At Project Site

Handle concrete from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which prevent segregation and loss of concrete mix materials.

3.15.2 Mechanical Equipment for Conveying Concrete

Equipment must ensure a continuous flow of concrete at delivery end, as approved. Provide runways for wheeled concrete-conveying equipment from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment must be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

3.16 CONCRETE FLOOR TOPPING

3.16.1 Standard Floor Topping

Provide topping for treads and platforms of metal steel stairs and elsewhere as indicated.

Materials

Provide materials that conform to requirements specified, except aggregate must be as follows:

TYPE OF AGGREGATE	SIEVE	PERCENT PASSING
Fine aggregate	3/8 in.	100
	No. 4	95 to 100
	No. 8	80 to 90
	No. 16	50 to 75
	No. 30	30 to 50
	No. 50	10 to 20
	No. 100	2 to 5
Coarse aggregate	1/2 in.	100
	3/8 in.	95 to 100
	No. 4	40 to 60
	No. 8	0 to 5

Standard Topping Mixture

Provide mixture that consists of one part portland cement, one part fine aggregate, and two parts coarse aggregate, by volume. Adjust exact proportions of fine and coarse aggregates to produce a well-graded total aggregate. Mixing water must not exceed 5 gallons per 94-pound sack of cement including unabsorbed moisture in aggregate. Maximum slump must be 2 inches.

Preparations Prior to Placing

When mixture is placed on a green concrete base slab, screed surface of base slab to a level not more than 1-1/2 inches nor less than 1 inch below required finish surface. Remove water and laitance from surface of base slab before placing topping mixture. As soon as water ceases to rise to surface of base slab, place topping mixture as specified.

When mixture is placed on a hardened concrete base slab, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from base slab surface, leaving a clean surface. Prior to placing topping mixture, (2-1/2-inches minimum) slab surface must be dampened and left free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Do not allow cement grout to set or dry before topping mixture is placed.

When mixture is placed on a metal surface, such as metal pans for steel stairs, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from metal surface. Immediately before topping mixture is placed, spray or brush a coating of concrete bonding agent onto metal surfaces and do not be allow to set or dry before topping mixture is applied.

Mixing

Do the mixing of topping material at the site in a mechanical mixer of the batch type. Equip batch mixer with a suitable charging hopper, water storage tank, and water-measuring device and must be capable of mixing aggregates, cement, and water into a uniform mix within specified mixing time and of discharging mix without segregation. Provide mixer that bear a rating plate indicating rated capacity and recommended revolutions per minute.

Mix each batch of 2 cubic yards or less for not less than 1-1/2 minutes. Increase mixing time 15 seconds for each additional cubic yard or fraction thereof.

Clean mixer, and replace blades in drum when they have lost 10 percent of their original depth.

Truck-mixed topping may be used when approved. Specify truck-mixed topping for ready-mix concrete.

Placing

Spread standard topping mixture evenly on previously prepared base slab or metal surface, brought to correct level with a straightedge, and struck off. Topping must be consolidated, floated, checked for trueness of surface, and refloated as specified for float finish.

Finishing

Give trowel finish standard floor topping surfaces.

Give other finishes standard floor topping surfaces as indicated. Specify such finishes for required finish.

3.16.2 Heavy-Duty Floor Topping

Provide topping where indicated.

Heavy-duty Topping Mixture

Provide mixture that consists of 1 part portland cement and 2-1/2 parts emery aggregate or 1 part fine aggregate and 1-1/2 parts

traprock coarse aggregate, by volume. Exact proportions of mixture must conform to recommendations of aggregate manufacturer. Mixing water must not exceed 3-1/4 gallons per 94-pound sack of cement including unabsorbed moisture in aggregate. Maximum slump must be 1 inch.

Base Slab

Screed surface of slab to a level no more than 1-1/2 inches nor less than 1 inch below grade of finished floor.

Give slab a scratch finish as specified.

Preparations prior to placing

Remove dirt, loose material, oil, grease, asphalt, paint and other contaminants from base slab surface. Prior to placing topping mixture, dampen slab surface and leave free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Allow cement grout to set or dry before topping mixture is placed.

Mixing

Do mixing of topping material at the site in a mechanical mixer of the batch type. Equip batch mixer with a charging hopper, water storage tank, and a water-measuring device and the batch mixer must be capable of mixing aggregates, cement, and water into a uniform mix within the specified mixing time and of discharging mix without segregation. Provide mixer that bears a rating plate indicating rated capacity and recommended revolutions per minute.

Mix each batch of 2 cubic yards or less for not less than 1-1/2 minutes.

Increase mixing time 15 seconds for each additional cubic yard or fraction thereof. Clean mixer, and replace pick-up and throw-over blades in drum when they have lost 10 percent of their original depth.

Placing

Spread heavy-duty topping mixture evenly on previously prepared base slab, and bring to correct level with a straightedge, and strike off. Provide topping that is consolidated, floated, and checked for trueness of surface as specified for float finish, except that power-driven floats is the impact type.

Finishing

Give trowel finish heavy-duty floor topping surfaces. Provide trowel finish as specified, except that additional troweling after first power troweling must be not less than three hand-troweling operations.

-- End of Section --

SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI/MCP-1	(2010) Manual of Concrete Practice Part 1
ACI/MCP-2	(2010) Manual of Concrete Practice Part 2
ACI/MCP-3	(2010) Manual of Concrete Practice Part 3
ACI/MCP-4	(2010) Manual of Concrete Practice Part 4

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 322M/M 322	(2007) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

ASTM INTERNATIONAL (ASTM)

ASTM A 185/A 185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 496/A 496M	(2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497/A 497M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 615/A 615M	(2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 82/A 82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 996/A 996M	(2009b) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM C 1107/C 1107M	(2008) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 143/C 143M	(2009) Standard Test Method for Slump of

	Hydraulic-Cement Concrete
ASTM C 150/C 150M	(2009) Standard Specification for Portland Cement
ASTM C 156	(2009a) Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2008) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173/C 173M	(2009) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(2009a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2009) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 311	(2007) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C 33/C 33M	(2008) Standard Specification for Concrete Aggregates
ASTM C 39/C 39M	(2009a) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42/C 42M	(2004) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 494/C 494M	(2008a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 618	(2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 920	(2008) Standard Specification for

	Elastomeric Joint Sealants
ASTM C 932	(2006) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering
ASTM C 94/C 94M	(2011) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2009a) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C 990	(2009) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 4397	(2009) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 5759	(1995; R 2005) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM D 6690	(2007) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM E 1155	(1996; R 2008) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E 329	(2009) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM E 648	(2009a) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2009; 28th Ed) Manual of Standard Practice

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS MMM-A-001993	(1978) Adhesive, Epoxy, Flexible, Filled (For Binding, Sealing, and Grouting)

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED GBDC	(2009) LEED Reference Guide for Green Building Design and Construction
LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 DEFINITIONS

a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, ground granulated blast-furnace slag, and silica fume.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcing Steel; G

Reproductions of contract drawings are unacceptable.

SD-03 Product Data

Joint sealants; (LEED NC)
Epoxy Bonding Compound; (LEED NC)

Submit manufacturer's product data, indicating VOC content. Manufacturer's catalog data for the following items must include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders.

Submit documentation relative to each material credit in accordance with the LEED GBDC.

Waterstops; (LEED NC)

SD-05 Design Data

Concrete Mix design; G

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, ground slag, and admixtures; and applicable reference specifications.

SD-06 Test Reports

Compressive strength tests

Air Content

Slump

Air Entrainment

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Drawings

1.6.1.1 Reinforcing Steel

ACI/MCP-4. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural

drawings to determine lengths of reinforcing bars.

1.6.2 Test Reports

1.6.2.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. Include mill test and all other test for cement, aggregates, and admixtures in the laboratory test reports.

1.7 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Perform concrete testing by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency must meet the requirements of ASTM E 329.

PART 2 PRODUCTS

2.1 CONCRETE

2.1.1 Ready-Mix Concrete

Provide 3,000 psi and/or 4,000 psi concrete that meets the requirements of ASTM C 94/C 94M.

2.1.2 Concrete Curing Materials

2.1.2.1 Moisture-Retaining Cover

Provide waterproof paper cover for curing concrete conforming to ASTM C 171, regular or white, or polyethylene sheeting conforming to ASTM C 171, or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap must conform to ASTM C 171, Class 3, and polyethylene film must conform to ASTM C 171. When tested for water retention in accordance with ASTM C 156, weight of water lost 72 hours after application of moisture retaining covering material must not exceed 0.039 gram per square centimeter of the mortar specimen surface.

2.1.2.2 Membrane-Forming Curing Compound

Provide liquid type compound conforming to ASTM C 309, Type 1, clear, Type 1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

2.2 MATERIALS

2.2.1 Cement

ASTM C 150/C 150M, Type I or II blended cement except as modified herein. Provide blended cement that consists of a mixture of ASTM C 150/C 150M, Type II, cement and one of the following materials: ASTM C 618 pozzolan or fly ash, ASTM C 989 ground granulated blast-furnace slag. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. Supplier must certify that no hazardous waste is used in the fuel mix or raw materials. Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no

additional pollutants are discharged. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

2.2.1.1 Fly Ash and Pozzolan

ASTM C 618, Type N, F, or C, except that the maximum allowable loss on ignition must be 6 percent for Types N and F. Add with cement. Fly ash content must be a minimum of 15 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C 311. Evaluate and classify fly ash in accordance with ASTM D 5759.

High contents of supplementary cementitious materials can have some detrimental effects on the concrete properties, such as slowing excessively the strength gain rate, and delaying and increasing the difficulty of finishing. The recommended maximum content (by weight of the total cementitious material) for these materials are:

1. For ground granulated blast-furnace (GGBF) slag: 50 percent

2. For fly ash or natural pozzolan: 40 percent (25 percent in cold climates)

3. For silica fume: 10 percent

2.2.1.2 Portland Cement

Provide cement that conforms to ASTM C 150/C 150M, Type I, IA, II, or IIA. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.2.2 Water

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementitious materials (cement plus pozzolans), and in general, improve workability by adjusting the grading rather than by adding water. Water must be fresh, clean, and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.2.3 Aggregates

ASTM C 33/C 33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement.

2.2.4 Nonshrink Grout

ASTM C 1107/C 1107M.

2.2.5 Admixtures

ASTM C 494/C 494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E,

water-reducing and accelerating admixture. Do not use calcium chloride admixtures.

2.2.5.1 High Range Water Reducer (HRWR) (Superplasticizers)

ASTM C 494/C 494M, Type F.

2.2.5.2 Pozzolan

Provide fly ash or other pozzolans used as admixtures that conform to ASTM C 618.

2.2.6 Vapor Barrier

ASTM D 4397 polyethylene sheeting, minimum thickness indicated in drawings.

2.2.7 Materials for Curing Concrete

Consider agents that are not toxic and emit low or no Volatile Organic Compounds (VOC).

2.2.7.1 Liquid Membrane-Forming Compound

ASTM C 309, white-pigmented, Type 2, Class B.

2.2.8 Expansion/Contraction Joint Filler

ASTM D 1751. Material must be 1/2 inch thick, unless otherwise indicated.

2.2.8.1 Preformed Joint Filler Strips

Provide nonextruding and resilient bituminous type filler strips conforming to ASTM D 1751.

2.2.9 Joint Sealants

Use concrete penetrating sealers with a low VOC content.

2.2.9.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D 6690 or ASTM C 920, Type M, Class 25, Use T.

2.2.9.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C 920, Type M, Grade NS, Class 25, Use T.

2.2.9.3 Waterstops

Provide waterstops made of rubber and that conform to ASTM D 1752 or provide waterstops made of polyvinylchloride (PVC) and that conform to ASTM C 990.

2.2.9.4 Joint Sealant Compound

Provide hot-poured, elastic type compound conforming to ASTM D 6690.

2.2.10 Epoxy Bonding Compound

ASTM C 881/C 881M. Provide Type I for bonding hardened concrete to

hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if placement temperature is below 40 degrees F; Class B if placement temperature is between 40 and 60 degrees F; or Class C if placement temperature is above 60 degrees F.

2.2.11 Biodegradable Form Release Agent

Provide form release agent that is colorless, biodegradable, and with a low VOC content. A minimum of 85 percent of the total product must be biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

2.3 REINFORCEMENT

2.3.1 Reinforcing Bars

ACI/MCP-2 unless otherwise specified. Use deformed steel.
ASTM A 615/A 615M and AASHTO M 322M/M 322 with the bars marked A, S, W, Grade 60; or ASTM A 996/A 996M with the bars marked R, Grade 60, or marked A, Grade 60.

2.3.2 Wire

ASTM A 82/A 82M or ASTM A 496/A 496M.

2.3.2.1 Welded Wire Fabric

ASTM A 185/A 185M or ASTM A 497/A 497M. Provide flat sheets of welded wire fabric for slabs and toppings.

2.3.3 Reinforcing Bar Supports

Provide bar ties and supports of coated or non corrodible material.

2.3.4 Supports for Reinforcement

Supports include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcing bars and wire fabric in place.

Provide wire bar type supports conforming to ACI/MCP-3, ACI/MCP-4 and CRSI 10MSP.

Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

2.4 BONDING MATERIALS

2.4.1 Concrete Bonding Agent

Provide aqueous-phase, film-forming, nonoxidizing, freeze and thaw-resistant compound agent suitable for brush or spray application conforming to ASTM C 932.

2.4.2 Epoxy-Resin Adhesive Binder

Provide two-component, epoxy-polysulfide polymer type binder with an amine-type curing-agent conforming to FS MMM-A-001993, Type I or ASTM C 881/C 881M.

2.5 CLASSIFICATION AND QUALITY OF CONCRETE

2.5.1 Concrete Classes and Usage

Provide concrete classes, compressive strength, requirements for air entrainment, and usage as follows:

CONCRETE CLASS	MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER SQ. IN.	REQUIREMENT FOR AIR ENTRAINMENT	USAGE
3A	3,000	Air-entrained	For foundation
4A	4,000	Air-entrained	For structural concrete work exposed to freezing and thawing, unless otherwise indicated or specified, such as exterior columns and spandrels

2.5.2 Limits for Concrete Proportions

Provide limits for maximum water/cement ratio and minimum cement content for each concrete class as follows:

CONCRETE CLASS	MAX. WATER/CEMENT RATIO BY WEIGHT	MIN. CEMENT FOR 3- TO 4-INCH SLUMP, (NO. OF 94-POUND SACKS) PER CU. YD.
3A	0.45	6.0
4A	0.46	6.0

* Weight of water to weight of cement in pounds in one cubic yard of concrete

2.5.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, must be as follows:

MAXIMUM SIZE OF AGGREGATE	ASTM C 33/C 33M SIZE NUMBER	TYPE OF CONSTRUCTION
3/4 inch	67	Reinforced walls, columns, girders, beams, and other formed sections having a dimension between forms of not

MAXIMUM SIZE OF AGGREGATE	ASTM C 33/C 33M SIZE NUMBER	TYPE OF CONSTRUCTION
		less than 6 inches and clear distance between reinforcing bars or reinforcing bar and face of form of not less than 1 inch
3/4 inch	67	Monolithic concrete slabs and other flatwork having a depth of not less than 2-1/2 inches and a clear distance between reinforcing bars of not less than 1 inch
1/2 inch	7	Concrete joist construction, beams, reinforced walls, and other formed work having a clear distance between reinforcing bars and face of form of less than 1 inch

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

2.5.4 Slump

Provide slump for concrete at time and in location of placement as follows:

TYPE OF CONSTRUCTION	SLUMP
Columns, beams, reinforced walls, monolithic slabs	Not less than 1 inch nor more than 4 inches

2.5.5 Total Air Content

Air content of exposed concrete and interior concrete must be in accordance with ASTM C 260 and/or as follows:

LIMITS CONCRETE EXPOSURE	REQUIREMENT FOR AIR ENTRAINMENT	MAXIMUM SIZE OF AGGREGATE	TOTAL AIR CONTENT BY VOLUME
Exposed to freezing and thawing or subjected to hydraulic pressure	Air-entrained	1-1/2 or 2 inches	4 to 6 percent
		3/4 inch	5 to 7 percent
		1/2 or 3/8 inch	6 to 8.5 percent

Provide concrete exposed to freezing and thawing or subjected to hydraulic pressure that is air-entrained by addition of approved air-entraining admixture to concrete mix.

PART 3 EXECUTION

3.1 EXAMINATION

Do not begin installation until substrates have been properly constructed; verify that substrates are plumb and true.

If substrate preparation is the responsibility of another installer, notify AContracting Officer of unsatisfactory preparation before processing.

Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Contracting Officer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, ice, and other deleterious substances before start of concrete placing.

Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, seal subgrade surface by covering surface with specified water barrier subgrade cover; this may also be used over semiporous, dry subgrade material instead of water sprinkling.

3.2.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

Previously constructed subgrade or fill must be cleaned of foreign materials and inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 12 inches of subgrade soil material-in-place must not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D 1557.

SOIL MATERIAL	PERCENT MAXIMUM DENSITY
Drainage fill	100
Cohesionless soil material	100
Cohesive soil material	95

Finish surface of drainage fill under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

Prepare subgrade or fill surface under exterior slabs on ground as specified for subgrade under foundations and footings.

3.2.4 Formwork

Complete and approve formwork. Remove debris and foreign material from interior of forms before start of concrete placing.

3.2.5 Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.6 Reinforcement and Other Embedded Items

Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

3.3 FORMS

ACI/MCP-2. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris. Forms submerged in water must be watertight.

3.3.1 General

Construct forms to conform, within the tolerances specified, to shapes

dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms must be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

3.3.2 Design and Construction of Formwork

Provide formwork design and construction that conforms to ACI/MCP-2, Chapter 4.

Provide forms that are tight to prevent leakage of cement paste during concrete placing.

Support form facing materials by structural members spaced close to prevent deflection of form facing material. Fit forms placed in successive units for continuous surfaces to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, camber formwork for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Chamfer exposed joints, edges, and external corners a minimum of 3/4 inch by moldings placed in corners of column, beam, and wall forms.

Provide shores and struts with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations. Obtain adjustment with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, provide trussed supports.

Provide temporary openings in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Provide forms that are readily removable without impact, shock, or damage to concrete.

3.3.3 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.3.4 Reshoring

Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, reshore slabs and beams over 10 feet in span and cantilevers over 4 feet for the remainder of the specified time period in accordance with paragraph entitled "Removal of Forms." Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Provide reshoring elements with the same load-carrying capabilities as original shoring and spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.3.5 Reuse

Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

3.3.6 Forms for Standard Rough Form Finish

Give rough form finish concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish must be the specified concrete form plywood or other approved form facing material that produces concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 1-inch nominal thickness lumber may be used. Provide horizontal joints that are level and vertical joints that are plumb.

3.3.7 Forms for Standard Smooth Form Finish

Give smooth form finish concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish must be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales must not exceed 0.0025 times the span.

Provide arrangement of form facing sheets that are orderly and symmetrical, and sheets that are in sizes as large as practical.

Arrange panels to make a symmetrical pattern of joints. Horizontal and vertical joints must be solidly backed and butted tight to prevent leakage and fins.

3.3.8 Form Ties

Provide ties that are factory fabricated metal, adjustable in length, removable or snap-off type that do allow form deflection or do not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts must be at least 1-1/2 inches back from concrete surface. Provide form ties that are free of devices that leave a hole larger than 7/8 inch or less than 1/2 inch in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.3.9 Tolerances for Form Construction

Construct formwork to ensure that after removal of forms and prior to patching and finishing of formed surfaces, provide concrete surfaces in accordance with tolerances specified in ACI/MCP-1 and ACI/MCP-2.

3.3.10 Removal of Forms and Supports

After placing concrete, forms must remain in place for the time periods specified in ACI/MCP-4. Do not remove forms and shores (except those used for slabs on grade and slip forms) until the Contracting Officer determines that the concrete has gained sufficient strength to support its weight and superimposed loads. Base such determination on compliance with one of the following:

a. The plans and specifications stipulate conditions for removal of forms and shores, and such conditions have been followed, or

b. The concrete has been properly tested with an appropriate ASTM standard test method designed to indicate the concrete compressive strength, and the test results indicate that the concrete has gained sufficient strength to support its weight and superimposed loads.

Prevent concrete damage during form removal. Clean all forms immediately after removal.

3.3.10.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if ASTM C 39/C 39M test results of field-cured samples from a representative portion of the structure indicate that the concrete has reached a minimum of 85 percent of the design strength.

3.4 WATERSTOP SPLICES

Fusion weld in the field.

3.5 FORMED SURFACES

3.5.1 Preparation of Form Surfaces

Coat contact surfaces of forms with form-coating compound before reinforcement is placed. Provide a commercial formulation form-coating compound that does not bond with, stain, nor adversely affect concrete surfaces and impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Do not allow excess form-coating compound to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete is placed. Make thinning of form-coating compound with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

3.5.2 Tolerances

ACI/MCP-4 and as indicated.

3.5.3 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Do not use material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which can impair

the texture of the concrete surface.

3.6 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI/MCP-2. Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

3.6.1 General

Provide details of reinforcement that are in accordance with ACI/MCP-3 and ACI/MCP-4 and as specified.

3.6.2 Vapor Barrier

Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tape or cement joints. Remove torn, punctured, or damaged vapor barrier material and provide with new vapor barrier prior to placing concrete. Concrete placement must not damage vapor barrier material.

3.6.3 Reinforcement Supports

Place reinforcement and secure with galvanized or non corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use concrete or other non corrodible material, having a compressive strength equal to or greater than the concrete being placed.

3.6.4 Splicing

As indicated. For splices not indicated ACI/MCP-2. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 2 inches.

3.6.5 Cover

ACI/MCP-2 for minimum coverage, unless otherwise indicated.

3.6.6 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.6.7 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.6.8 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 1/2 inch wide

unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.6.9 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

Provide fabrication tolerances that are in accordance with ACI/MCP-1, ACI/MCP-2 and ACI/MCP-3.

Provide hooks and bends that are in accordance with ACI/MCP-3 and ACI/MCP-4.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Tolerance on nominally square-cut, reinforcing bar ends must be in accordance with ACI/MCP-3.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances

b. Bends or kinks not indicated on drawings or approved shop drawings

c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.6.10 Placing Reinforcement

Place reinforcement in accordance with ACI/MCP-3 and ACI/MCP-4.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire fabric on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

Contractor must cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor must notify the Contracting Officer so that conflicts may be reconciled before placing concrete.

Anchors and embedded items must be positioned and supported with appropriate accessories.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Provide supports for reinforcing bars that are sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI/MCP-3, ACI/MCP-4 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

Equip supports on ground and similar surfaces with sand-plates.

Support welded wire fabric as required for reinforcing bars.

Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

With the exception of temperature reinforcement, tied to main steel approximately 24 inches on center, reinforcement must be accurately placed, securely tied at intersections with 18-gage annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to ACI/MCP-3.

Bending of reinforcing bars partially embedded in concrete is permitted only as specified in ACI/MCP-3 and ACI/MCP-4.

3.6.11 Spacing of Reinforcing Bars

Spacing must be as indicated. If not indicated, spacing must be in accordance with ACI/MCP-3 and ACI/MCP-4.

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to approval.

3.6.12 Concrete Protection for Reinforcement

Concrete protection must be in accordance with the ACI/MCP-3, ACI/MCP-4, and ASTM E 648.

3.7 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C 94/C 94M, and ACI/MCP-2, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.7.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

3.7.2 Mixing

ASTM C 94/C 94M and ACI/MCP-2. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.7.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.8 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement, consolidation, and finishing; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

3.8.1 General Placing Requirements

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation.

Concrete to receive other construction must be screeded to proper level to avoid excessive skimming or grouting.

Do not use concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Use of retempered concrete is permitted. Remove

rejected concrete from the site.

3.8.2 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

3.8.3 Vibration

ACI/MCP-2. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 9,000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 20 inches apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 24 inch maximum vertical lifts. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

3.8.4 Pumping

ACI/MCP-2. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.8.5 Cold Weather

ACI/MCP-2. Do not allow concrete temperature to decrease below 50 degrees FObtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

3.8.6 Hot Weather

Maintain required concrete temperature using Figure 2.1.5 in ACI/MCP-2 to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete

when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.8.7 Follow-up

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

3.8.8 Placing Concrete in Forms

Deposit concrete placed in forms in horizontal layers not exceeding 24 inches.

Remove temporary spreaders in forms when concrete placing has reached elevation of spreaders.

Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Design vibrators to operate with vibratory element submerged in concrete and maintain a speed of not less than 9,000 impulses per minute when submerged in concrete. Provide vibrating equipment adequate in number of units and power of each unit to properly consolidate concrete. Vibration of forms and reinforcement is not be permitted. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Do not insert vibrator into lower courses of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Do not start placing of concrete in supporting elements until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

3.8.9 Placing Concrete Slabs

Place and consolidate concrete for slabs in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, consolidate concrete by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground by mechanical vibrators as specified. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other approved method. Limit consolidation operations to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated must be as dry as practical and surfaces thereof must not be manipulated prior to finishing operations. Bring concrete correct level with a straightedge and struck-off. Use bull floats or darbies to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface is not permitted.

Provide finish of slabs as specified.

3.8.10 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Apply such bonding material to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

3.9 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.9.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 1 square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI/MCP-4. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise specified.

3.9.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

3.9.3 Formed Surfaces

3.9.3.1 Tolerances

ACI/MCP-1 and as indicated.

3.9.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch these holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 0.25 inch in height.

3.9.3.3 Standard Smooth Finish

Finish must be as-cast concrete surface as obtained with form facing material for standard smooth finish. Repair and patch defective areas as specified; and all fins and remove other projections on surface.

3.9.4 Grout Finish

Provide finish that is standard, smooth coated with grout as specified.

Give finish to interior and exterior concrete vertical surfaces that are to be exposed to view.

Grout is required consisting of one part portland cement to 1-1/2 parts fine aggregate by volume, mixed with water to produce a consistency of thick paint. Portland cement portion must be a blend of standard portland cement and white portland cement, proportioned as determined by trial mixes so that final color of grout when dry approximates color of surrounding concrete. Fine aggregate must pass No. 30 mesh sieve.

Surface of concrete is required to be wetted, and grout must be applied immediately to wetted surfaces. Spread grout over surface with clean burlap pads or sponge-rubber floats to fill pits, air bubbles, and surface holes. Remove excess grout by scraping, then rubbing surface with clean burlap to remove visible grout film. Keep grout damp by means of fog spray during setting period. Complete finish the day it is started, and make limits of a finished area at natural breaks in finished surface.

3.10 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

ACI/MCP-2, unless otherwise specified. Slope floors uniformly to drains where drains are provided.

3.10.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.10.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. After the concrete has been placed, consolidated, struck off, and leveled to a Class C tolerance as defined below,roughen the

surface with stiff brushes of rakes before final set.

3.10.1.2 Steel Troweled

Use for floors intended as walking surfaces, and for reception of floor coverings. First, provide a floated finish. Next, the finish must be power troweled two times, and finally hand troweled. The first troweling after floating needs to produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings done by hand after the surface has hardened sufficiently. The final troweling is done when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate the surface by the hand troweling operations. The finished surface must be essentially free of trowel marks and uniform in texture and appearance. The finished surface must produce a surface level to within 1/4 inch in 10 feet. On surfaces intended to support floor coverings, remove any defects of sufficient magnitude to show through the floor covering by grinding.

3.10.1.3 Nonslip Finish

Use on surfaces of exterior platforms, steps, and landings; and on exterior and interior pedestrian ramps. Apply dry shake aggregate of ceramically bonded aluminum oxide to the surface at a minimum rate of 25 pounds per 100 square feet. Blend approximately two-thirds of the aggregate with portland cement as recommended by the manufacturer and apply to the surface evenly and without segregation. After blended material has been embedded by floating, apply the remainder of the blended material to the surface at right angles to the previous application. Apply blended material heavier in any areas not sufficiently covered by the first application. Perform a second floating immediately following the first. After the selected material has been embedded by the two floatings, complete the operation with a broomed finish.

3.10.1.4 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.10.1.5 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by belting. Lay belt flat on the concrete surface and advance with a sawing motion; continue until a uniform but gritty nonslip surface is obtained. Round edges and joints with an edger having a radius of 1/8 inch.

3.10.2 Flat Floor Finishes

ACI/MCP-2. Construct in accordance with one of the methods recommended in Table 7.15.3, "Typical Composite Ff/FL Values for Various Construction Methods." ACI/MCP-1 for tolerance tested by ASTM E 1155.

a. Specified Conventional Value:

Floor Flatness (Ff)	20	13 minimum
Floor Levelness (FL)	15	10 minimum

b. Specified Industrial:

Floor Flatness (Ff)	30	15 minimum
Floor Levelness (FL)	20	10 minimum

3.10.3 Concrete Walks

Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints one inch deep with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.

3.10.4 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.11 CURING AND PROTECTION

ACI/MCP-2 unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.11.1 General

Protect freshly placed concrete from premature drying and cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Start initial curing as soon as free water has disappeared from surface of concrete after placing and finishing. Keep concrete moist for minimum 72 hours.

Final curing must immediately follow initial curing and before concrete has dried. Continue final curing until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 50 degrees F has totaled 168

hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Prevent rapid drying at end of final curing period.

3.11.2 Moist Curing

Remove water without erosion or damage to the structure. Prevent water run-off.

3.11.2.1 Ponding or Immersion

Continually immerse the concrete throughout the curing period. Water must not be more than 50 degrees F less than the temperature of the concrete. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.11.2.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.11.2.3 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.11.3 Liquid Membrane-Forming Curing Compound

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 2.1.5 in ACI/MCP-2 indicates that hot weather conditions cause an evaporation rate exceeding 0.2 pound of water per square foot per hour.

3.11.3.1 Application

Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has a dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats must be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound must form a uniform, continuous, coherent film that does not check, crack, or peel. Immediately apply an additional coat of compound

to areas where the film is defective. Re-spray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.11.3.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.11.4 Requirements for Type III, High-Early-Strength Portland Cement

The curing periods are required to be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

3.11.5 Curing Periods

ACI/MCP-2 except 10 days for retaining walls, pavement or chimneys, 21 days for concrete that is in full-time or intermittent contact with seawater, salt spray, alkali soil or waters. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.11.6 Curing Methods

Accomplish curing by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified.

Moist curing:

Accomplish moisture curing by any of the following methods:

Keeping surface of concrete wet by covering with water

Continuous water spraying

Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Place absorptive cover to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Accomplish moisture-retaining cover curing by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Place cover directly on concrete in widest practical width, with sides and ends lapped at least 3 inches. Weight cover to prevent displacement; immediately repair tears or holes appearing during curing period by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Accomplish membrane curing by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Apply curing compound uniformly in a two-coat operation

by power-spraying equipment using a spray nozzle equipped with a wind guard. Apply second coat in a direction at right angles to direction of first coat. Total coverage for two coats must be not more than 200 square feet per gallon of curing compound. Respray concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied by method and at rate specified. Maintain continuity of coating for entire curing period and immediately repair damage to coating during this period.

Membrane-curing compounds must not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, painting, and other coatings and finish materials.

3.11.7 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.11.8 Curing Unformed Surfaces

Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

Unless otherwise specified, accomplish final curing of unformed surfaces by any of curing methods specified above, as applicable.

Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.11.9 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.11.10 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive

vibration and from damage caused by rain or running water.

3.11.11 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.12 FIELD QUALITY CONTROL

3.12.1 Sampling

ASTM C 172. Collect samples of fresh concrete to perform tests specified. ASTM C 31/C 31M for making test specimens.

3.12.2 Testing

3.12.2.1 Slump Tests

ASTM C 143/C 143M. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

3.12.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.12.2.3 Compressive Strength Tests

ASTM C 39/C 39M. Make five test cylinders for each set of tests in accordance with ASTM C 31/C 31M. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. Take samples for strength tests of each mix design of concrete placed each day not less than once a day, nor less than once for each 160 cubic yards of concrete, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 450 psi, take a minimum of three ASTM C 42/C 42M core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core test is considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Retest locations represented by erratic core strengths. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.12.2.4 Air Content

ASTM C 173/C 173M or ASTM C 231 for normal weight concrete. Test

air-entrained concrete for air content at the same frequency as specified for slump tests.

3.12.2.5 Strength of Concrete Structure

Compliance with the following is considered deficient if it fails to meet the requirements which control strength of structure in place, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

3.12.2.6 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C 42/C 42M, and as follows:

Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

Test cores after moisture conditioning in accordance with ASTM C 42/C 42M if concrete they represent is more than superficially wet under service.

Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.13 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows.

3.13.1 Mixing Equipment

Before concrete pours, designate Company-owned site meeting environmental standards for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.13.2 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.14 JOINTS

3.14.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Locate construction joints as follows:

In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

Joints must be perpendicular to main reinforcement. Reinforcement must be continued across construction joints.

3.14.2 Waterstops

Provide waterstops in construction joints as indicated.

Install waterstops to form a continuous diaphragm in each joint. Make adequate provisions to support and protect waterstops during progress of work. Make field joints in waterstops in accordance with waterstop manufacturer's printed instructions, as approved. Protect waterstops protruding from joints from damage.

3.14.3 Isolation Joints in Slabs on Ground

Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inchin depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

3.14.4 Contraction Joints in Slabs on Ground

Provide joints to form panels as indicated.

Under and on exact line of each contraction joint, cut 50 percent of welded wire fabric reinforcement before placing concrete.

Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface or by cutting the concrete with a saw after the concrete has set. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.

3.14.5 Sealing Joints in Slabs on Ground

Isolation and contraction joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

Sealing is not required for isolation and contraction joints to be covered with finish flooring material. Groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.15 INSTALLATION OF ANCHORAGE DEVICES

3.15.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, set and build in cast-in-place concrete as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

3.15.2 Placing Anchorage Devices

Anchorage devices and embedded items must be positioned accurately and supported against displacement. Fill openings in anchorage devices such as slots and threaded holes with an approved, removable material to prevent entry of concrete into openings.

3.16 CONCRETE CONVEYING

3.16.1 Transfer of Concrete At Project Site

Handle concrete from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which prevent segregation and loss of concrete mix materials.

3.16.2 Mechanical Equipment for Conveying Concrete

Equipment must ensure a continuous flow of concrete at delivery end, as approved. Provide runways for wheeled concrete-conveying equipment from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment must be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

-- End of Section --

SECTION 03 40 00.00 10

PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION
08/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 318	(2011; Errata 1 2011; Errata 2 2012; Errata 3-4 2013) Building Code Requirements for Structural Concrete and Commentary

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

ACPA QPC	(2005; Ver 3.0) QCast Plant Certification Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 185/A 185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 36/A 36M	(2008) Standard Specification for Carbon

	Structural Steel
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM A 615/A 615M	(2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 82/A 82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C 1064/C 1064M	(2008) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C 1107/C 1107M	(2008) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1116/C 1116M	(2009) Standard Specification for Fiber-Reinforced Concrete
ASTM C 1240	(2005) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C 1244	(2005e1) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM C 138/C 138M	(2009) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 14	(2007) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 143/C 143M	(2009) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 1478	(2008) Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals
ASTM C 150/C 150M	(2009) Standard Specification for Portland Cement
ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 173/C 173M	(2009) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192/C 192M	(2007) Standard Practice for Making and Curing Concrete Test Specimens in the

	Laboratory
ASTM C 231	(2009a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2009) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33/C 33M	(2008) Standard Specification for Concrete Aggregates
ASTM C 330	(2005) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C 39/C 39M	(2009a) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 443	(2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 478	(2009) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 494/C 494M	(2008a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 595/C 595M	(2009) Standard Specification for Blended Hydraulic Cements
ASTM C 618	(2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 877	(2008) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C 920	(2008) Standard Specification for Elastomeric Joint Sealants
ASTM C 923	(2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C 989	(2009a) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C 990	(2009) Standard Specification for Joints

	for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-210	(Rev A, Notice 3) Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

NPCA QC Manual	(2005; R 2006) Quality Control Manual for Precast Plants

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED GBDC	(2009) LEED Reference Guide for Green Building Design and Construction
LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 SYSTEM DESCRIPTION

This specification only applies to civil/site work precast concrete structures. Furnish precast concrete units designed and fabricated by an experienced and acceptable precast concrete manufacturer who has been, for at least 3 years, regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings. Coordinate precast work with the work of other trades.

1.2.1 Standard Precast Units

Design standard precast concrete units to withstand indicated design load conditions in accordance with applicable industry design standards. Design shall also consider stresses induced during handling, shipping and installation as to avoid product cracking or other handling damage. Indicate design loads for precast concrete units on the shop drawings.

1.2.2 Proprietary Precast Units

Products manufactured under franchise arrangements shall conform to all the requirements specified by the franchiser. Items not included in the franchise specification, but included in this specification, shall conform to the requirements in this specification.

1.2.3 Joints and Sealants

Provide joints and sealants between adjacent units of the type and configuration indicated on shop drawings meeting specified design and performance requirements.

1.2.4 Concrete Mix Design

1.2.4.1 Concrete Mix Proportions

Base selection of proportions for concrete on the methodology presented in

ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportions using the same type and brand of cement, the same type and brand of pozzolan, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete containing reinforcing steel or other embedded metal items. The use of self-consolidating concrete is permitted, provided that mix design proportions and constituents meet the requirements of this specification.

1.2.4.2 Concrete Strength

Provide precast concrete units with a 28-day compressive strength (f'c) of 5000 psi.

1.2.4.3 Water-to-Cement Ratio

Furnish concrete, that will be exposed to freezing and thawing, containing entrained air and with water-cement ratios of 0.45 or less. Furnish concrete which will not be exposed to freezing, but which is required to be watertight, with a water-cement ratio of 0.48 or less if the concrete is exposed to fresh water, or 0.45 or less if exposed to brackish water or sea water. Furnish reinforced concrete exposed to deicer salts, brackish water or seawater with a water-cement ratio of 0.40 or less for corrosion protection.

1.2.4.4 Air Content

The air content of concrete that will be exposed to freezing conditions shall be within the limits given below.

NOMINAL MAXIMUM AGGREGATE SIZE	AIR CONTENT % SEVERE EXPOSURE	MODERATE EXPOSURE
10 mm (3/8 inch)	6.0 to 9.0	4.5 to 7.5
13 mm (1/2 inch)	5.5 to 8.5	4.0 to 7.0
19 mm (3/4 inch)	4.5 to 7.5	3.5 to 6.5
25 mm (1.0 inch)	4.5 to 7.5	3.0 to 6.0
38 mm (1.5 inch)	4.5 to 7.0	3.0 to 6.0

Note: For specified compressive strengths greater than 5000 psi, air content may be reduced 1 percent

1.3 SUBMITTALS

All submittals are the responsibility of the precast concrete producer. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Procedures

Quality control procedures established by the precast manufacturer in accordance with NPCA QC Manual and/or ACPA QPC.

SD-03 Product Data

Standard Precast Units; G (LEED NC)

Cut sheets, for standard precast concrete units, showing conformance to project drawings and requirements, and to applicable industry design standards listed in this specification. Submit documentation relative to each material credit in accordance with the LEED GBDC.

Accessories; (LEED NC)

Proper installation instructions and relevant product data for items including, but not limited to, sealants, gaskets, connectors, steps, cable racks and other items installed before or after delivery. Submit documentation relative to each material credit in accordance with the LEED GBDC.

SD-06 Test Reports

Test Reports

1.4 QUALITY ASSURANCE

Demonstrate adherence to the standards set forth in NPCA QC Manual and/or ACPA QPC. Meet requirements written in the subparagraphs below.

1.4.1 NPCA and ACPA Plant Certification

The precast concrete producer shall be certified by the National Precast Concrete Association's and/or the American Concrete Pipe Association's Plant Certification Program prior to and during production of the products for this project.

1.4.2 Qualifications, Quality Control and Inspection

1.4.2.1 Qualifications

Select a precast concrete producer that has been in the business of producing precast concrete units similar to those specified for a minimum of 3 years. The precast concrete producer shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis.

1.4.2.2 Quality Control Procedures

Show that the following QC tests are performed as required and in accordance with the ASTM standards indicated.

a. Slump: Perform a slump test for each 150 cu yd of concrete produced, or once a day, whichever comes first. Perform slump tests in accordance with ASTM C 143/C 143M.

b. Temperature: Measure the temperature of fresh concrete when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C 1064/C 1064M.

c. Compressive Strength: Make at least four compressive strength specimens for each 150 cubic yards of concrete of each mix in accordance with the following Standards: ASTM C 31/C 31M,

ASTM C 192/C 192M, ASTM C 39/C 39M.

d. Air Content: Perform tests for air content on air-entrained, wet-cast concrete for each 150 cu yd of concrete, but not less often than once each day when air-entrained concrete is used. Determine the air content in accordance with either ASTM C 231 or ASTM C 173/C 173M for normal weight aggregates and ASTM C 173/C 173M for lightweight aggregates.

e. Unit Weight: Perform tests for unit weight a minimum of once per week to verify the yield of batch mixes. Perform unit weight tests for each 100 cu yd of lightweight concrete in accordance with ASTM C 138/C 138M.

Submit test reports as Follows:

a. Copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

b. Copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze thaw durability, abrasion and absorption. Clearly detail in the specifications special tests for precast concrete or cast-in items.

c. Sufficient documentation, when the use of self-consolidating concrete (SCC) is proposed, showing a minimum of 30-days production track records demonstrating that SCC is appropriate for casting of the product.

d. Copies of in-plant QA/QC inspection reports, upon the request of the Contracting Officer.

1.4.2.3 Inspection

The Contracting Officer may place an inspector in the plant when the units covered by this specification are being manufactured. The precast concrete producer shall give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver precast units to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite, all precast concrete units will be inspected by the Contracting Officer for quality and final acceptance.

1.5.2 Storage

Store units off the ground or in a manner that will minimize potential

damage.

1.5.3 Handling

Handle, transport, and store products in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Perform lifting with methods or devices intended for this purpose as indicated on shop drawings.

PART 2 PRODUCTS

2.1 MATERIALS

Except as otherwise specified in the following paragraphs, conform materials to Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

2.1.1 Cement

Furnish cement conforming to ASTM C 150/C 150M, Type I, II, III or V. Furnish blended cements that conform to ASTM C 595/C 595M.

2.1.2 Silica Fume

Provide silica fume conforming to ASTM C 1240. Provide available alkalies conforming to the optimal limit given in Table 2 of ASTM C 1240. Silica fume may be furnished as a dry, densified material or as a slurry. When necessary, coordinate the services of a technical representative experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume.

2.1.3 Fly Ash and Pozzolans

Fly ash is used as an admixture conforming to ASTM C 618, Class C or F with 4 percent maximum loss on ignition and 35 percent maximum cement replacement by weight.

2.1.4 Ground Granulated Blast-Furnace Slag

Ground granulated blast furnace slag is used as an admixture conforming to ASTM C 989, Grade 120 with between 25 to 50 percent maximum cement replacement by weight.

2.1.5 Water

Furnish water potable or free of deleterious substances in amounts harmful to concrete or embedded metals.

2.1.6 Aggregates

2.1.6.1 Selection

Furnish aggregates conforming to ASTM C 33/C 33M. Provide aggregates not containing any substance, which may be deleteriously reactive with the alkalies in the cement.

2.1.6.2 Aggregates for Lightweight Concrete

ASTM C 330

2.1.7 Admixtures

2.1.7.1 Air-Entraining

ASTM C 260

2.1.7.2 Accelerating, Retarding, Water Reducing

ASTM C 494/C 494M

2.1.8 Reinforcement

2.1.8.1 Reinforcing Bars

a. Deformed Billet-steel: ASTM A 615/A 615M

2.1.8.2 Reinforcing Wire

a. Plain Wire: ASTM A 82/A 82M

2.1.8.3 Welded Wire Fabric

a. Plain Wire: ASTM A 185/A 185M

2.1.9 Synthetic Fiber Reinforcement

Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 2 inch.

2.1.10 Inserts and Embedded Metal

All items embedded in concrete shall be of the type required for the intended task, and meet the following standards.

a. Structural Steel Plates, Angles, etc.: ASTM A 36/A 36M
b. Hot-dipped Galvanized: ASTM A 153/A 153M
c. Proprietary Items: In accordance with manufacturers published literature

2.1.11 Accessories

a. Rubber Gaskets for Circular Concrete Sewer Pipe and Culvert Pipe: ASTM C 443.

b. External Sealing Bands for Noncircular Sewer, Storm Drain and Culvert Pipe: ASTM C 877.

c. Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections: ASTM C 990.

d. Elastomeric Joint Sealants: ASTM C 920

e. Grade Rings: Use precast concrete grade rings to support and adjust manhole frames. Grade rings shall conform to ASTM C 478 and shall be set in a full bed of mortar.

2.1.12 Pipe Entry Connectors

Pipe entry connectors shall conform to ASTM C 923 or ASTM C 1478.

2.1.13 Grout

Nonshrink grout shall conform to ASTM C 1107/C 1107M. Cementitious grout shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.

2.1.14 Precast Concrete Manholes

Precast concrete manholes shall conform to ASTM C 478.

2.1.14.1 Manhole Bases

Manhole bases shall be precast concrete. Their design and fabrication shall conform to the general requirements of this Section and the provisions of ASTM C 478. The bases shall conform to the dimensions shown on the drawings. The horizontal joint at the top of the base shall be compatible with that of the precast wall sections.

The precast bases shall be manufactured to contain openings in the wall of minimum size to receive the ends of the pipe. All penetrations shall be cast in at the concrete precast plant. Drilled openings shall not be permitted. These openings shall be accurately set to conform to line and grade of pipe.

All precast concrete bases shall be free from cracks, damaged joints, exposed reinforcing, aggregate pockets, spalls, and dimensional distortions or other irregularities. Any units rejected by the Contracting Officer shall be tagged and removed from the job site immediately.

2.1.14.2 Manhole Wall and Top

Precast concrete walls shall be made up of straight, circular sections and eccentric tops if manhole steps are required. The total height of precast wall required for each manhole shall be determined in the field and shall be such that the vertical distance between the top of the assembled precast units and the bottom of the installed cast-iron manhole frame is a minimum of 4 inches and a maximum of 12 inches to allow for masonry work or precast concrete grade rings.

All precast units shall be laid up plumb and level. Minimum longitudinal and circumferential reinforcing steel shall be in conformance with ASTM C 478.

All precast concrete sections shall be free from cracks, damaged joints, exposed reinforcing, aggregate pockets, spalls, dimensional distortions, or other irregularities. Any units rejected by the Contracting Officer shall be tagged and removed from the job site immediately.

Precast reinforced concrete slab tops for manholes shall be 8 inches thick and manufactured in accordance with ASTM C 478. Openings shall be eccentric when manholes are furnished with steps and concentric if they have no steps and of the proper diameter to receive the frame specified. Slab tops shall be set in a full bed of mortar.

2.1.14.3 Manhole Bench Walls

The flow channels in each manhole shall be carefully shaped following the details on the drawings. They shall match the inverts and size of pipes which connect to the manhole, creating a channel of gradual slope and curvature so that a smooth, uninterrupted flow through the manhole is ensured. The inverts of these channels shall be construction of half pipe sections or concrete. For bends, short sections of half pipe may be cut and used to form the channel. Refer to drawings for details. The bench surface itself shall extend laterally to the manhole walls, pitching slightly toward the flow channel.

Minimum concrete Class C mix shall be used for bench walls and all exposed surfaces shall receive a steel-troweled finish. Horizontal surfaces shall then be brush finished.

2.1.14.4 Manhole Frames and Covers

Frames and covers shall have 24-inch openings and shall be heavy duty, non-penetrating pickhole type of non-rocking design and shall have machined bearing surfaces to prevent rocking and rattling under traffic loads.

Material shall be gray cast iron conforming to ASTM A48/A48M, Class 30; or shall be ductile cast iron conforming to ASTM A536, Grade 60-40-18.

Castings shall be manufactured true to pattern and shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage distortion, or other defects. Components shall fit together completely.

Covers shall have cast-in, 1-1/2-inch-wide, raised letters with lettering as shown in the drawings.

The finish shall be smooth and well cleaned by shot-blasting or by some other approved method.

Frames shall be firmly seated in a full bed of mortar and be positioned to conform to the adjacent finished grade or to the specific elevation shown on the drawings. Frames shall be set parallel to surface slopes. Covers shall seat uniformly in any position in the frame without rocking.

2.1.14.5 Manhole Steps

When shown on the drawings, manhole steps shall be copolymer polypropylene plastic with 1/2-inch Grade 60 steel reinforcement as manufactured by M.A. Industries, Inc., or equal.

Steps are to be cast in or grouted solid into the precast units at intervals of 12 inches. Steps shall be in conformance with OSHA requirements, having drop front or equivalent. Bolted-on types are not acceptable.

2.1.14.6 Jointing Precast Sections

Seal tongue-and-groove joints of precast manhole sections with either rubber O-ring gaskets or preformed flexible joint sealant. O-ring gaskets shall conform to ASTM C 443 and FS SS-S-210. Preformed flexible joint sealant shall be Kent Seal No. 2 by Hamilton-Kent, Ram-Nek by Henry, or equal.

After the joints are assembled the gap between sections shall be packed on the inside and outside with Anti-Hydro "Axpandaretes," Masterflow 713 by Master Builders or Five Star Grout by U.S. Grout Corp. and shall be troweled smooth so that no projections remain on the inside.

The completed joint shall withstand 15-psi internal water pressure without leakage or displacement of gasket or sealant.

2.1.14.7 Pipe Connections to Manholes

Connect pipe to manholes in the following ways:

Flexible sleeve - integrally cast the sleeve in a precast manhole section or install the sleeve in a formed or cored opening. Fasten pipe in sleeve with stainless steel clamp(s). Coat stainless steel clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve, Kor-N-Seal connector, or equal.

Compression gasket - integrally cast the compression gasket in a precast manhole section. Insert pipe into compression gasket. The compression gasket shall be A-Lok or equal.

At the discretion of the Contracting Officer the following procedure may be allowed:

Grout-in-place - precast manhole sections shall have a formed, tapered circular opening larger than the pipe outside diameter. Grout shall be non-shrink and waterproof equal to Hallemite, Waterplug, or Embeco. Plastic pipe shall have a waterstop gasket secured to the pipe with a stainless steel clamp before grouting.

2.1.14.8 Drop Sections

Whenever the invert of a pipe entering a manhole is 24 inches or more in height above the invert of the lowest pipe leaving the manhole, it shall be connected to the manhole with a drop section as shown on the drawings. The manhole shall be constructed in the normal manner, except that the concrete base shall be extended for outside drop pipes and a straight clean-out pipe shall be connected through the wall as detailed on the drawings.

Fittings and special adapters required for the outside drop section shall be of the same material and class as the pipe entering the manhole. After installing the outside drop section and pipe connections into the manhole, encase the entire vertical, outside assembly in concrete, as shown, using Concrete Class "C" mix.

2.1.14.9 Dampproofing

Apply two coats of bituminous waterproofing material to the exterior surfaces of precast concrete structures by brush or spray and in accordance with the manufacturer's recommendations. Dampproofing shall be Hydrocide 648 by Sonneborn Building Products, Dehydratine 4 by A.C. Horn Inc., RIW Marine Liquid by Toch Brothers, or equal.

2.1.15 Precast Valve Vaults

Precast valve vaults shall be sized as shown on the Drawings and shall conform to the requirements of ACI 318. The vaults shall also meet the permeability requirements specified by ASTM C 14.

The units shall be cured as specified in Section 03 30 53, MISCELLANEOUS CAST-IN-PLACE CONCRETE, and shall not be shipped until at least 10 days after casting. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the outside of each precast section.

All pipe openings and access accessories shall be cast in at the precast plant.

The manufacturer shall reinforce the valve vaults to meet all applicable codes. Alternatively, the valve vaults may be redesigned using the applicable backfill, surcharge, and dead loads. Minimum live load shall be an equivalent lateral fluid pressure of 100 psf per foot of depth.

Access plate shall be as specified in Contract Drawings and Section 05 50 13, MISCELLANEOUS METAL FABRICATIONS.

The valve vault and access hatch shall be integral with the sidewalls with slab reinforcing tied to wall steel.

PART 3 EXECUTION

3.1 FABRICATION AND PLACEMENT

Perform fabrication in accordance with NPCA QC Manual and/or ACPA QPC unless specified otherwise.

3.1.1 Forms

Use forms, for manufacturing precast concrete products, of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Construct forms so that the forces and vibrations to which the forms will be subjected can cause no product damage. Clean forms of concrete build-up after each use. Apply form release agents according to the manufacturers recommendations and do not allow to build up on the form casting surfaces.

3.1.2 Reinforcement

Follow applicable ASTM Standard or ACI 318 for placement and splicing. Fabricate cages of reinforcement either by tying the bars, wires or welded wire fabric into rigid assemblies or by welding, where permissible, in accordance with AWS D1.4/D1.4M. Position reinforcing as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover shall be one-third of that specified but not more than 1/2 inch. Provide concrete cover not less than 1/2 inch. Take positive means to assure that the reinforcement does not move significantly during the casting operations.

3.1.3 Embedded Items

Position embedded items at locations specified in the design documents.

Perform welding in accordance with AWS D1.1/D1.1M when necessary. Hold rigidly in place inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products so that they do not move significantly during casting operations.

3.1.4 Synthetic Fiber Reinforced Concrete

Add fiber reinforcement to the concrete mix in accordance with the applicable sections of ASTM C 1116/C 1116M and the recommendations of the manufacturer, and in an amount of 0.1 percent by volume.

3.2 CONCRETE

3.2.1 Concrete Mixing

Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

3.2.2 Concrete Placing

Deposit concrete into forms as near to its final location as practical. Keep the free fall of the concrete to a minimum. Consolidate concrete in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Use vibrators to consolidate concrete with frequencies and amplitudes sufficient to produce well consolidated concrete.

3.2.2.1 Cold Weather Concreting

Perform cold weather concreting in accordance with ACI 306.1.

a. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.

b. Free from frost all concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact.

c. Do not use frozen materials or materials containing ice.

d. In cold weather the temperature of concrete at the time of placing shall not be below 45 degrees F. Discard concrete that freezes before its compressive strength reaches 500 psi.

3.2.2.2 Hot Weather Concreting

Recommendations for hot weather concreting are given in detail in ACI 305R. During hot weather, give proper attention to constituents, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing shall not exceed 90 degrees F.

3.2.3 Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing.

3.2.3.1 Curing by Moisture Retention

Prevent moisture evaporation from exposed surfaces until adequate strength for stripping is reached by one of the following methods:

a. Cover with polyethylene sheets a minimum of 6 mils thick in accordance with ASTM C 171.

b. Cover with burlap or other absorptive material and keep continually moist.

c. Use of a membrane-curing compound applied at a rate not to exceed 200 square ft/gallon, or in accordance with manufacturers' recommendations according to ASTM C 309.

3.2.3.2 Curing with Heat and Moisture

Curing with heat and moisture is not permitted.

3.2.4 Surface Finish

Finish unformed surfaces of wet-cast precast concrete products as specified. If no finishing procedure is specified, finish such surfaces using a strike-off to level the concrete with the top of the form.

3.2.4.1 Formed Non-Architectural Surfaces

Cast surfaces against approved forms following industry practices in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be accepted but no major imperfections, honeycombs or other major defects will be permitted.

3.2.4.2 Unformed Surfaces

Finish unformed surfaces with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be accepted but no major imperfections, honeycombs, or other major defects shall be permitted.

3.2.4.3 Special Finishes

Troweled, broom or other finishes shall be according to the requirements of project documents and performed in accordance with industry standards or supplier specifications. Submit finishes for approval when required by the project documents. The sample finishes shall be approved prior to the start of production.

3.2.5 Stripping Products from Forms

Do not remove products from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal.

3.2.6 Patching and Repair

No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas, unless the surfaces are required by the

design to be finished.

3.2.6.1 Repairing Minor Defects

Defects that will not impair the functional use or expected life of a precast concrete product may be repaired by any method that does not impair the product.

3.2.6.2 Repairing Honeycombed Areas

When honeycombed areas are to be repaired, remove all loose material and cut back the areas into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Use proprietary repair materials in accordance with the manufacturer's instructions. If a proprietary repair material is not used, saturate the area with water. Immediately prior to repair, the area should be damp, but free of excess water. Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

3.2.6.3 Repairing Major Defects

Evaluate, by qualified personnel, defects in precast concrete products which impair the functional use or the expected life of products to determine if repairs are feasible and, if so, to establish the repair procedure.

3.2.7 Shipping Products

Do not ship products until they are at least 5 days old, unless it can be shown that the concrete strength has reached at least 75 percent of the specified 28-day strength, or that damage will not result, impairing the performance of the product.

3.3 INSTALLATION

3.3.1 Site Access

It is the Contractor's responsibility to provide adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.

3.3.2 Precast Structure Installation

Precast section ends shall be clean of foreign materials and carefully inspected for chips or cracks. Any sections with damaged joint tongue shall not be used. Preformed plastic gaskets and joint sealant shall be installed in strict conformance with the manufacturer's recommendations. Only primer furnished by the gasket manufacturer will be approved.

Invert elevations shall be in strict conformance with the drawings. All sharp edges or rough sections that obstruct flow shall be removed.

Access door framing shall be cast in top slabs in methods approved by the Contracting Officer and shall be flush and level with the top of concrete. Reference Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS for additional criteria.

Set precast concrete sections vertical and in true alignment. Install

O-ring rubber gasket in the recess in the base of previously set section or prime and double seal joint surfaces with "RAM-NEK" premolded plastic joint sealer or Contracting Officer-approved equal.

Completely plug, seal, and smooth all holes in sections used for their handling and the annular space between the wall and entering pipe with nonshrink grout. Finish grout smooth and flush with the adjoining interior and exterior manhole wall surfaces and make watertight.

All structures shall be installed plumb.

3.3.2.1 Dampproofing

Paint outer surfaces of precast structure with two coats of bituminous dampproofing at the rate of 30 to 60 square feet per gallon, in accordance with the manufacturer's instructions.

3.3.3 Manhole Installation

Manholes shall be constructed to the dimensions shown on the drawings and as specified in this Section. Protect all work against flooding and flotation.

Place the manhole base on a bed of 12-inch crushed stone as shown on the drawings. Minimum diameter of the stone foundation shall be the outside diameter of the base plus 2 feet. Set the manhole base grade so that a maximum grade adjustment of 12 inches is required to bring the manhole frame and cover to final grade.

Use precast concrete producer's instructions. In the absence of such instructions, install underground utility structures grade rings or brick and non-shrink mortar to adjust the manhole frame and cover to final grade.

Set precast concrete manhole sections plumb with a 1/4-inch maximum out-of-plumb tolerance allowed. Seal joints of precast barrel sections with either a rubber O-ring set in a recess or preformed flexible joint sealant in sufficient quantity to fill 75 percent of the joint cavity. Fill the outside and inside joint with non-shrink mortar and finish flush with the adjoining surfaces. Caulk the inside of any leaking barrel section joint with lead wool or non-shrink grout to the satisfaction of the Contracting Officer.

Allow joints to set for 14 hours before backfilling unless the Contracting Officer specifically approves a shorter period.

Plug holes in the concrete barrel sections required for handling with a non-shrinking grout or non-shrinking grout in combination with concrete plugs. Finish flush on the inside.

The ends of the pipe shall be accurately positioned in the openings and properly secured against movement.

Backfill carefully and evenly around manhole sections.

3.3.3.1 Manhole Pipe Connections

Construct manhole pipe connections, including pipe stubs, as specified above. Close or seal pipe stubs for future connections with a gasketed watertight plug.

3.3.3.2 Mortar

Mix mortar only in such quantity as may be required for immediate use. Use mortar before initial set has taken place. Mortar shall be used within 1-1/2 hours and shall be constantly worked with hoe or shovel until used. Anti-freeze mixtures shall not be included in the mortar. Install masonry when the outside temperature is above 40 degrees F unless provisions are made to protect the mortar and finished work from frost by heating and enclosing the work with tarpaulins or other suitable material. The Contracting Officer's decision regarding the adequacy of protection against freezing shall be final.

3.3.3.3 Setting Manhole Frame and Cover

Set manhole covers and frames in a full mortar bed so that the space between the top of the manhole masonry and the bottom flanges of the frame will be completely filled and made watertight. Precast concrete grade rings a maximum of 12 inches thick shall be used to ensure that the frame and cover are set to the finished grade. Set the manhole frame and cover to final grade before placing permanent paving. Install curb inlet stones as shown on the drawings.

Set manhole frames and covers flush with finish pavement or 3 inches above the finished grade in unpaved areas. Place a ring of mortar around the outside of the bottom flange at least 1 inch thick and pitched to shed water away from the frame. Extend mortar to the outer edge of the masonry and finish smooth and flush with the top of the flange.

3.3.3.4 Dampproofing

Paint outer surfaces of manholes with two coats of bituminous dampproofing at the rate of 30 to 60 square feet per gallon, in accordance with the manufacturer's instructions.

3.3.4 Leakage Tests

Test each sewer manhole and wetwell for leakage by one of the methods described below. The Contracting Officer shall observe each test.

3.3.4.1 Exfiltration Test

Assemble precast structure in place; fill and point all lifting holes and exterior joints within 6 feet of the ground surface with an approved non-shrinking mortar. Test before placing the shelf and invert and before filling and pointing the horizontal joints below 6 feet of depth. Lower the groundwater table below the bottom of the structure for the duration of the test. Plug all pipes and other openings into the precast structures and brace to prevent blow out.

Fill the manhole or wetwell with water to the top of the structure. If the excavation has not been backfilled and no water is observed moving down the surface of the structure, the manhole or wetwell is satisfactorily watertight. If the test as described above is unsatisfactory as determined by the Contracting Officer or if the excavation has been backfilled, continue the test. A period of time may be permitted to allow for absorption. Following this period, refill the manhole or wetwell to the top of the structure, if necessary, and wait at least 8 hours. At the end of the test period, refill the manhole or

wetwell to the top of the structure again, measuring the volume of water added. Extrapolate the refill amount to a 24-hour leakage rate. The leakage for each manhole or wetwell shall not exceed 1 gallon per vertical foot for a 24-hour period. If the manhole or wetwell fails this requirement, but the leakage does not exceed 3 gallons per vertical foot per day, the Contractor may make repairs by approved methods as directed by the Contracting Officer. If leakage due to a defective section of joint exceeds 3 gallons per vertical foot per day, the structure shall be rejected. Uncover the rejected structure as necessary to disassemble, reconstruct, or replace it as directed by the Contracting Officer. Retest the manhole or wetwell and, if satisfactory, fill and paint the interior joints.

No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorptions, etc. It will be assumed that all loss of water during the test is a result of leaks through the joints or through the concrete.

3.3.4.2 Infiltration Test

An infiltration test may be substituted for an exfiltration test if the groundwater table is above the highest joint in the manhole. If the Contracting Officer determines there is no leakage into the manhole, the manhole will be considered watertight. If the Contracting Officer is not satisfied, the Contractor shall perform an exfiltration or air testing.

3.3.4.3 Vacuum Test

Vacuum testing shall conform to ASTM C 1244.

If the pressure drop exceeds the acceptable limits, the Contractor will be allowed to make necessary repairs, as approved by the Contracting Officer. The manhole shall then be re-tested.

When a successful vacuum test has been completed, fill and point the interior and exterior joints.

3.3.4.4 Leakage Tests for Drain Manholes

The Contracting Officer will visually inspect drain manholes for possible leaks before backfilling is allowed. All joints shall be sealed to the satisfaction of the Contracting Officer.

The Contracting Officer may require an exfiltration test as described for sewer manholes on any structure for which the Contracting Officer deems such a test appropriate.

3.4 CLEANING

The Contractor shall thoroughly clean all precast structures of all silt, debris, and foreign matter of any kind before final inspections.

-- End of Section --

SECTION 03 45 00

PRECAST ARCHITECTURAL CONCRETE
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 301	(2010; Errata 2011) Specifications for Structural Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305.1	(2006) Specification for Hot Weather Concreting
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 318	(2011; Errata 1 2011; Errata 2 2012; Errata 3-4 2013) Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2010; Change 2010; Change 2011; Errata 2011; Change 2011) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C2	(2003) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes

ASME INTERNATIONAL (ASME)

ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A27/A27M	(2010) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A283/A283M	(2012a) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A416/A416M	(2012) Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM A449	(2010) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings

ASTM A496/A496M	(2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A497/A497M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A615/A615M	(2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A706/A706M	(2009b) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C109/C109M	(2012) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C114	(2011b; E 2013) Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C115	(2010) Standard Test Method for Fineness of Portland Cement by the Turbidimeter
ASTM C117	(2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2012) Standard Test Method for Lightweight Particles in Aggregate
ASTM C125	(2013a) Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C127	(2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2013) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142/C142M	(2010) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2012) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C151/C151M	(2009) Standard Test Method for Autoclave Expansion of Hydraulic Cement
ASTM C172/C172M	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C183	(2008) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C185	(2008) Standard Test Method for Air Content of Hydraulic Cement Mortar
ASTM C186	(2005) Standard Test Method for Heat of Hydration of Hydraulic Cement
ASTM C191	(2008) Standard Test Method for Time of Setting Hydraulic Cement by Vicat Needle
ASTM C192/C192M	(2013) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C204	(2011) Standard Test Method for Fineness of Hydraulic Cement by Air Permeability Apparatus
ASTM C231/C231M	(2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C232/C232M	(2013a) Standard Test Methods for Bleeding of Concrete
ASTM C233/C233M	(2011) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C266	(2008; E 2011) Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles

ASTM C289	(2007) Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C29/C29M	(2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C31/C31M	(2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2013) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2012) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	(2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C403/C403M	(2008) Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C42/C42M	(2013) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C451	(2008) Standard Test Method for Early Stiffening of Hydraulic Cement (Paste Method)
ASTM C494/C494M	(2013) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2012) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C595/C595M	(2013) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C70	(2013) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78/C78M	(2012; E 2013) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

ASTM C88	(2013) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94/C94M	(2013a) Standard Specification for Ready-Mixed Concrete
ASTM C989/C989M	(2012a) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1149	(2007; R 2012) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D3744/D3744M	(2011a) Standard Test Method for Aggregate Durability Index
ASTM D635	(2010) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D746	(2013) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D75/D75M	(2009) Standard Practice for Sampling Aggregates

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED GBDC	(2009) LEED Reference Guide for Green Building Design and Construction

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1999) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 4th Edition
PCI MNL-117	(1996) Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, 3rd Edition
PCI MNL-122	(2007) Architectural Precast Concrete, 3rd Edition

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Precast architectural concrete: Provide shop drawings for the following.
Precast architectural concrete panels; G

1. Panel Sizes
2. Joint Locations
3. Joint Widths

4. Reveal and False-joint Locations and Dimensions

Architect/Engineer review of shop drawings is for general conformance with design concept and project requirements only, and does not imply approval or any variance from the Contract Documents.

Precast architectural concrete coping; G

Precast architectural concrete column covers; G
Precast tower corner condition

SD-03 Product Data

Cast-in embedded items and connectors; G

Connection devices; G; (LEED NC)

Concrete; G; (LEED NC)

SD-04 Samples

Job mock ups for precast architectural concrete. For Precast Architectural Concrete. Provide samples to be approved at precast manufacturer's plant, by Contracting Officer, prior to delivery; G.

Precast architectural concrete panels.

Precast architectural concrete coping

Precast architectural concrete column covers
Precast architectural horizontal soffit panel

SD-05 Design Data

Precast concrete design calculations; G

Precast architectural concrete panels.

Precast architectural concrete coping

Precast architectural concrete column covers

Precast architectural horizontal soffit panel

Contractor-furnished mix design; G

Concrete mix design for repair of surface defects; G

Precast concrete architectural panel connection and embedment design calculations; G

SD-06 Test Reports

Strength tests; G

Submit commercial testing results in accordance with PCI MNL-117 and as required in paragraph entitled "Sampling and Testing."

SD-08 Manufacturer's Instructions

Installation of precast concrete architectural panels, coping and column covers; G.

Cleaning of wall panels, coping and column covers; G.

Include precast concrete architectural panel manufacturer's written recommendations for installation and cleaning.

SD-11 Closeout Submittals

Concrete batch ticket information; G

Manufacturer's Qualifications

Calculations

Mix Design

Precast Concrete Manufacturer

Wall-panel Installer

Concrete

Exposed-to-View Concrete

Backing Concrete

Slump

Air Content

Compressive Strength

Mock-Ups: Provide the following:

Precast Architectural Concrete Panel
Precast Architectural Concrete Coping
Precast Architectural Concrete Column Covers

Precast architectural soffit panels
Precast Tower Corner Condition

Pre-Installation Meeting

Tolerances

Portland Cement

Exposed-to-View Finished Surfaces

Air-Entrained Admixtures

Finish Aggregate

Gasket

Erection

Local / Regional Materials; (LEED NC)

Recycled Content

1.4 MODIFICATION OF REFERENCES

In the referenced ACI and PCI publications, consider the advisory provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 GENERAL REQUIREMENTS

Precast concrete units must be designed and fabricated by an experienced and acceptable precast concrete manufacturer certified under the PCI Plant Certification Program. The manufacturer needs to have been regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings for at least 3 years. The Contractor must submit a statement detailing the Manufacturer's Qualifications as specified in the Submittals paragraph. Coordinate precast work with the work of other trades.

1.6 DESIGN

1.6.1 Standards and Loads

Precast unit design must conform to ASCE 7, ACI 318 and PCI MNL-122. Indicate design loads for precast concrete on the drawings. A differential temperature of30 degrees F, between interior and exterior faces of the units, must be considered in the design. Stresses due to restrained volume change caused by shrinkage and temperature differential, handling, transportation and erection must be accounted for in the design.

1.6.2 Connections

Connection of units to other members, or to other units must be of the type and configuration indicated. The design and sizing of connections

for all design loads will be completed by the Contractor.

1.6.3 Concrete Strength

Precast concrete units must have a 28-day compressive strength of 5000 psi.

1.6.4 Concrete Proportion

Base the selection of proportions for concrete on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportion using the same type and brand of cement, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete and admixtures containing chloride ions, nitrates, or other substances that are corrosive will not be used in prestressed concrete.

1.6.5 Calculations

Calculations for design of members and connections not shown must be made by a professional engineer experienced in the design of precast architectural concrete. Calculation will include the analysis of member for lifting stresses and the sizing of the lifting inserts.

1.6.6 Mix Design

The Contractor must submit the mix design formula giving the maximum nominal coarse aggregate size, the proportions of all ingredients and the type and amount of any admixtures that will be used in the manufacture of each strength and type of concrete, prior to commencing operations. Submit certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, and aggregates. The statement must be accompanied by test results from an approved testing laboratory, certifying that the proportions selected will produce concrete of the properties required. Make no substitutions without additional tests to verify that the concrete properties are satisfactory.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials to the project site in the original, unbroken packages or containers, each bearing a label clearly identifying manufacturer's name, brand name, weight or volume, and other pertinent information. Store packaged materials, and materials in containers, in a weathertight and dry place until ready for use.

Store products in manufacturer's unopened packaging in dry storage area, with ambient temperature between 30 degrees F and 120 degrees F, until installation.

1.8 STORAGE AND INSPECTION AT MANUFACTURER'S PLANT

Protect precast units temporarily stored at the manufacturer's plant from damage in accordance with PCI MNL-116and PCI MNL-117 and PCI MNL-122. Immediately prior to shipment to the jobsite, all precast concrete units must be inspected for quality to insure all precast units conform to the requirements specified. Inspection for quality will include, but will not be limited to, the following elements: color, texture, dimensional

tolerances, chipping, cracking, staining, warping and honeycombing. Replace or repair all defective precast concrete units as approved.

1.9 PLANT INSPECTION

At the option of the Contracting Officer, precast units may be inspected. The Contractor is to give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.9.1 PCI Quality Certifications

1.9.1.1 Product Quality Control

PCI MNL-117 for PCI enrolled plants. Where panels are manufactured by specialist in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-117 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

1.9.1.2 Product Quality Control

Plants must be certified by the PCI Plant Certification Program for Category A1 work, or Architectural Precast Association (APA) certification.

1.10 QUALIFICATIONS FOR PRECAST CONCRETE MANUFACTURER

Panels, coping, and column covers are to be manufactured by an organization experienced in the manufacture of precast architectural concrete panels, coping and column covers..

Submit a letter of reference for the manufacturer giving the qualifications of personnel, location of plant, concrete batching facilities, manufacturing equipment and facilities, list of projects similar to specified work, and other information as may be required by the Contracting Officer.

1.11 QUALIFICATIONS FOR WALL-PANEL INSTALLER

Panels, coping, and column covers must be installed by an organization experienced in the installation of precast wall concrete architectural panels, coping and column covers.

Submit a letter of reference for the installer giving the qualifications of personnel, handling and erection equipment, lists of projects similar to specified work, and other information as may be required by the Contracting Officer.

1.12 CONCRETE SAMPLING AND TESTING

1.12.1 Test for Concrete Materials

Sample and test concrete materials proposed for use in the work as follows:

MATERIALS	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Aggregate	Sampling sieve analysis, calculating fineness modulus	ASTM D75/D75M ASTM C136 ASTM C125	One for each material source and grading size
	Amount of material passing No. 200 sieve	ASTM C117	
	Amount of friable particles	ASTM C142/C142M	
	Amount of organic impurities	ASTM C40	
	Amount of coal and lignite	ASTM C123/C123M	
	Magnesium sulfate soundness test	ASTM C88	
	Aggregate durability	ASTM D3744/D3744M	
	Specific gravity of fine aggregate	ASTM C128	
	Specific gravity of course aggregates	ASTM C127	
	Resistance to abrasion of small size course aggregate	ASTM C131 or ASTM C535	
	Potential reactivity to alkalis	ASTM C289	
Portland Cement	Sampling	ASTM C183	One for each material source, type and color
	Chemical analysis	ASTM C114	

MATERIALS	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Fineness	ASTM C115 or ASTM C204	
	Autoclave expansion time of setting	ASTM C151/C151M, ASTM C191 or ASTM C266	
	Air Content of mortar	ASTM C185	
	Compressive strength	ASTM C109/C109M	
	Heat of hydration	ASTM C186	
	False set	ASTM C451	
Air-entraining admixture using air-entrained concrete made of the proposed concrete materials	Materials for test	ASTM C233/C233M	One set of tests for each type and color of portland cement proposed for use
	Number of specimens	ASTM C233/C233M, Table 1	
	Bleeding	ASTM C232/C232M	
	Time of setting	ASTM C403/C403M and ASTM C233/C233M	
	Compressive strength test specimen	ASTM C192/C192M and ASTM C233/C233M	
	Compressive strength test at 3, 7 and 28 calendar days	ASTM C39/C39M and ASTM C233/C233M	

MATERIALS	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete made of the proposed concrete materials	Water absorption	As specified	Three 4 by 8 inch cylinders or 4 inch cube concrete specimens for each type of mixture required

Submit reports for each material sampled and tested prior to the start of work. Reports must contain the project name and number, date, name of Contractor, name of precast manufacturer, name of concrete testing service, source of concrete aggregates, generic name of aggregate, and values specified.

1.12.2 Concrete Design Mixes

Concrete design mix for concrete, including Exposed-to-View Concrete facing mixture and Backing Concrete mixture, must be determined and tested as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Specific gravity and absorption of fine aggregate	ASTM C128	As required for the concrete aggregates
Specific gravity and absorption of course aggregate	ASTM C127	
Moisture content of both fine and coarse aggregate	ASTM C70 and ASTM C566	
Dry-rodded unit weight of course aggregate	ASTM C29/C29M	
Trial mixes using at least three different water/cement ratios, minimum allowable cement content and maximum allowable slump; all with air-entrainment	ACI 211.1	As required to determine the concrete mix having the properties specified
Making and curing concrete specimens in the laboratory	ASTM C192/C192M	Two sets of three specimens for each design mix
Sampling fresh concrete in the laboratory	ASTM C192/C192M	One for each set of design mix specimens

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Slump	ASTM C143/C143M ACI 211.1	
Air Content	ASTM C231/C231M	
Yield	ASTM C138/C138M	
Compressive Strength	ASTM C39/C39M	Three specimens tested at 7 calendar days and three specimens tested at 28 calendar days

From the results of the tests, plot a curve for each concrete mixture, showing the relationships between water/cement ratios and compressive strengths. Maximum permissible water/cement ratio must be that value not exceeding the maximum water/cement ratio specified, indicated by the curve to produce a design minimum laboratory compressive strength at 28 calendar days not less than that specified.

Submit report of the design mix for both exposed-to-view facing mixture and backing mixture for approval at least 15 calendar days prior to start of fabricating panels. Report is to contain the project name and number, date, name of Contractor, name of precast concrete architectural panel manufacturer, name of concrete testing service, use of concrete mixture (facing or backing), source of concrete aggregates for each mixture, manufacturer and brand name of manufactured materials, the exact proportions of each concrete mix, the concrete properties specified, and the test results for each requirement specified for the concrete design mixes.

1.12.3 Quality Control Testing During Panel Fabrication

Sample and test concrete for quality control during fabrication as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Sampling fresh concrete	ASTM C172/C172M except modified for slump per ASTM C94/C94M	As required for each test

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Slump test	ASTM C143/C143M	One for each concrete load at point of discharge and one for each set of compressive strength tests
Air Content by pressure method	ASTM C231/C231M	One for each set of compressive strength tests
Compressive test specimens	ASTM C31/C31M	One set of six specimens for each Compressive Strength test

Compression test specimens may be either standard 6 by 12 inch cylinders or 4-inchcubes. Cubes may be molded individually or cut from slabs. Preparation and testing of cube specimens must be as nearly consistent with the test methods specified as possible, with the exception that the concrete will be placed in a single layer.

Curing of compression test specimens must be the same as the curing method used for the precast concrete architectural panels until panels are stripped of forms and then standard moist cure will continue.

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete temperature		Each time a set of compression test specimens is made
Compressive strength tests	ASTM C39/C39M	One set of facing strength tests mix and one set of backing mix for every ten panels or fraction thereof cast in any one day; two specimens in each set tested at 7 calendar days; three specimens in each set tested at 28 calendar days, and one specimen in each set retained in reserve for testing if required

Submit test reports on the same day that tests are made.

Test results that fail to meet the value for any concrete property specified in "Quality of Concrete" must be noted in the report.

Reports for Compressive Strength tests need to contain the project name and number, date of concrete placement, name of Contractor, name of precast architectural concrete manufacturer, name of concrete testing service, panel identification letter and number, use of concrete mixture (facing or backing), design compressive strength at 28 calendar days, concrete-mix proportions and materials, and compressive breaking strength and type of break.

If 4-inch cubes are used for compressive strength specimens, average strength of the cubes at any test age must be multiplied by the factor of 0.8 to arrive at an estimate of the corresponding 6 by 12 inch cylinder strength. Report both of these values.

1.13 QUALITY ASSURANCE

1.13.1 Drawings

a. Precast architectural concrete panel dimensions, cross-section, and edge details; location, size, and type of reinforcement, including reinforcement necessary for safe handling and erection of panels. Comply with ACI SP-66.

b. Layout, dimensions, and identification of each panel, corresponding to installation sequence.

c. Setting drawings, instructions, and directions for installation of concrete inserts.

d. Location and details of anchorage devices and lifting devices embedded in panels, and connection details to building framing system.

1.13.2 Design Calculations

Submit design calculations prepared and sealed by a registered professional engineer demonstrating compliance with indicated loading conditions.

1.13.3 Connection and Embedment Design Calculations

Submit design calculations prepared and sealed by a professional engineer demonstrating compliance with the indicating connection and embedment details.

1.13.4 Mix Designs

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Include a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolan, ground slag, and admixtures; and applicable reference specifications.

1.13.5 Precast Architectural Concrete Samples

Submit a concrete wall panel sample 12 inches by 12 inches by approximately 1 1/2 inches in thickness, to illustrate quality, color, and texture of both exposed-to-view surface finish and finish of exposed surfaces that

will be concealed by other construction. Obtain approval prior to submission of sample panels.

1.13.6 Required Records

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.13.7 Mock-Ups

Apply specified products to determine acceptability of appearance and optimum coverage rate required for application.

1. Finish areas designated by Architect
2. Apply in accordance with manufacturer's instructions.
3. After materials have cured, water test surface to determine that sufficient water repellent has been applied.
4. Do not proceed with remaining work until mock-up is approved by Architect.
5. Provide dense reveal pattern for color #2 at first level per detail 12/A206

Precast Architectural Concrete Panel: Provide full size control panel to be approved by the Owner at the precast manufacturer's plant, prior to delivery.

1. Incorporate edge and revealdetail as shown on drawings.

2. Maintain Mock Up for comparison with finished work.

Precast architectural concrete Coping: Provide mock up of concrete coping to be approved by the owner at the precast manufacturer's plant, prior to delivery

Precast architectural concrete column covers: Provide mock up of column covers to be approved by the Owner at the precast manufacturer's plant, prior to delivery.

Precast tower corner condition: Provide one additional full size mockup panel for the tower precast corner condition, refer to the Drawings Detail 1/A263. Provide two separate panels that include consistent finishes on all three exposed surfaces.

Provide mock-ups to establish that proposed materials and construction techniques provide acceptable visual effect. Materials used for mock-ups should be those proposed for actual construction; retain samples of cement and aggregates used.

Provide mock-ups which typify the most difficult areas to build.

Do not proceed with remaining work until workmanship, color, and detail are approved by Architect. Modify mock-ups as required to produce acceptable work. After approval by Contracting Officer, transport mock-ups to job-site and erect where directed by Contracting Officer.

1.13.8 Pre-Installation Meeting

Hold a meeting at the job site with representative of the manufacturer and the applicator prior to application of water repellents. Notify the Owner and the Architect at least 3 days in advance of the time of the meeting.

1.14 Tolerances

Dimensions of the finished panel, at the time of erection in the structure, must conform to the tolerances for precast, non-prestressed elements in ACI 117, unless otherwise specified by the Architect.

PART 2 PRODUCTS

2.1 SUSTAINABLE DESIGN REQUIREMENTS

LEED NC: Furnish documentation relative to each material credit in accordance with the LEED GBDC.

2.2 PROPERTIES OF CONCRETE

PROPERTY	VALUE
Design compressive strength at 28 calendar days, 6 by 12 inch cylinders	Not less than 5,000 psi
Maximum aggregate size	As specified
Maximum water/cement ratio	4.25 gallons per 94-pound sack of cement
Minimum cement content	7.5 94-pound sacks sacks of cement per 0.76 cubic yard
Slump at point of concrete discharge	Not to exceed 2 inches
Total air content by volume at point of concrete discharge	Not less than 4 percent nor more than 6 percent

2.3 PRECAST CONCRETE

Precast concrete includes the following:

Precast architectural concrete panels
Precast architectural concrete coping
Precast architectural concrete column covers
Precast architectural soffit panels

2.4 CONCRETE

2.4.1 Contractor-Furnished Mix Design

ACI 211.1 and ACI 301. Concrete must have a 28-day compressive strength of 5000 psi. Architectural precast concrete units shall be formed, cast and finished to provide dense surfaces with consistently even distribution of

facing aggregates, matrix, color and finish texture. Cracking potential of precast concrete elements shall be minimized by implementing expansion and control joints in the precast assembly. Joints include properly sized and placed backing material and fully loaded and tooled sealant joint of no less than 1/4 inch sealant material thickness.

2.4.2 Exposed-to-View Facing Mixture

Provide aggregates for exposed-to-view facing mixture; white, gray, or buff portland cement or a blend of two or more portland cements; and water. Provide exact proportions of facing mixture to produce concrete having the specified properties and capable of obtaining the approved surface color and finish. Architectural precast concrete includes the following; color, texture, and patterns, size. Units are described as follows:

Architectural Precast Color 1: Gate GPK2465 SBL-M by Gate Precast, or equal as approved by the Contracting Officer.

Architectural Precast Color 2: Gate GPK2541 SB-M MetWest by Gate Precast, or equal as approved by the Contracting Officer.

Architectural Precast Color 3: Gray structural precast at roof level behind curtain wall; with no exposed aggregate, reveals or other architectural characteristics. Provide wall protective coating to back of panel.

2.4.3 Backing Mixture

Provide the approved mix design.

2.5 MATERIALS

2.5.1 Fine Aggregates

ASTM C33/C33M. The optional method of reducing the No. 50 and No. 100 sieve aggregates does not apply. The restriction to use only fine aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply.

2.5.2 Coarse Aggregate

ASTM C33/C33M, Size No. 57, Class 5S. The restriction to use only coarse aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply. Aggregate must not contain slag or crushed concrete.

2.5.3 Exposed Aggregate

In addition to the above, facing mixture aggregate, and aggregate for homogeneous panels with exposed aggregate finish, will be gravel of size and color to produce exposed surfaces to match the color and texture of the sample on file with the Contracting Officer.

2.5.4 Cement

ASTM C150/C150M, Type I or IIor ASTM C595/C595M, Type IP(MS) or IS(MS) blended cement except as modified herein. The blended cement must consist of a mixture of ASTM C150/C150M cement and one of the following

materials: ASTM C618 pozzolan or fly ash, or ASTM C989/C989M ground iron blast furnace slag. The pozzolan or fly ash content can not exceed 25 percent, and ground slag can not exceed 50 percent, by weight of the total cementitious material. For exposed concrete, use one manufacturer for each type of cement, pozzolan, fly ash, and ground slag.

2.5.5 Fly Ash and Pozzolan

ASTM C618, Type N, F, or C, except that the maximum allowable loss on ignition will be 6 percent for Type N and F. Add with cement.

2.5.6 Ground Iron Blast-Furnace Slag

ASTM C989/C989M, Grade 100 or 120.

2.5.7 Admixtures

ASTM C260/C260M for air-entraining admixtures. Other admixtures: ASTM C494/C494M. Certify that admixtures are free of chlorides.

2.5.8 Water

Fresh, clean, and potable.

2.5.9 Reinforcement

All exposed steel must be phosphate treated, primed, and coated to prevent rust.

2.5.9.1 Reinforcing Bars

ACI 301 unless otherwise specified. ASTM A706/A706M, Grade 60, ASTM A615/A615M,60.

2.5.9.2 Welded Wire Fabric

ASTM A185/A185M or ASTM A497/A497M.

2.5.9.3 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening in place.

a. Supports: ASTM A615/A615M, wire-type reinforcing bars and welded wire fabric.

b. Legs of supports in contact with formwork: Stainless steel, ASTM A167, Type 302 or Type 304.

2.5.10 Prestressing Strands

Prestressing strands need to conform to ASTM A416/A416M.

2.5.11 Tie Wire

Tie wire must be soft monel or 18-8 stainless steel.

2.5.12 Inserts

Inserts will be manufacturer's standard, suited for the application.

2.5.13 Plates, Angles, Anchors and Embedment

Material will be as specified in PCI MNL-117. Coat steel items, other than stainless, with a rust-inhibiting paint or provide hot-dip galvanized steel. Steel items, including items embedded in concrete, must be either stainless steel or hot dip galvanized steel.

2.5.14 Form Release Agent

Release agent must be manufacturer's standard non-staining type.

2.5.15 Portland Cement

Portland cement must conform to ASTM C150/C150M, Type I or II.

Blended hydraulic cement must conform to ASTM C595/C595M, Type II.

Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.5.16 Ground Granulated Blast Furnace (GGBF) Slag

GGBF slag used as an admixture must conform to ASTM C989/C989M, Grade 120 with between 25 to 50 percent maximum cement replacement by weight.

2.5.17 Air-Entrained Admixtures

Admixture must contain no sodium chloride or nitrates and will conform to ASTM C260/C260M.

2.6 Cast-In Embedded Items and Connectors

Design structural embedded anchorage and connections to panels to withstand gravity loads, live loads, dynamic loads, any volume change stresses inherent in the structure, and loads indicated.

2.6.1 Inserts

2.6.1.1 Threaded-Type Concrete Inserts

ASTM A47/A47M, Grade 32510 or 35018, or may be medium strength cast steel conforming to ASTM A27/A27M, Grade U-60-30. Provide galvanized ferrous casting having enlarged base with two nailing lugs minimum length less than the thickness of panel less 3/4 inch, and internally threaded to receive 3/4 inch diameter machine bolt. Ferrous castings must be ferritic malleable iron. Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

2.6.1.2 Wedge-Type Concrete Inserts

Provide galvanized, box-type ferrous castings with integral anchor loop at back of box to accept 3/4 inch diameter bolts having special wedge-shaped head. Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

2.6.1.3 Slotted-Type Concrete Inserts

Provide pressed steel plate, welded construction, box type with slot to receive 3/4 inch diameter square head bolt, and provide lateral adjustment of bolt. Length of insert body, less anchorage lugs, must be 4 1/2 inches minimum. Provide insert with knockout cover. Steel plate must be 1/8 inch minimum thickness, ASTM A283/A283M, Grade C. Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

2.6.1.4 Wood Nailer Inserts

Inserts will be kiln-dried "standard" grade Douglas fir or "No. 2" grade southern pine, surfaced 4 sides, and sized as indicated. Pressure treat wood with an approved wood preservative.

2.6.1.5 Flashing Reglets

Reglets must be sheet metal open-type with continuous groove not less than 1-1/8 inchesdeep by 3/16-inch wide at opening and sloped upward, designed to anchor snap-lock counter flashing.

Metal must be minimum 0.011-inch thick conforming to ASTM A167, Type 302 or 304, No. 1 finish, soft temper.

Metal must be copper strip weighing a minimum of 16 ounces per square foot, and conforming to ASTM B370, cold-rolled temper.

Metal is to be 26-gage galvanized steel sheet conforming to ASTM A653/A653M, G90.

2.6.2 Embedded Plates

ASTM A36/A36M, galvanized ferrous metal plate connectors for attachment to the structural framing using manufacturer standard construction procedures. Headed studs will use 60,000 psi steel with construction conforming to AWS D1.1/D1.1M, Type B. Deformed bar anchors must conform to ASTM A496/A496M. Provide embedded anchors galvanized after fabrication in accordance with ASTM A153/A153M.

2.6.3 Embedded Attachments

2.6.3.1 Embedded Wood Nailer

Kiln-dried Standard Grade Douglas Fir or No. 2 Grade Southern Pine. Surface four sides. Treat with waterborne pressure-preservative in accordance with AWPA C1 and AWPA C2. All wood needs to be air or kiln dried after treatment. Verify specific treatments by the report of an approved independent inspection agency. The AWPA C1 and AWPA C2 Quality Mark "C1" and "C2" on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

2.6.3.2 Flashing Reglets

Fabricate of sheet metal, open-type with continuous groove 1 1/8 inches deep minimum by 3/16 inch wide at opening and sloped upward at 45 degrees. Top surface will have toothed lip section to anchor upturned edge of metal snap-lock counter flashing when inserted. Sheet metal must be 0.0197 inch minimum thickness (26 gage), galvanized carbon steel sheet,

ASTM A653/A653M, Coating Designation G90.

2.6.4 Connection Devices

2.6.4.1 Clip Angles

ASTM A36/A36M steel, galvanized after fabrication in accordance with ASTM A153/A153M.

2.6.4.2 Ferrous Casting Clamps

ASTM A47/A47M, Grade 32510 or Grade 35018 malleable iron or cast steel, or ASTM A27/A27M, Grade U-60-30, cast steel casting, hot-dip galvanized in accordance with ASTM A153/A153M.

2.6.4.3 Threaded Fasteners

Provide galvanized machine bolts, washers and, when required, nuts.

a. Bolts: ASTM A449, 3/4 inch diameter machine bolts with hexagon head.

b. Washers: ASME B18.21.1, medium or heavy lock-spring washers.

c. Nuts: ASTM A563, Grade C, heavy, hexagon-type nuts.

d. Square Nuts: ASTM A563, Grade A, plain, square-type nuts where required for slotted-type concrete inserts.

2.6.5 Form Materials

Provide forms and form-facing materials of wood, metal, plastic, or other approved material to produce concrete having the specified finish. Construct forms mortar-tight and of sufficient strength to withstand all pressures due to concrete placing operations and temperature changes within the specified fabrication tolerances.

2.7 FABRICATION

2.7.1 Formwork and Fabrication Tolerances

Provide metal or wood forms. Brace and stiffen against deformation. Provide form liners where required to produce indicated finish. Provide dimensional tolerances as follows:

Overall panel dimensions:	
10 feet or less	Plus 1/8 inch, minus zero
10 to 20 feet	Plus or minus 1/8 inch
20 feet or more	Plus of minus 3/16 inch
Thickness: Plus 1/4 inch, minus 1/8 inch	

Angular deviation of sides: Plus or minus one percent, 1/16 inch maximum
Deviation from square (difference in length of two diagonals): Not to exceed 0.1 percent, 1/4 inch maximum
Size and location of openings within one unit: Plus or minus 1/4 inch
Local smoothness (deviation from a true plane): Plus or minus 0.2 percent
Bowing (convex or concave): Length of bow/480 (0.2 percent), with a maximum of 5/8 inch
Position of reinforcement: Within 1/4 inch of indicated position
Position of anchorage devices: Plus or minus 1/2 inch
Position of pick-up devices: Plus or minus 3 inches

2.7.2 Reinforcement

ACI 301. Place reinforcing bars and welded wire fabric. Secure in position with tie wires, bar supports, and spacers.

2.7.3 Preparation for Placing Concrete

Remove hardened concrete, excess form parting compound, standing water, ice, snow, or other deleterious substances from form interiors and reinforcement before concrete placement. Secure reinforcement and embedded items.

2.7.4 Concrete Mixing and Conveying

2.7.4.1 Batch Plant, Mixer, Mixing, and Measuring of Materials

ASTM C94/C94M.

2.7.4.2 Conveying

Prevent segregation and loss of materials.

2.7.5 Concrete Placing

ACI 304R. Deposit concrete in the forms continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the precast concrete architectural panel. Place concrete at a constant temperature of between 50 and 90 degrees F throughout fabrication of each panel. Make temperature of forms or molds the same as or close to the concrete temperature. For hot or cold weather, use methods recommended by

ACI 305R and ACI 306.1. Vibrate and consolidate concrete to prevent segregation and to produce a high-density concrete free of honeycomb and rock pockets. When specified, the exposed-to-view facing mixture is required to be a minimum thickness of 3/4 inches. Place backing mixture before facing mixture attains initial set.

2.7.6 Identification Markings

Permanently mark each panel to indicate pick-up points, location, orientation in the building, and date of casting. Identification markings need to correlate with approved detail drawings. Do not locate in exposed-to-view finished surfaces.

2.7.7 Finishing

2.7.7.1 Unformed Concealed Surfaces (Standard Smooth Finish)

Provide a trowel finish. Level surface with a straightedge, and strike off. After surface water has disappeared, float and trowel surface. Provide smooth finished surface, free of trowel marks, and uniform in texture and appearance.

2.7.7.2 Smooth, Exposed-to-View Surfaces

Provide a standard smooth finish to all exposed-to-view surfaces of panels, unless otherwise indicated. Provide a concrete surface having the texture imparted by a steel form or other approved smooth surfaces form-facing material.

2.7.7.3 Exposed Aggregate Finish

Provide for exposed-to-view surfaces of panels, including chamfers, edges, recesses, and projections, unless otherwise indicated. Provide standard smooth finish with outer skin of mortar removed, before concrete has hardened, and exposing coarse aggregate. A chemical retarder may be used on exposed face to facilitate removal of mortar. Match finish of the approved surface finish sample. Expose aggregates as soon after concrete placing as practicable by wire brushing, sand blasting, or bush hammeringor by washing the concrete surface with a diluted solution of muriatic acid to thoroughly clean exposed aggregate. Rinse concrete surface with fresh, clean water to remove traces of acid, whichever is the most appropriate method to obtain the approved finish.

2.7.7.4 Other Surfaces

Surfaces of precast units not exposed to view or not otherwise indicated to be finished are to be finished in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.7.8 Curing

Provide moist or steam curing or curing compound. Do not remove panel from forms; prevent moisture loss and maintain 50 degrees F minimum for at least 24 hours after finishing. Maintain panels in a surface damp condition at 50 degrees F minimum until concrete has attained 75 percent minimum of the design compressive strength. Do not use steam curing with wood forms or in connection with chemically retarded exposed aggregate surfaces.

2.7.9 Repair of Surface Defects

Cut out defective areas to solid concrete, with edges of cuts perpendicular to the surface of the concrete, and clean thoroughly. Dampen area to be patched and brush-coat with nonshrink grout or bonding agent. Patch the surface in accordance with procedures previously submitted by the Contractor and approved by the Contracting Officer. Where exposed to view, the patches, when dry, needs to be indistinguishable from the surrounding surfaces.

2.7.9.1 Smooth, Concealed Surfaces

Acceptable defective area will be limited to holes left by rods and other temporary inserts, and to honeycomb or rock pockets of 1/4 inch diameter maximum. Remove fins and other projections on the surfaces.

2.7.9.2 Exposed-to-View Surfaces

The combined area of acceptable defective areas must not exceed 0.2 percent of the exposed-to-view surface area and will be limited to holes of 1/4 inch diameter maximum.

2.7.10 Embedded Accessories

Furnish and install anchors, inserts, lifting devices, and other accessories which are to be embedded in the precast units in accordance with the approved detail drawings. Embedded items must be accurately positioned in their designed location, and have sufficient anchorage and embedment to satisfy design requirements.

2.7.11 Stripping

Do not remove precast concrete units from forms until units develop sufficient strength to safely strip the formwork and to remove the precast concrete units from the forms to prevent damage to the units from overstress or chipping.

2.7.12 Forms

Forms and facing materials must be wood, metal, plastic, or other approved material that is non-reactive with concrete. Completed panels must conform to the shapes, lines, and dimensions indicated, within the limits of the specified fabrication tolerances.

2.7.13 Built-In Anchorage Devices

Accurately position and securely anchor all anchorage devices. Openings in anchorage devices must be filled temporarily to prevent entry of concrete.

2.7.14 Lifting Devices

Lifting devices must be provided, and designed for a safety factor of 4, which includes 100 percent impact. Do not use brittle material.

2.7.15 Weather Limitations

Do not place concrete when the temperature of the atmosphere is below 40 degrees Fnor during rain, sleet, or snow unless adequate protection is

provided. Protection during inclement weather must prevent entry of rain, sleet, or snow into the forms or into the fresh concrete.

2.7.16 Finishing for Formed Surfaces

Prior to fabrication, three samples of Exposed-to-View Surface Finish (12 by 12 inches), and Finish Aggregate for exposed-to-view facing material is to be provided by the Contractor.

After approval of the surface, Contractor must provide one full size sample of each precast unit. Approved samples may be used in construction when properly identified.

Upon removal of forms, repair and patch defective areas. Where the finished surface will be exposed to view, the combined area of defective areas must not exceed 0.2 percent of the surface and will be limited to honeycomb or rock pockets not deep enough to expose the reinforcement. Where the finished surface will be concealed by other construction, defective areas are limited to holes left by the rods and other temporary inserts and honeycomb or rock pockets not deep enough to expose the reinforcement. Defective areas must be cut out to solid concrete, cleaned, and patched with grout. Where concrete surface will be exposed to view, the patches, when dry, must be indistinguishable from the surrounding surfaces.

Exposed-aggregate finish must match the finish of the approved sample. Aggregates in exposed-to-view surfaces will be exposed as soon after concrete placing as practical by power sanders, wire brushes, or other acceptable methods. Give surfaces one or more washings with a dilute solution of muriatic acid, then washed with fresh, clean water to remove all traces of the acid.

2.8 JOINT MATERIALS

Gasket must be elastomeric material, premolded to cross section indicated.

Material must be a vulcanized closed-cell expanded chloroprene conforming to ASTM D1056, Grade No. SCE 42, with the following additional properties:

Brittleness temperature will be minus 40 degrees F when tested in accordance with ASTM D746.

Flammability resistance needs to be self-extinguishing when tested in accordance with ASTM D635.

Resistance to ozone must be "no cracks" after exposure of a sample, at 20 percent elongation, to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 104 degrees F when tested in accordance with ASTM D1149.

PART 3 EXECUTION

3.1 GENERAL

Install panels and accessories in accordance with the approved shop drawings and as specified.

If substrate preparation is the responsibility of an installer other than the Contractor, notify Architect of unsatisfactory preparation before

proceeding.

3.2 EXAMINATION

Do not begin installation until supporting structures have been properly prepared.

If support structure is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

Verify that all parts of the supporting structure are complete and ready to receive the panels and that site conditions are conducive to proper installation. Install precast concrete architecturalpanels and accessories in accordance with approve detail drawings and descriptive data, and as specified below.

3.3.1 Building Framing System

Provide supporting members, including anchorage items attached to or embedded in building structural elements, prior to placement of panels.

3.3.2 Placing Panels, Coping and Column Covers

Panels must attain the specified 28-day compressive design strength prior to placement. Provide temporary supports and bracing, as required, to maintain panel position and alignment during attachment to the building framing system. Secure adjustable connections after panels have been properly positioned. All welded connections need to conform to the requirements of AWS D1.1/D1.1M and AWS D1.4/D1.4M.

3.3.3 Erection Tolerances

Locate panels to accommodate adjacent products, proper joint width, and alignment with adjacent precast members. Non-cumulative dimensional tolerances for erection of panels are as follows:

a. Face width of joint

Panel dimension normal to joint

10 feet or under: Plus or minus 3/16 in

10 feet to 20 feet: Plus 3/16 inch minus 1/4 inch

Each additional 10 feet: Plus or minus 1/16 inch

b. Joint taper (panel edges not parallel): 0.2 percent or 1/16 inch total, whichever is larger, but not greater than 3/8 inch

c. Panel alignment

Jog in alignment of edge: 1/4 inch

Offset in face of panel (exterior face unless otherwise noted):1/4 inch

d. Variation from theoretical position, any location: Plus or minus 1/4 inch

e. Deviation from plumb: 0.2 percent, 3/8 inch maximum

f. Maximum warpage after erection: One corner out of plane of other three, 0.5 percent of distance from nearer adjacent corner, or1/8 inch

g. Differential bowing or camber of adjacent panels: 1/4 inch maximum

3.3.4 Joints

Joint widths between panels will be as specified unless otherwise indicated. Provide joints with sealants in accordance with Section 07 92 00 JOINT SEALANTS.

3.3.4.1 JOINT SEALING

Joint sealing will be as specified in Section 07 92 00 JOINT SEALANTS.

3.3.5 Protection

Protect exposed-to-view facing from staining and other damage. Do not allow laitance to penetrate, stain, or harden on exposed surfaces.

3.4 ERECTION

Erect precast units in accordance with the detail drawings and without damage to other units or to adjacent members. Set units true to alignment and level, with joints properly spaced and aligned both vertically and horizontally. Erection tolerances must be in accordance with the requirements of PCI MNL-117 and PCI MNL-122. As units are being erected, shims and wedges will be placed as required to maintain correct alignment. After final attachment, grout precast units as shown. After erection, clean and touch-up welds and abraded surfaces of steel with a zinc-rich paint. Welds must be made by a certified welder in accordance with the manufacturer's erection drawings. Finish pickup points, boxouts, inserts, and similar items to match adjacent areas after erection. Erection of precast units must be supervised and performed by workmen skilled in this type of work. Welding and the qualifications of welders must be in accordance with AWS D1.1/D1.1M.

3.5 PROTECTION OF WORK

Protect precast units against damage from subsequent operations.

3.6 DEFECTIVE WORK

Repair precast concrete units damaged during erection as soon after occurrence as possible or replaced, as directed, using approved procedures. All repairs to precast concrete units must match the adjacent surfaces in color and texture, as approved. Unless otherwise approved, repair procedures will conform to PCI MNL-116 and PCI MNL-117.

3.7 CONCRETE INSERTS EMBEDDED IN CAST-IN-PLACE CONCRETE

Deliver inserts to the site in time to be installed before the start of concrete placing. Contractor must provide setting drawings, instructions, and directions for the installation of inserts.

3.8 CONCRETE STRENGTH AT TIME OF PANEL INSTALLATION

Do not install panels until concrete has attained the minimum laboratory compressive strength at 28 calendar days specified.

Do not install panels before 28 calendar days from the date of casting unless approval has been obtained to make one compressive strength test, ASTM C39/C39M, and one flexural strength test using simple beam with third-point loading, ASTM C78/C78M, on field cured concrete test specimens, ASTM C31/C31M, for each individual panel to determine the strength of the concrete.

3.9 INSTALLATION TOLERANCES

Install panels within the tolerances specified in PCI MNL-116.

3.10 PLACING PANELS

Supporting members, including anchorage items attached to or embedded in building structural elements, must be in place before placing panels is started.

Install panels plumb, level, in alignment, and within limits of the installation tolerances.

3.11 CONNECTIONS TO THE BUILDING FRAMING SYSTEM

Connect panels to the building framing system as indicated on the approved shop drawings. Fix adjustable connections by locknuts or other approved means after panels have been positioned.

3.12 JOINTS AND GASKETS

Joints between panels must be the width indicated and within limits of installation tolerances.

Install gaskets in joints as indicated, continuous throughout the joint length, and compressed at least 25 percent by volume.

3.13 PROTECTION

Protect panels against staining of exposed-to-view facing and other damage until completion of the work.

3.14 INSPECTION AND ACCEPTANCE PROVISIONS

3.14.1 Evaluation of Compressive Strength Tests

Concrete quality control tests specified will be evaluated as specified.

Concrete delivered to the point of placement having a slump or total air content outside the values specified must not be used in the work.

Compressive strength tests will be considered satisfactory if the average of any group of five consecutive compressive strength tests which may be selected is in each instance equal to or greater than the 28-day design compressive strength, or if not more than one compressive strength test in 10 has a value less than 90 percent of the 28-day design compressive strength.

If the compressive strength tests fail to meet the minimum requirements specified, panels fabricated of concrete represented by such tests will be considered deficient in strength and subject to the provisions specified.

3.14.2 Dimensional Tolerances

Panels having dimensions outside the limits for fabrication tolerances will be rejected.

3.14.3 Surface Finish Requirements

Panels will be rejected for the following surface finish deficiencies:

Exposed-to-view surfaces that do not match the color, aggregate size and distribution, and texture of the approved sample

Exposed-to-view surfaces that contain defects that affect the appearance of the finish, such as cracks, spalls, honeycomb, rock pockets, or stains and discoloration of aggregate or matrix that cannot be removed by cleaning

Concealed surfaces that contain cracks in excess of 0.01 inch wide, cracks that penetrate to the reinforcement regardless of width, honeycomb, rock pockets, and spalls except minor breakage at corners and edges

3.14.4 Strength of Panels

Strength of precast concrete architectural panels will be considered potentially deficient if the panels fail to comply with the requirements that control the strength of the panels, including the following conditions:

Failure to meet compressive strength tests

Reinforcement not conforming to the requirements specified

Concrete curing and protection of panels against extremes of temperature during curing not conforming to the requirements specified

Panels damaged during handling and erection

3.14.5 Testing Panels for Strength

When there is evidence that the strength of precast concrete architectural panels does not meet specification requirements, cores drilled from hardened concrete for compressive strength determination must be made in accordance with ASTM C42/C42M and as follows:

Take at least three representative cores from the precast-concrete panels that are considered potentially deficient.

Test cores with the saturated surface dry.

Strength of cores will be considered satisfactory if their average is equal to or greater than 90 percent of the 28-day design compressive strength of 6 by 12 inch cylinders.

Submit test reports on the same day that tests are made. Reports must

contain the project name and number, date, name of contractor, name of precast concrete architectural panel manufacturer, name of concrete-testing service, identification letter and number of panel or panels represented by core tests, nominal maximum size of aggregate, design compressive strength of concrete at 28 calendar days, compressive breaking strength and type of break, length of core test specimen before capping, compressive strength after correcting for length diameter ratio, direction of application of the load on the core test specimen with respect to the horizontal plane of the concrete as placed, and the moisture condition of the core test specimen at time of testing.

If the results of the core tests are unsatisfactory or if core tests are impractical to obtain, make static load tests of a panel and will be evaluated in accordance with ACI 305.1 and ACI 318.

Replace panels used for core tests or static load tests with panels that meet the requirements of this section.

3.14.6 Panels-in-Place

Panels will be rejected for any one of the following deficiencies:

Panels not conforming to the requirements for installation tolerances

Panels that are damaged during construction operations

Panels that develop surface-finish deficiencies as specified

3.15 CLEANING

Clean exposed-to-view surfaces of panels thoroughly with detergent and water; use a brush to remove foreign matter. Remove stains that remain after washing in accordance with recommendations of the panel manufacturer. Surfaces must be clean and uniform in color.

3.16 SAMPLING AND TESTING

3.16.1 Product Quality Control

PCI MNL-117 for PCI enrolled plants. Where panels are manufactured by specialists in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-117 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

3.16.1.1 Aggregate Tests

ASTM C33/C33M. Perform one test for each aggregate size, including determination of the specific gravity.

3.16.1.2 Strength Tests

ASTM C172/C172M. Provide ASTM C39/C39M and ASTM C31/C31M compression tests. Perform ASTM C143/C143M slump tests. Mold six cylinders each day or for every 20 cubic yards of concrete placed, whichever is greater. Perform strength tests using two cylinders at 7 days and two at 28 days. Cure four cylinders in the same manner as the panels and place at the point where the poorest curing conditions are offered. Moist cure two

cylinders and test at 28 days.

3.16.1.3 Changes in Proportions

If, the compressive strength falls below that specified, adjust the mix proportions and water content and make necessary changes in the temperature, moisture, and curing procedures to secure the specified strength. Notify the Contracting Officer of all changes.

3.16.1.4 Strength Test Results

Evaluate compression test results at 28 days in accordance with ACI 214R using a coefficient of variation of 20 percent. Evaluate the strength of concrete by averaging the test results (two specimens) of standard cylinders tested at 28 days. Not more than 20 percent of the individual tests can have an average compressive strength less than the specified ultimate compressive strength.

3.16.2 Rejection

Panels in place may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished. "Visible" means visible to a person with normal eyesight when viewed from a distance of 20 feet in broad daylight.

a. Nonconformance to specified tolerances.

b. Air voids (bugholes or blowholes) larger than 3/8 inch diameter.

c. Visible casting lines.

d. Visible from joints.

e. Visible irregularities.

f. Visible stains on panel surfaces.

g. Visible differences between panel and approved sample.

h. Visible non-uniformity of textures or color.

i. Visible areas of backup concrete bleeding through the facing concrete.

j. Visible foreign material embedded in the face.

k. Visible repairs.

l. Visible reinforcement shadow lines.

m. Visible cracks.

3.16.3 Field Quality Control

Perform field inspection of panel connections. Notify the Contracting Officer in writing of defective welds, bolts, nuts and washers within 7 working days of the date of inspection. All defective connections or welds are to be removed and re-welded or repaired as required by the

Contracting Officer.

3.16.3.1 Welded Connection Visual Inspection

AWS D1.1/D1.1M, furnish the services of AWS-certified welding inspector for erection inspections. Welding inspector must visually inspect all welds and identify all defective welds.

-- End of Section --

SECTION 04 20 00

MASONRY
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 318	(2011; Errata 1 2011; Errata 2 2012; Errata 3-4 2013) Building Code Requirements for Structural Concrete and Commentary
ACI 530/530.1	(2011; Errata 2011; Errata 2013) Building Code Requirements and Specification for Masonry Structures and Related Commentaries
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A615/A615M	(2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A641/A641M	(2009a) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A82/A82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C1019	(2013) Standard Test Method for Sampling and Testing Grout
ASTM C1072	(2013) Standard Test Method for Measurement of Masonry Flexural Bond Strength

ASTM C1142	(1995; R 2013) Standard Specification for Extended Life Mortar for Unit Masonry
ASTM C129	(2011) Standard Specification for Nonloadbearing Concrete Masonry Units
ASTM C140	(2012) Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C144	(2011) Standard Specification for Aggregate for Masonry Mortar
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C207	(2006; R 2011) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C270	(2012a) Standard Specification for Mortar for Unit Masonry
ASTM C315	(2007; R 2011) Clay Flue Linings
ASTM C476	(2010) Standard Specification for Grout for Masonry
ASTM C494/C494M	(2013) Standard Specification for Chemical Admixtures for Concrete
ASTM C593	(2006; R 2011) Fly Ash and Other Pozzolans for Use with Lime for Soil Stabilization
ASTM C641	(2009) Staining Materials in Lightweight Concrete Aggregates
ASTM C780	(2012a) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C90	(2013) Loadbearing Concrete Masonry Units
ASTM C91/C91M	(2012) Standard Specification for Masonry Cement
ASTM C94/C94M	(2013a) Standard Specification for Ready-Mixed Concrete
ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2240	(2005; R 2010) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2287	(2012) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E119	(2012a) Standard Test Methods for Fire Tests of Building Construction and

Materials

ASTM E514/E514M	(2011) Standard Test Method for Water Penetration and Leakage Through Masonry

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 SYSTEM DESCRIPTION

1.3.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources. See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Masonry materials may be locally available. Submit documentation indicating distance between manufacturing facility and the project site, and distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in the project.

1.3.2 Environmental Data

Submit manufacturer's descriptive data. Documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

1.3.3 Design Requirements

1.3.3.1 Unit Strength Method

Compute compressive strength of masonry system "Unit Strength Method", ACI 530/530.1. Submit calculations and certifications of unit and mortar strength.

1.3.3.2 Masonry Strength

Determine masonry strength in accordance with ACI 530/530.1; submit test reports on three prisms as specified in ACI 530/530.1. The cost of testing shall be paid by the Contractor.

1.3.4 Additional Requirements

a. Maintain at least one spare vibrator on site at all times.

b. Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by local code.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data; G

Concrete Masonry Units; G; (LEED NC)

Cement

Cold Weather Installation
Water-Repellant Admixture

SD-04 Samples

Anchors, Ties, and Bar Positioners
Expansion-Joint Materials
Joint Reinforcement

SD-05 Design Data

Pre-mixed Mortar
Unit Strength Method

SD-06 Test Reports

Field Testing of Mortar
Field Testing of Grout
Prism tests
Masonry Cement
Masonry Inspector Qualifications
Single-Wythe Masonry Wall Water Penetration Test; G

SD-07 Certificates

Concrete Masonry Units (CMU)
Anchors, Ties, and Bar Positioners
Joint Reinforcement
Masonry Cement
Precast Concrete Items
Admixtures for Masonry Mortar
Admixtures for Grout

SD-08 Manufacturer's Instructions

Masonry Cement

SD-10 Operation and Maintenance Data

Take-Back Program

SD-11 Closeout Submittals

Local / Regional Materials; (LEED NC)
Recycled Content
Environmental Data
Cement; (LEED NC)

1.5 QUALITY ASSURANCE

1.5.1 Masonry Inspector Qualifications

A qualified masonry inspector approved by the Contracting Officer shall perform inspection of the masonry work. Minimum qualifications for the masonry inspector shall be 5 years of reinforced masonry inspection experience or acceptance by a State, municipality, or other governmental body having a program of examining and certifying inspectors for reinforced masonry construction. The masonry inspector shall be present during preparation of masonry prisms, sampling and placing of masonry units, placement of reinforcement (including placement of dowels in footings and foundation walls), inspection of grout space, immediately prior to closing of cleanouts, and during grouting operations. The masonry inspector shall assure compliance with the drawings and specifications. The masonry inspector shall keep a complete record of all inspections and shall submit daily written reports to the Quality Control Supervisory Representative reporting the quality of masonry construction. Submit copies of masonry inspector reports.

1.5.2 Detail Drawings

Submit detail drawings showing bar splice locations. . Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. Wall dimensions, bar clearances, and wall openings greater than one masonry unit in area shall be shown. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, the approved shop drawings shall be resubmitted with the additional openings shown along with the proposed changes. Location of these additional openings shall be clearly highlighted. The minimum scale for wall elevations shall be 1/4 inch per foot. Reinforcement bending details shall conform to the requirements of ACI SP-66. Submit drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; lintels; and wall openings.

1.6 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered, stored, handled, and protected to avoid chipping, breakage, and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

1.6.1 Masonry Units

Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C90. Mark prefabricated lintels on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.6.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.6.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Store sand and aggregates in a manner to prevent contamination or segregation.

1.7 PROJECT/SITE CONDITIONS

Conform to ACI 530/530.1 for hot and cold weather masonry erection.

1.7.1 Hot Weather Installation

Take the following precautions if masonry is erected when the ambient air temperature is more than 99 degrees F in the shade and the relative humidity is less than 50 percent or the ambient air temperature exceeds 90 degrees F and the wind velocity is more than 8 mph. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 4 feet ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

1.7.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 40 degrees F or temperature of masonry units is below 40 degrees F, submit a written statement of proposed cold weather construction procedures for approval.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval. Submit sample of colored mortar with applicable masonry unit and color samples of three stretcher units and one unit for each type of special shape. Units shall show the full range of color and texture. Submit test reports from an approved independent laboratory. Test reports on a previously tested material shall be certified as the same as that proposed for use in this project. Submit certificates of compliance stating that the materials meet the specified requirements.

2.2 Concrete Masonry Units (CMU)

Submit samples and certificates as specified. Cement shall have a low alkali content and be of one brand. Units shall contain a minimum of 10 percent post-consumer recycled content, or a minimum of 40 percent post-industrial recycled content.See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Units may contain post-consumer or post-industrial recycled content. Units shall be of modular dimensions and air, water, or steam cured. Surfaces of units which are to be plastered or stuccoed shall be sufficiently rough to provide bondExterior concrete masonry units shall have water-repellant

admixture added during manufacture.

b. Hollow Non-Load-Bearing Units: ASTM C129, made with normal weight aggregate. Load-bearing units may be provided in lieu of non-load-bearing units.

2.2.1 Aggregates

Aaggregates used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification.

2.2.2 Kinds and Shapes

Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work as indicated. In exposed interior masonry surfaces, units having a bullnose shall be used for vertical external corners except at door, window, and louver jambs. Radius of the bullnose shall be 1 inch. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

2.2.3 Fire-Rated CMU

Concrete masonry units used in fire-rated construction shown on the drawings shall be of minimum equivalent thickness for the fire rating indicated and the corresponding type of aggregates indicated in TABLE I. Units containing more than one of the aggregates listed in TABLE I will be rated on the aggregate requiring the greater minimum equivalent thickness to produce the required fire rating. Construction shall conform to ASTM E119.

TABLE I

FIRE-RATED CONCRETE MASONRY UNITS

See note (a) in Table III

	Minimum equivalent thickness in inches for fire rating of:		
Aggregate Type	4 hours	3 hours	2 hours
Pumice	4.7	4.0	3.0
Expanded slag	5.0	4.2	3.3
Expanded clay, shale, or slate	5.7	4.8	3.7

TABLE I FIRE-RATED CONCRETE MASONRY UNITS See note (a) in Table III			
Limestone, scoria, cinders or unexpanded slag	5.9	5.0	4.0
Calcareous gravel	6.2	5.3	4.2
Siliceous gravel	6.7	5.7	4.5

Minimum equivalent thickness shall equal net volume as determined in conformance with ASTM C140 divided by the product of the actual length and height of the face shell of the unit in inches

2.3 PRECAST CONCRETE ITEMS

Trim, lintels, copings, splashblocks and door sills shall be factory-made units from a plant regularly engaged in producing precast concrete units. Unless otherwise indicated, concrete shall be 4,000 psi minimum conforming to Section 03 30 00 CAST-IN-PLACE CONCRETE using 1/2 inch to No. 4 nominal-size coarse aggregate, and minimum reinforcement shall be the reinforcement required for handling of the units. Clearance of 3/4 inch shall be maintained between reinforcement and faces of units. Unless precast-concrete items have been subjected during manufacture to saturated-steam pressure of at least 120 psi for at least 5 hours, the items, after casting, shall be either damp-cured for 24 hours or steam-cured and shall then be aged under cover for 28 days or longer. Cast-concrete members weighing over 80 pounds shall have built-in loops of galvanized wire or other approved provisions for lifting and anchoring. Units shall have beds and joints at right angles to the face, with sharp true arises and shall be cast with drip grooves on the underside where units overhang walls. Exposed-to-view surfaces shall be free of surface voids, spalls, cracks, and chipped or broken edges. Precast units exposed-to-view shall be of uniform appearance and color. Unless otherwise specified, units shall have a smooth dense finish. Prior to use, each item shall be wetted and inspected for crazing. Items showing evidence of dusting, spalling, crazing, or having surfaces treated with a protective coating will be rejected. Submit specified factory certificates.

2.3.1 Lintels

Precast lintels, unless otherwise shown, shall be of a thickness equal to the wall and reinforced with two No. 4 bars for the full length. Top of lintels shall be labeled "TOP" or otherwise identified and each lintel shall be clearly marked to show location in the structure. In reinforced masonry, lintels shall conform to ACI 318 for flexural and shear strength and shall have at least 8 inches bearing at each end. Concrete shall have a minimum 28 day compressive strength of 4000 psi using 1/2 inch to No. 4 nominal-size coarse aggregate. Reinforcement shall conform to ASTM A615/A615M Grade 60,000 psi. Limit lintel deflection due to dead plus live load to L/600 or 0.3 inches. Provide top and bottom bars for lintels over 36 inches in length.

2.3.2 Splash Blocks

Splash blocks shall be as detailed. Reinforcement shall be the manufacturer's standard.

2.3.3 Flue Linings and Thimbles

ASTM C315, free from fractures. Sizes and shapes shall be as indicated.

2.4 MORTAR FOR STRUCTURAL MASONRY

ASTM C270, Type S. Strength (f'm) shall be1,500 psi . Test in accordance with ASTM C780. Use Type II portland cement. Do not use admixtures containing chlorides. When structural reinforcement is incorporated, maximum air-content shall be 12 percent in cement-lime mortar and 18 percent in masonry cement mortar. Use up to 40 percent Class F fly ash with type IP cement in cement-lime mortar. Fly ash shall comply with ASTM C593.

2.5 MASONRY MORTAR

Type M mortar shall conform to ASTM C270 and shall be used for foundation walls and piers. Mortar Type S shall conform to the proportion specification of ASTM C270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate; Type N cement-lime mortar proportions shall be 1 part cement, 1 part lime and 6 parts aggregate. Type N or S mortar shall be used for non-load-bearing, non-shear-wall interior masonry; approved commercial fire clay mortar or refractory cement (calcium-aluminate) mortar for fire brick and flue liners; and Type S for remaining masonry work; except where higher compressive strength is indicated on structural drawings. When masonry cement ASTM C91/C91M is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C780 and ASTM C1072. Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

2.5.1 Admixtures for Masonry Mortar

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C494/C494M, Type C. Submit the required certifications.

2.5.2 Hydrated Lime and Alternates

Hydrated lime shall conform to ASTM C207, Type S.

2.5.3 Cement

Portland cement shall conform to ASTM C150/C150M, Type I, II, or III. Masonry cement shall conform to ASTM C91/C91M, Type S. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar. Incorporate to the maximum extent, without conflicting with other requirements of this section, up to 40 percent fly

ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume.. When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates and on mixing to obtain the type of mortar required. Additives shall conform to requirements in Section 03 30 00 CAST-IN-PLACE CONCRETE .

2.5.4 Pre-Mixed Mortar

Pre-mixed mortar shall conform to ASTM C1142, Type RS. Submit pre-mixed mortar composition.

2.5.5 Sand and Water

Sand shall conform to ASTM C144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

2.6 WATER-REPELLANT ADMIXTURE

Polymeric type formulated to reduce porosity and water penetration and water absorption of the mortar and masonry units required to provide for the exterior single-wythe masonry wall water penetration resistance indicated in Paragraph SINGLE-WYTHE MASONRY WALL WATER PENETRATION TEST.

2.7 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C476, fine . Cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 10 inches. Minimum grout strength shall be 2000 psi in 28 days, as tested by ASTM C1019. Use grout subject to the limitations of Table III. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C94/C94M.

2.7.1 Admixtures for Grout

In cold weather, a non-chloride based accelerating admixture may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C494/C494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer. Submit required certifications.

2.7.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

2.8 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A153/A153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A82/A82M. Wire ties or anchors in exterior walls shall conform to ASTM A641/A641M. Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A641/A641M; coordinate with paragraph JOINT REINFORCEMENT below. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face. Submit two anchors, ties and bar positioners of

each type used, as samples.

2.8.1 Wire Mesh Ties

Wire mesh for tying 4 inch thick concrete masonry unit partitions to other intersecting masonry partitions shall be 1/2 inch mesh of minimum 16 gauge steel wire. Minimum lengths shall be not less than 12 inches.

2.8.2 Wall Ties

Provide wall ties rectangular-shaped or Z-shaped fabricated of 3/16 inch diameter zinc-coated steel wire. Rectangular wall ties shall be no less than 4 inches wide. Wall ties may also be of a continuous type conforming to paragraph JOINT REINFORCEMENT. Adjustable type wall ties, if approved for use, shall consist of two essentially U-shaped elements fabricated of 3/16 inch diameter zinc-coated steel wire. Adjustable ties shall be of the double pintle to eye type and shall allow a maximum of 1/2 inch eccentricity between each element of the tie. Play between pintle and eye opening shall be not more than 1/16 inch. The pintle and eye elements shall be formed so that both can be in the same plane.

2.8.3 Dovetail Anchors

Provide dovetail anchors of the flexible wire type, 3/16 inch diameter zinc-coated steel wire, triangular shaped, and attached to a 12 gauge or heavier steel dovetail section. Use these anchors for anchorage of veneer wythes or composite-wall facings extending over the face of concrete columns, beams, or walls. Fill cells within vertical planes of these anchors solid with grout for full height of walls or partitions, or solid units may be used. Dovetail slots are specified in Section03 30 00 CAST-IN-PLACE CONCRETE.

2.8.4 Adjustable Anchors

Adjustable anchors shall be 3/16 inch diameter steel wire, triangular-shaped. Anchors attached to steel shall be 5/16 inch diameter steel bars placed to provide 1/16 inch play between flexible anchors and structural steel members. Spacers shall be welded to rods and columns. Equivalent welded-on steel anchor rods or shapes standard with the flexible-anchor manufacturer may be furnished when approved. Welds shall be cleaned and given one coat of zinc-rich touch up paint.

2.8.5 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

2.9 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A82/A82M, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A153/A153M, Class B-2. All wires shall be a minimum of 9 gauge. Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between

crosswires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcement shall be provided with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features. Submit one piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

2.10 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A615/A615M, Grade 60.

2.11 CONTROL JOINT KEYS

Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D2000or polyvinyl chloride conforming to ASTM D2287. The material shall be resistant to oils and solvents. The control joint key shall be provided with a solid shear section not less than 5/8 inch thick and 3/8 inch thick flanges, with a tolerance of plus or minus 1/16 inch. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves. The control joint key shall be flexible at a temperature of minus 30 degrees F after five hours exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D2240.

2.12 EXPANSION-JOINT MATERIALS

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07 92 00 JOINT SEALANTS. Submit one piece of each type of material used.

2.13 THROUGH WALL FLASHING

Provide Through Wall Flashing as specified in Section 07 60 00 FLASHING AND SHEET METAL. Provide one of the following types except that flashing indicated to terminate in reglets shall be metal or coated-metal flashing andexcept that the material shall be one which is not adversely affected by dampproofing material.

a. Coated-Copper Flashing: 7 ounce, electrolytic copper sheet, uniformly coated on both sides with acidproof, alkaliproof, elastic bituminous compound. Factory apply coating to a weight of not less than 6 ounces/square foot (approximately 3 ounces/square foot on each side).

b. Copper or Stainless Steel Flashing: Copper, ASTM B370, minimum 16 ounce weight; stainless steel, ASTM A167, Type 301, 302, 304, or 316, 0.015 inch thick, No. 2D finish. Provide with factory-fabricated deformations that mechanically bond flashing against horizontal movement in all directions. Deformations shall consist of dimples, diagonal corrugations, or a combination of dimples and transverse corrugations.

2.14 SALVAGED BRICK

The government shall provide salvaged brick to be installed by the Contractor for interior partitions, as indicated, at the first floor main lobby area.

PART 3 EXECUTION

3.1 PREPARATION

Prior to start of work, masonry inspector shall verify the applicable conditions as set forth in ACI 530/530.1, inspection. The Contracting Officer will serve as inspector or will select a masonry inspector.

3.1.1 Protection

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

a. Air Temperature 40 to 32 Degrees F. Sand or mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees F

b. Air Temperature 32 to 25 Degrees F. Sand and mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing.

c. Air Temperature 25 to 20 Degrees F. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 15 mph.

d. Air Temperature 20 Degrees F and below. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees F. Temperature of units when laid shall not be less than 20 degrees F.

3.1.2 Completed Masonry and Masonry Not Being Worked On

a. Mean daily air temperature 40 to 32 degrees F. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.

b. Mean daily air temperature 32 to 25 degrees F. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

c. Mean Daily Air Temperature 25 to 20 degrees F. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

d. Mean Daily Temperature 20 degrees F and Below. Masonry temperature shall be maintained above 32 degrees F for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.1.3 Stains

Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

3.1.4 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.1.5 Surfaces

Clean surfaces on which masonry is to be placed of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least 1/8 inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

3.2 LAYING MASONRY UNITS

a. Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Masonry units shall be laid in running bond pattern. Facing courses shall be level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances shall be plus or minus 1/2 inch. Each unit shall be adjusted to its final position while mortar is still soft and plastic.

b. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and relaid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb.

c. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a nonfurrowed full bed of mortar. Mortar for veneer wythes shall be beveled and sloped toward the center of the wythe from the cavity side. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below.

d. In double wythe construction, the inner wythe may be brought up not more than 16 inches ahead of the outer wythe. Collar joints shall be filled with mortar or grout during the laying of the facing wythe, and filling shall not lag the laying of the facing wythe by more than 8 inches.

3.2.1 Forms and Shores

Provide bracing and scaffolding as required. Design bracing to resist

wind pressure as required by local codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.2.2 Reinforced Concrete Masonry Units Walls

Where vertical reinforcement occurs, fill cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent leakage of grout. Remove mortar fins protruding from joints before placing grout. Minimum clear dimensions of vertical cores shall be 2 by 3 inches. Position reinforcing accurately as indicated before placing grout. As masonry work progresses, secure vertical reinforcing in place at vertical intervals not to exceed 160 bar diameters. Use puddling rod or vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be not less than 1/2 inch. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tying them together.

3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Foundation walls below grade shall be grouted solid. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

3.2.4 Tolerances

Lay masonry plumb, true to line, with courses level. Keep bond pattern plumb throughout. Square corners unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, lay masonry within the following tolerances (plus or minus unless otherwise noted):

TABLE II TOLERANCES	
Variation from the plumb in the lines and surfaces of columns, walls and arises	
In adjacent masonry units	1/8 inch
In 10 feet	1/4 inch
In 20 feet	3/8 inch

TABLE II TOLERANCES	
In 40 feet or more	1/2 inch
Variations from the plumb for external corners, expansion joints, and other conspicuous lines	
In 20 feet	1/4 inch
In 40 feet or more	1/2 inch
Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	
In 20 feet	1/4 inch
In 40 feet or more	1/2 inch
Variation from level for bed joints and top surfaces of bearing walls	
In 10 feet	1/4 inch
In 40 feet or more	1/2 inch
Variations from horizontal lines	
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch
Variations in cross sectional dimensions of columns and in thickness of walls	
Minus	1/4 inch
Plus	1/2 inch

3.2.5 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

3.2.6 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal

joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

3.2.6.1 Flush Joints

Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight. Flush joints for architectural units, such as fluted units, shall completely fill both the head and bed joints.

3.2.6.2 Tooled Joints

Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

3.2.6.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch.

3.2.7 Joint Widths

Joint widths shall be as follows:

3.2.7.1 Concrete Masonry Units

Concrete masonry units shall have 3/8 inch joints, except for prefaced concrete masonry units.

3.2.8 Embedded Items

Fill spaces around built-in items with mortar. Point openings around flush-mount electrical outlet boxes in wet locations with mortar. Embed anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in as the masonry work progresses. Fully embed anchors, ties and joint reinforcement in the mortar. Fill cells receiving anchor bolts and cells of the first course below bearing plates with grout.

3.2.9 Unfinished Work

Step back unfinished work for joining with new work. Toothing may be resorted to only when specifically approved. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

3.2.10 Masonry Wall Intersections

Masonry bond each course at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

3.2.11 Partitions

Partitions shall be continuous from floor to underside of floor or roof deck where shown. Openings in firewalls around joists or other structural members shall be filled as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 4 inches above the ceiling level. An isolation joint shall be placed in the intersection between partitions and structural or exterior walls as shown. Interior partitions having 4 inch nominal thick units shall be tied to intersecting partitions of 4 inch units, 5 inches into partitions of 6 inch units, and 7 inches into partitions of 8 inch or thicker units. Cells within vertical plane of ties shall be filled solid with grout for full height of partition or solid masonry units may be used. Interior partitions having masonry walls over 4 inches thick shall be tied together with joint reinforcement. Partitions containing joint reinforcement shall be provided with prefabricated pieces at corners and intersections or partitions.

3.3 ANCHORED VENEER CONSTRUCTION

Completely separate the inner and outer wythes by a continuous airspace as indicated. Lay up both the inner and the outer wythes together except when adjustable joint reinforcement assemblies are approved for use. When both wythes are not brought up together, through-wall flashings shall be protected from damage until they are fully enclosed in the wall. The airspace between the wythes shall be kept clear and free of mortar droppings by temporary wood strips laid on the wall ties and carefully lifted out before placing the next row of ties. A coarse gravel or drainage material shall be placed behind the weep holes in the cavity to a minimum depth of 4 inches of coarse aggregate or 10 inches of drainage material to keep mortar droppings from plugging the weep holes.

3.4 WEEP HOLES

Wherever through-wall flashing occurs, provide weep holes to drain flashing to exterior at acceptable locations as indicated on drawings. Weep holes shall be open head joints.. Weep holes shall be provided not more than 24 inches on centers in mortar joints of the exterior wythe above wall flashing, over foundations, bond beams, and any other horizontal interruptions of the cavity. Weep holes shall be perfectly horizontal or slightly canted downward to encourage water drainage outward and not inward. Weep holes shall be constructed using weep hole ventilators. Other approved methods may be used for providing weep holes. Weep holes shall be kept free of mortar and other obstructions.

3.5 COMPOSITE WALLS

Tie masonry wythes together with joint reinforcement or with unit wall ties. Anchor facing to concrete backing with wire dovetail anchors set in slots built in the face of the concrete as specified in Section03 30 00 CAST-IN-PLACE CONCRETE. Anchor or tie the facing wythe to the backup at a maximum spacing of 16 inches on center vertically and 24 inches on center horizontally. Unit ties shall be spaced not over 24 inches on centers horizontally, in courses not over 16 inches apart vertically, staggered in alternate courses. Ties shall be laid not closer than 5/8 inch to either masonry face. Ties shall not extend through control joints. Collar joints between masonry facing and masonry backup shall be filled solidly

with grout.

3.6 MORTAR MIX

Mix mortar in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measure ingredients for mortar by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Mix water with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Retemper mortar that has stiffened because of loss of water through evaporation by adding water to restore the proper consistency and workability. Discard mortar that has reached its initial set or that has not been used within 2.5 hours after mixing.

3.7 REINFORCING STEEL

Clean reinforcement of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 2 inches of tops of walls.

3.7.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

3.7.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

3.8 JOINT REINFORCEMENT INSTALLATION

Joint reinforcement shall be installed at 16 inches on center or as indicated. Reinforcement shall be lapped not less than 6 inches. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 5/8 inch cover to either face of the unit.

3.9 PLACING GROUT

Fill cells containing reinforcing bars with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours

after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

3.9.1 Vertical Grout Barriers for Fully Grouted Walls

Provide grout barriers not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.9.2 Horizontal Grout Barriers

Embed grout barriers in mortar below cells of hollow units receiving grout.

3.9.3 Grout Holes and Cleanouts

3.9.3.1 Grout Holes

Provide grouting holes in slabs, spandrel beams, and other in-place overhead construction. Locate holes over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Provide additional openings spaced not more than 16 inches on centers where grouting of all hollow unit masonry is indicated. Openings shall not be less than 4 inches in diameter or 3 by 4 inches in horizontal dimensions. Upon completion of grouting operations, plug and finish grouting holes to match surrounding surfaces.

3.9.3.2 Cleanouts for Hollow Unit Masonry Construction

Provide cleanout holes at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds 5 feet. Where all cells are to be grouted, construct cleanout courses using bond beam units in an inverted position to permit cleaning of all cells. Provide cleanout holes at a maximum spacing of 32 inches where all cells are to be filled with grout. Establish a new series of cleanouts if grouting operations are stopped for more than 4 hours. Cleanouts shall not be less than 3 by 4 inch openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, close cleanout holes in an approved manner to match surrounding masonry.

3.9.3.3 Cleanouts for Solid Unit Masonry Construction

Provide cleanouts for construction of walls consisting of a grout filled cavity between solid masonry wythes at the bottom of every pour by omitting every other masonry unit from one wythe. Establish a new series of cleanouts if grouting operations are stopped for more than 4 hours. Do not plug cleanout holes until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, close cleanout holes in an approved manner to match surrounding masonry.

3.9.4 Grouting Equipment

3.9.4.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Operate pumps to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, remove waste materials and debris from the equipment, and dispose of outside the masonry.

3.9.4.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. Maintain at least one spare vibrator at the site at all times. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation.

3.9.5 Grout Placement

Lay masonry to the top of a pour before placing grout. Do no place grout in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 5 feet in height. High-lift grout methods shall be used on pours exceeding 5 feet in height.

3.9.5.1 Low-Lift Method

Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 1/2 inch into the grout space shall be removed before beginning the grouting operation. Grout pours 12 inches or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 12 inches in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. Low-lift grout shall be used subject to the limitations of Table III.

3.9.5.2 High-Lift Method

Mortar droppings shall be cleaned from the bottom of the grout space and from reinforcing steel. Mortar protruding more than 1/4 inch into the grout space shall be removed by dislodging the projections with a rod or stick as the work progresses. Reinforcing, bolts, and embedded connections shall be rigidly held in position before grouting is started. CMU units shall not be pre-wetted. Grout, from the mixer to the point of deposit in the grout space shall be placed as rapidly as practical by pumping and placing methods which will prevent segregation of the mix and cause a minimum of grout splatter on reinforcing and masonry surfaces not being immediately encased in the grout lift. The individual lifts of

grout shall be limited to 4 feet in height. The first lift of grout shall be placed to a uniform height within the pour section and vibrated thoroughly to fill all voids. This first vibration shall follow immediately behind the pouring of the grout using an approved mechanical vibrator. After a waiting period sufficient to permit the grout to become plastic, but before it has taken any set, the succeeding lift shall be poured and vibrated 12 to 18 inches into the preceding lift. If the placing of the succeeding lift is going to be delayed beyond the period of workability of the preceding, each lift shall be reconsolidated by reworking with a second vibrator as soon as the grout has taken its settlement shrinkage. The waiting, pouring, and reconsolidation steps shall be repeated until the top of the pour is reached. The top lift shall be reconsolidated after the required waiting period. The high-lift grouting of any section of wall between vertical grout barriers shall be completed to the top of a pour in one working day unless a new series of cleanout holes is established and the resulting horizontal construction joint cleaned. High-lift grout shall be used subject to the limitations in Table III.

TABLE III
POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

			Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells in inches (1,2)	
Maximum Grout Pour Height feet (4)	Grout Type	Grouting Procedure	Multiwythe Masonry (3)	Hollow-unit Masonry
1	Fine	Low Lift	3/4	1-1/2 x 2
5	Fine	Low Lift	2	2 x 3
8	Fine	High Lift	2	2 x 3
12	Fine	High Lift	2-1/2	2-1/2 x 3
24	Fine	High Lift	3	3 x 3
1	Coarse	Low Lift	1-1/2	1-1/2 x 3
5	Coarse	Low Lift	2	2-1/2 x 3
8	Coarse	High Lift	2	3 x 3
12	Coarse	High Lift	2-1/2	3 x 3
24	Coarse	High Lift	3	3 x 4

Notes:

(1) The actual grout space or cell dimension shall be larger than the sum of the following items:

(a) The required minimum dimensions of total clear areas given in the table above;

(b) The width of any mortar projections within the space;
(c) The horizontal projections of the diameters of the horizontal reinforcing bars within a cross section of the grout space or cell.

(2) The minimum dimensions of the total clear areas shall be made up of one or more open areas, with at least one area being 3/4 inch or greater in width.

(3) For grouting spaces between masonry wythes.

(4) Where only cells of hollow masonry units containing reinforcement are grouted, the maximum height of the pour shall not exceed the distance between horizontal bond beams.

3.10 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 1/2 inch shall be maintained between reinforcement and interior faces of units.

3.11 CONTROL JOINTS

Control joints shall be provided as indicated and shall be constructed by using mortar to fill the head joint in accordance with the details shown on the drawings. Sash jamb units shall have a 3/4 by 3/4 inch groove near the center at end of each unit. The vertical mortar joint at control joint locations shall be continuous, including through all bond beams. This shall be accomplished by utilizing half blocks in alternating courses on each side of the joint. The control joint key shall be interrupted in courses containing continuous bond beam steel. In single wythe exterior masonry walls, the exterior control joints shall be raked to a depth of 3/4 inch; backer rod and sealant shall be installed in accordance with Section 07 92 00 JOINT SEALANTS. Exposed interior control joints shall be raked to a depth of 1/4 inch. Concealed control joints shall be flush cut.

3.12 JOINTS SHOWN ON THE DRAWINGS

a. Concrete masonry veneer joints

b. will be located, detailed, and constructed as shown on the drawings. Keep joints free of mortar and other debris.

3.13 SHELF ANGLES

Adjust shelf angles as required to keep the masonry level and at the proper elevation. Shelf angles shall be galvanized and provided in sections not longer than 10 feet and installed with a 1/4 inch gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 4 feet, unless limited by wall configuration.

3.14 LINTELS

3.14.1 Masonry Lintels

Construct masonry lintels with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated on the drawings. Lintel reinforcement shall extend beyond each side of masonry opening 40 bar diameters or 24 inches, whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 1/2 inch above the bottom inside surface of the lintel unit.

3.14.2 Precast Concrete and Steel Lintels

Construct precast concrete and steel lintels as shown on the drawings. Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of 8 inches unless otherwise indicated on the drawings.

3.15 SILLS AND COPINGS

Sills and copings shall be set in a full bed of mortar with faces plumb and true.

3.16 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

3.16.1 Anchorage to Concrete

Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 16 inches on centers vertically and 24 inches on center horizontally.

3.16.2 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 16 inches on centers vertically, and if applicable, not over 24 inches on centers horizontally.

3.17 PARGING

The outside face of below-grade exterior concrete-masonry unit walls enclosing usable rooms and spaces, except crawl spaces, shall be parged with type S mortar. Parging shall not be less than 1/2 inch thick troweled to a smooth dense surface so as to provide a continuous unbroken shield from top of footings to a line 6 inches below adjacent finish grade, unless otherwise indicated. Parging shall be coved at junction of wall and footing. Parging shall be damp-cured for 48 hours or more before backfilling. Parging shall be protected from freezing temperatures until hardened.

3.18 SPLASH BLOCKS

Locate splash blocks as indicated.

3.19 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, completely remove mortar and grout daubs or splashings from masonry-unit surfaces that will be exposed or painted. Before completion

of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

3.19.1 Dry-Brushing

a. Exposed concrete masonry unit

b. Exposed

c. shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.20 BEARING PLATES

Set bearing plates for beams, joists, joist girders and similar structural members to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Bedding mortar and non-shrink grout shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.21 PROTECTION

Protect facing materials against staining. Cover top of walls with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of 2 feet down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

3.22 WASTE MANAGEMENT

Manage waste according to the Waste Management Plan and as follows. Minimize water used to wash mixing equipment. Use trigger operated spray nozzles for water hoses.

3.22.1 Separate and Recycle Waste

Place materials defined as hazardous or toxic waste in designated containers. Fold up metal banding, flatten, and place in designated area for recycling. Collect wood packing shims and pallets and place in designated area. Use leftover mixed mortar as retaining wall footing ballast or cavity fill at grade where lower strength mortar meets the requirements for bulk fill. Separate masonry waste and place in designated area for use as structural fill. Separate selected masonry waste and excess for landscape uses, either whole or crushed as ground cover.

3.22.2 Take-Back Program

Collect information from manufacturer for take-back program options. Set aside masonry units, full and partial to be returned to manufacturer for

recycling into new product. When such a service is not available, local recyclers shall be sought after to reclaim the materials. Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

3.23 TEST REPORTS

3.23.1 Field Testing of Mortar

Take at least three specimens of mortar each day. Spread a layer of mortar 1/2 to 5/8 inch thick on the masonry units and allowed to stand for one minute. Prepare and test the specimens for compressive strength in accordance with ASTM C780. Submit test results.

3.23.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2000 psi at 28 days. Submit test results.

3.23.3 Prism Tests

Perform at least one prism test sample for each 5,000 square feet of wall but not less than three such samples shall be made for any building. Three prisms will be used in each sample. Prisms shall be tested in accordance with ACI 530/530.1. Seven-day tests may be used provided the relationship between the 7- and 28-day strengths of the masonry is established by the tests of the materials used. Compressive strength shall not be less than 1900 psi at 28 days. If the compressive strength of any prism falls below the specified value by more than 500 psi, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. If the likelihood of low-strength masonry is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled, or prisms sawed, from the area in question may be required. In such case, three specimens shall be taken for each prism test more than 500 psi below the specified value. Masonry in the area in question shall be considered structurally adequate if the average compressive strength of three specimens is equal to at least 85 percent of the specified value, and if the compressive strength of no single specimen is less than 75 percent of the specified value. Additional testing of specimens extracted from locations represented by erratic core or prism strength test results will be permitted. Submit test results.

3.23.4 Single-Wythe Masonry Wall Water Penetration Test

Prior to start of field construction of the single-wythe masonry wall, perform masonry wall water penetration test on mock-up wall assemblies consisting of the identical design, materials, mix, and construction methods as the actual wall construction and in accordance with ASTM E514/E514M. Prepare a minimum of three specimens and cure for minimum 28 days prior to testing. Construct panels by the same methods, processes, and applications to be used on the project's construction site. The spray test duration shall be 6 hours for each specimen. No water shall be visible on back of test panels during the test and any areas of dampness on the backside of the test panels shall not exceed 25 percent of

the wall area. Dampness is defined as any area of surface darkening or discoloration due to moisture penetration or accumulation below the observed surface. Construct additional test panels for each failed test performed until three test panels pass the test. Factors that can affect test performance include materials, mixing, and quality of application and workmanship. Materials, mixing, and methods adjustments may be necessary in order to provide construction that passes the water penetration test. Document and record the test specimen construction materials and application and provide written test report in accordance with ASTM E514/E514M, supplemented by a detailed discussion of the specifics of test panel construction, application methods and processes used, quality of construction, and any variances or deviations that may have occurred between test panels during test panel construction. For failed test panels, identify in the supplemental report any variances, deficiencies or flaws that contributed to test panel failure and itemize the precautions to be taken in field construction of the masonry wall to prevent similar deficiencies and assure the wall construction replicates test panel conditions that pass the water penetration test. Submit the complete, certified test report, including supplemental report, to the Contracting Officer prior to start of single-wythe masonry wall construction. Significant changes to materials, proportions, or construction techniques from those used in the passing water penetration test are grounds for performing new tests, at the discretion of the Contracting Officer.

-- End of Section --

SECTION 05 05 23

WELDING, STRUCTURAL
11/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2010) Specification for Structural Steel Buildings

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2011; Text Correction 2013) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0M/A3.0	(2010) Standard Welding Terms and Definitions
AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2008; Errata 2008) Structural Welding Code - Sheet Steel
AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel
AWS D14.1/D14.1M	(2005) Specification for Welding Industrial and Mill Cranes and Other Material Handling Equipment
AWS D14.4/D14.4M	(2012) Specification for Welded Joints for Machinery and Equipment
AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM E165	(2009) Standard Test Method for Liquid Penetrant Examination
ASTM E709	(2008) Standard Guide for Magnetic

1.2 DEFINITIONS

Definitions of welding terms are in accordance with AWS A3.0M/A3.0. The following classifications Class 1 (highest class) to Class 6 (lowest class) indicate the project's class(es) of weld joints.

1.2.1 Class 1 Weld Joints

This covers complete penetration weld joints only. These weld joints apply where failure would cause a loss of the system and/or be hazardous to personnel. Class 1 weld joints are highly stressed (dynamic and cyclic loading) and characterized as a single point of failure with no redundancy for the redistribution of stress into another member.

1.2.2 Class 2 Weld Joints

This covers both complete and partial penetration groove weld joints and fillet weld joints. These weld joints apply where failure would reduce the overall efficiency of a system but loss of the system or a hazard to personnel would not be experienced.

1.2.3 Class 3 Weld Joints

This covers both complete and partial penetration groove weld joints and fillet weld joints. These weld joints apply where failure would not affect the efficiency of a system nor create a hazard to personnel. Class 3 weld joints are connections of secondary members not subject to dynamic action and/or low stressed miscellaneous applications.

1.2.4 Class 4 Weld Joints

This covers weld joints applicable to welding reinforcing steel to primary structural members.

1.2.5 Class 5 Weld Joints

This covers weld joints applicable to welding concrete reinforcing steel splices (prestressing steel excepted), steel connection devices, and inserts and anchors required in concrete construction.

1.2.6 Class 6 Weld Joints

This covers plug and slot weld joints as applicable to the requirements of the project's code(s).

1.3 SYSTEM DESCRIPTION

Conform the design of welded connections to AISC 360, unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Perform welding as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Do not commence welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Perform all testing at or near the work site. Each Contractor performing welding shall maintain records of the test results

obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

1.3.1 Pre-erection Conference

Hold a pre-erection conference prior to the start of the field welding, to bring all affected parties together and to gain a naturally clear understanding of the project and the Welding Procedure Specifications (WPS) (which the Contractor shall develop and submit for all welding, including welding done using pre-qualified procedures). Mandatory attendance is required by all Contractor's welding production and inspection personnel and appropriate Government personnel. Include as items for discussion: responsibilities of various parties; welding procedures and processes to be followed; welding sequence (both within a joint and joint sequence within the building); inspection requirements and procedures, both visual and ultrasonic; welding schedule; fabrication of mock-up model; and other items deemed necessary by the attendees.

1.3.2 Mock-up Model

Perform first the field-welded connection designated as the mock-up model on the drawings. All welders, qualified and designated to perform field-welded groove joints, shall be present during the welding of the mock-up model connections and each one shall perform a part of the welding. Simulate with the mock-up test all physical and environmental conditions that will be encountered during the welding of all groove joints. Execute all inspection procedures required for groove welded joints, including NDE tests, on the mock-up model. All Contractor inspection and testing personnel designated to perform QC of groove welded joints shall be present during the welding of the mock-up model and each one shall perform the inspection procedures to be performed on production welding of these joints. This mock-up model connection represents the standard of performance, both for the welding and inspection procedures used and the results to be achieved in the production welding for these groove welded joints.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval.5 Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Welding Procedure Qualifications; G
Welder, Welding Operator, and Tacker Qualification
Inspector Qualification
Previous Qualifications
Pre-qualified Procedures

SD-06 Test Reports

Quality Control
Nondestructive Examination

SD-07 Certificates

Certified Welding Procedure Specifications (WPS)

Certified Brazing Procedure Specifications (BPS)
Certified Procedure Qualification Records (PQR)
Certified Welder Performance Qualifications (WPQ)
Certified Brazer Performance Qualifications (BPQ)

1.5 QUALITY ASSURANCE

Except for pre-qualified (in accordance with AWS D1.1/D1.1M) and previously qualified procedures, each Contractor performing welding shall record in detail and qualify the welding procedure specification for any welding procedure followed in the fabrication of weldments. Conform welding procedure qualifications to AWS D1.1/D1.1M and to the specifications in this section. Submit for approval copies of the welding procedure specification and the results of the procedure qualification test records for each type of welding which requires procedure qualification and the welder, welding operator, or tacker qualification test records.. Approval of any procedure, however, does not relieve the Contractor of the sole responsibility for producing a finished structure meeting all the specified requirements. Submit this information on the forms in Annex M of AWS D1.1/D1.1M. Individually identify and clearly reference on the detail drawings and erection drawings all welding procedure specifications, or suitably key them to the contract drawings. In case of conflict between this specification and AWS D1.1/D1.1M, this specification governs.

1.5.1 General Requirements

To perform this work provide an organization certified in the following: American Institute of Steel Construction (AISC) Quality Certification Program Category Category I Conventional Steel Structures.

a. For Structural Projects, provide documentation of the following:

(1) Component Thickness 1/8 inch and greater: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.1/D1.1M.

(2) Component Thickness Less than 1/8 inch: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.3/D1.3M.

(3) Reinforcing Steel: Qualification documents (WPS, PWR, and WPQ) in accordance with AWS D1.4/D1.4M.

b. For other applications, provide documentation of the following:

(1) Submit for review to the Contracting Officer two copies of Certified Welding Procedure Specifications (WPS), Certified Brazing Procedure Specifications (BPS) and Certified Procedure Qualification Records (PQR) within fifteen calendar days after receipt of Notice to Proceed.

(2) Cranes: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D14.1/D14.1M.

(3) Submit for review to the Contracting Officer two copies of Certified Welder Performance Qualifications (WPQ)and Certified Brazer Performance Qualifications (BPQ) within fifteen calendar days prior to any employee welding on the project material.

(4) Machinery: Qualification documents (WPS, PQR, and WPQ) in

accordance with AWS D14.4/D14.4M.

1.5.2 Previous Qualifications

Welding procedures previously qualified by test may be accepted for this contract without re-qualification, upon receipt of the test results, if the following conditions are met:

a. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.

c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.5.3 Pre-qualified Procedures

Welding procedures which are considered pre-qualified as specified in AWS D1.1/D1.1M will be accepted without further qualification. Submit for approval a listing or an annotated drawing to indicate the joints not pre-qualified. Procedure qualification is mandatory for these joints.

1.5.4 Retests

If welding procedure fails to meet the requirements of AWS D1.1/D1.1M, revise and re-qualify the procedure specification, or at the Contractor's option, welding procedure may be retested in accordance with AWS D1.1/D1.1M. If the welding procedure is qualified through retesting, submit all test results, including those of test welds that failed to meet the requirements, with the welding procedure.

1.5.5 Welder, Welding Operator, and Tacker Qualification

Each welder, welding operator, and tacker assigned to work on this contract shall be qualified in accordance with the applicable requirements of AWS D1.1/D1.1M and as specified in this section. Welders, welding operators, and tackers who make acceptable procedure qualification test welds will be considered qualified for the welding procedure used.

1.5.5.1 Previous Personnel Qualifications

At the discretion of the Contracting Officer, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this contract without re-qualification if all the following conditions are met:

a. Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are submitted and approved in accordance with the specified requirements for detail drawings.

b. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

c. The previously qualified welding procedure conforms to the

requirements of this specification and is applicable to welding conditions encountered under this contract.

d. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.5.5.2 Certificates

Before assigning any welder, welding operator, or tacker to work under this contract, submit the names of the welders, welding operators, and tackers to be employed, and certification that each individual is qualified as specified. State in the certification the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person certifying the qualification tests. Keep the certification current, on file, and furnish 3 copies.

1.5.5.3 Renewal of Qualification

Re-qualification of a welder or welding operator is required under any of the following conditions:

a. It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.

b. There is specific reason to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.

c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract, and a qualification test has not been taken within the past 12 months. Submit as evidence of conformance all records showing periods of employment, name of employer where welder, or welding operator, was last employed, and the process for which qualified.

d. A tacker who passes the qualification test is considered eligible to perform tack welding indefinitely in the positions and with the processes for which he/she is qualified, unless there is some specific reason to question the tacker's ability. In such a case, the tacker is required to pass the prescribed tack welding test.

1.5.6 Inspector Qualification

Inspector qualifications shall be in accordance with AWS D1.1/D1.1M. Qualify all nondestructive testing personnel in accordance with the requirements of ASNT SNT-TC-1A for Levels I or II in the applicable nondestructive testing method. The inspector may be supported by assistant welding inspectors who are not qualified to ASNT SNT-TC-1A, and assistant inspectors may perform specific inspection functions under the supervision of the qualified inspector.

1.5.7 Symbols and Safety

Symbols shall be in accordance with AWS A2.4, unless otherwise indicated. Safe welding practices and safety precautions during welding shall conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 WELDING EQUIPMENT AND MATERIALS

Provide all welding equipment, electrodes, welding wire, and fluxes capable of producing satisfactory welds when used by a qualified welder or welding operator performing qualified welding procedures. All welding equipment and materials shall comply with the applicable requirements of AWS D1.1/D1.1M.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

3.1.1 Requirements

Conform workmanship and techniques for welded construction to the requirements of AWS D1.1/D1.1M and AISC 360. When AWS D1.1/D1.1M and the AISC 360 specification conflict, the requirements of AWS D1.1/D1.1M govern.

3.1.2 Identification

Identify all welds in one of the following ways:

a. Submit written records to indicate the location of welds made by each welder, welding operator, or tacker.

b. Identify all work performed by each welder, welding operator, or tacker with an assigned number, letter, or symbol to identify welds made by that individual. The Contracting Officer may require welders, welding operators, and tackers to apply their symbol next to the weld by means of rubber stamp, felt-tipped marker with waterproof ink, or other methods that do not cause an indentation in the metal. Place the identification mark for seam welds adjacent to the weld at 3 foot intervals. Identification with die stamps or electric etchers is not allowed.

3.2 QUALITY CONTROL

Perform testing using an approved inspection or testing laboratory or technical consultant; or if approved, the Contractor's inspection and testing personnel may be used instead of the commercial inspection or testing laboratory or technical consultant. Perform visual and radiographic, ultrasonic, magnetic particle, and dye penetrant inspections to determine conformance with paragraph STANDARDS OF ACCEPTANCE. Conform procedures and techniques for inspection with applicable requirements of AWS D1.1/D1.1M, ASTM E165, ASTM E709, except that in radiographic inspection only film types designated as "fine grain," or "extra fine," are acceptable. Submit a quality assurance plan and records of tests and inspections.

3.3 STANDARDS OF ACCEPTANCE

Conform dimensional tolerances for welded construction, details of welds, and quality of welds with the applicable requirements of AWS D1.1/D1.1M and the contract drawings. Reference 05 12 00 for additional requirements.

3.3.1 Nondestructive Examination

The welding is subject to inspection and tests in the mill, shop, and field. Inspection and tests in the mill or shop do not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment. Submit all records of nondestructive examination in accordance with paragraph "Acceptance Requirements".

3.3.2 Destructive Tests

Make all repairs when metallographic specimens are removed from any part of a structure. Employ only qualified welders or welding operators, and use the proper joints and welding procedures, including peening or heat treatment if required, to develop the full strength of the members and joints cut and to relieve residual stress.

3.4 GOVERNMENT INSPECTION AND TESTING

In addition to the inspection and tests performed by the Contractor for quality control, the Government will perform inspection and testing for acceptance to the extent determined by the Contracting Officer. The costs of such inspection and testing will be borne by the Contractor if unsatisfactory welds are discovered, or by the Government if the welds are satisfactory. The work may be performed by the Government's own forces or under a separate contract for inspection and testing. The Government reserves the right to perform supplemental nondestructive and destructive tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

3.5 CORRECTIONS AND REPAIRS

If inspection or testing indicates defects in the weld joints, repair defective welds using a qualified welder or welding operator as applicable. Conduct corrections in accordance with the requirements of AWS D1.1/D1.1M and the specifications. Repair all defects in accordance with the approved procedures. Repair defects discovered between passes before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, blend the affected area into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before re-welding, examine the area by suitable methods to ensure that the defect has been eliminated. Repaired welds shall meet the inspection requirements for the original welds. Any indication of a defect is regarded as a defect, unless re-evaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

-- End of Section --

SECTION 05 12 00

STRUCTURAL STEEL
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 201	(2006) AISC Certification Program for Structural Steel Fabricators
AISC 303	(2010) Code of Standard Practice for Steel Buildings and Bridges
AISC 325	(2011) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 341	(2010) Seismic Provisions for Structural Steel Buildings
AISC 360	(2010) Specification for Structural Steel Buildings
AISC DESIGN GUIDE 10	(1997) Erection Bracing of Low-Rise Structural Steel Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B46.1	(2009) Surface Texture, Surface Roughness, Waviness and Lay

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143/A143M	(2007) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A325	(2010; E 2013) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A490	(2012) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A500/A500M	(2010a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A514/A514M	(2005; R 2009) Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A572/A572M	(2012) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A6/A6M	(2013) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992/A992M	(2011) Standard Specification for Structural Steel Shapes
ASTM B695	(2004; R 2009) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C1107/C1107M	(2013) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C827/C827M	(2010) Change in Height at Early Ages of Cylindrical Specimens from Cementitious

	Mixtures
ASTM F1554	(2007a; E 2011) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F436	(2011) Hardened Steel Washers
ASTM F844	(2007a) Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F959	(2013) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting of Steel
SSPC PS 13.01	(1982; E 2004) Epoxy Polyamide Painting System
SSPC Paint 25	(1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II
SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.756	Steel Erection; Beams and Columns

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 SYSTEM DESCRIPTION

Provide the structural steel system, including shop primer, galvanizing, complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided in accordance with AISC 360 and AISC 341 except as modified in this contract.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Erection Drawings, including description of temporary supports; G

Fabrication drawings including description of connections; G

Shear Connector Placement Drawings

SD-03 Product Data

Shop primer

Welding electrodes and rods

Load indicator washers

Non-Shrink Grout

Load indicator bolts

Welded Shear Studs

High-Strength Bolts

Shop Primer

Steel ; (LEED NC)

Include test report for Class B primer.

SD-06 Test Reports

Class B coating

Bolts, nuts, and washers

Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

SD-07 Certificates

Steel

Bolts, nuts, and washers

Galvanizing

AISC Quality Certification

Welding procedures and qualifications

SD-11 Closeout Submittals

Local / Regional Materials; (LEED NC)
Recycled Content

1.5 AISC QUALITY CERTIFICATION

Work shall be fabricated in an AISC certified Category Std fabrication plant.The structural steel fabricator shall have not less than 5 years of experience in the successful fabrication of structural steel similar to this project. The structural steel fabricator must participate in the AISC Quality Certification Program and be designated an AISC Certified Plant in Category STD, Standard for Steel Building Structures

The structural steel detailer shall have not less than 2 years of experience in the successful detailing of structural steel similar to this project including experience in selecting or completing structural steel connection details using information found in tables in the AISC "Steel Construction Manual. The structural steel detailer firm shall be certified under the Quality Procedures Program of the National Institute of Steel Detailing. The project shall be detailed by qualified structural steel detailers who are either personally certified under the National Institute of Steel Detailing as a Class I or Class II Detailer in the Structural/Miscellaneous discipline or are supervised by a detailer certified as a Class I Senior Detailer in the Structural/Miscellaneous discipline.

The structural steel erector shall have not less than 5 years of successful experience in the erection of structural steel of a similar nature to this project. The structural steel erector must participate in the AISC Erector Certification Program and be designated an AISC CERTIFIED STEEL ERECTOR

1.6 QUALITY ASSURANCE

1.6.1 Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326 and AISC 325. Fabrication drawings shall not be reproductions of contract drawings. Sign and seal fabrication drawings by a professional engineer registered in the State of Florida. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts, camber, holes and other pertinent data. Double connections that require an erection seat to comply with OSHA 29 CFR 1926.756(c)(1) shall be shown on the shop drawings, reviewed and approved by the structural engineer of record. Use AWS A2.4 standard welding symbols. Shoring and temporary bracing shall be designed and sealed by a registered professional engineer and submitted for record purposes, with calculations, as part of the drawings. Member substitutions of details shown on the contract drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings

Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others

The licensed professional engineer responsible for the design of any of the connections shown on the shop drawings shall submit a letter that is sealed attesting that the connection design engineer has reviewed the shop drawings and that the connections detailed and shown on the shop drawings conform to the engineer's design.

Submit Erection Drawings for review, reference and information complete erection drawings showing field-installation and member-placing instructions for locating and attaching the individual shipping pieces

Submit Shear Connector Placement Drawings. Provide shop drawing showing proper placement (longitudinal and transverse spacing) of shear connectors on each composite beam requiring such connectors. The shop drawing shall show the proper relationship of the shear connectors to the flutes in the steel deck and the arrangement of shear connectors along the span of the composite beam. Show the method of attachment of shear connectors and proposed brand and model of equipment to be used

1.6.2 Certifications

1.6.2.1 NOT USED

1.6.2.2 Erection Drawings

Submit for record purposes. Complete erection-bracing drawings to illustrate the sequence of erection, any requirements for temporary supports and the requirements for raising, bolting, and/or welding.

1.6.2.3 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welding operator is more than one-year old, the welding operator's qualification certificate shall be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

Conform to all requirements specified in AWS D1.1/D1.1M.

PART 2 PRODUCTS

2.1 STEEL

2.1.1 Structural Steel

ASTM A36/A36M.

2.1.2 High-Strength Structural Steel

2.1.2.1 Low-Alloy Steel

ASTM A572/A572M , Grade 50. ASTM A992/A992M Grade 50.

2.1.3 Structural Shapes for Use in Building Framing

Wide flange shapes, ASTM A992/A992M.

2.1.4 Structural Steel Tubing

ASTM A500/A500M, Grade B.

2.1.5 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B, weight class STD (Standard), XS (Extra Strong) and XXS (Double-extra Strong).

2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.2.1 Structural Steel, Steel Pipe

2.2.1.1 Bolts

ASTM A325, Type 1, ASTM A490, Type 1. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.2.1.2 Nuts

ASTM A563, Grade and Style for applicable ASTM bolt standard recommended.

2.2.1.3 Washers

ASTM F436 washers for ASTM A325 and ASTM A490 bolts.

2.2.2 High-Strength Structural Steel and Structural Steel Tubing

2.2.2.1 Bolts

ASTM A325, Type 1 ASTM A490, Type 1 or 2.

Bolts in contact with galvanized material shall have a Rockwell hardness not greater than C-32

2.2.2.2 Nuts

ASTM A563, Grade and Style as specified in the applicable ASTM bolt standard.

2.2.2.3 Washers

ASTM F436, plain carbon steel.

2.2.3 Foundation Anchorage

2.2.3.1 Anchor Bolts

ASTM F1554 Gr 36, Class 2A.

2.2.3.2 Anchor Nuts

ASTM A563, Grade A, hex style.

2.2.3.3 Anchor Washers

ASTM F844.

2.2.3.4 Anchor Plate Washers

ASTM A36/A36M .

2.2.4 Load Indicator Washers

ASTM F959. Provide ASTM B695, Class 50, Type 1 galvanizing.

2.2.5 Load Indicator Bolts

ASTM A325, Type 1; ASTM A490, Type 1, with a manufactured notch between the bolt tip and threads. The bolt shall be designed to react to the opposing rotational torques applied by the installation wrench, with the bolt tip automatically shearing off when the proper tension is obtained.

2.2.6 Self-Locking Nuts

Provide nuts with a locking pin set in the nut. The locking pin shall slide along the bolt threads, and by reversing the direction of the locking pin, the nut shall be removed without damaging the nut or bolt. Provide stainless steel locking pins.

2.3 STRUCTURAL STEEL ACCESSORIES

2.3.1 Welding Electrodes and Rods

AWS D1.1/D1.1M.

2.3.2 Non-Shrink Grout

ASTM C1107/C1107M, with no ASTM C827/C827M shrinkage. Grout shall be nonmetallic.

2.3.3 Welded Shear Stud Connectors

AWS D1.1/D1.1M.

2.4 Shop Primer

SSPC Paint 25, (alkyd primer) or SSPC PS 13.01 epoxy-polyamide, green primer (Form 150) type 1, except provide a Class B coating in accordance with AISC 325 for slip critical joints. Primer shall conform to Federal, State, and local VOC regulations. If flash rusting occurs, re-clean the surface prior to application of primer.

Structural Steel that is exposed to view or on exterior of building shall receive special zinc rich primer as specified by architect. Surface preparation and application of primer shall be as specified by the architect, compatible with finish and/or paint system and as recommended by the manufacturer

2.5 GALVANIZING

ASTM A123/A123M or ASTM A153/A153M, as applicable, unless specified otherwise galvanize after fabrication where practicable.

All structural steel items and their connections permanently exposed to exterior conditions or that are within areas of unconditioned airspace, whether specified on the drawings or not, shall be hot-dipped galvanized

after fabrication unless indicated on the drawings or in Division 9 of the Specification to receive a primer and/or finish coat. Such items include, but are not limited to:

a. Base plates and anchor rods supporting galvanized members shall also be galvanized

b. Shelf angles

c. Parapet wall supporting members

d. Screen wall supporting members

e. Window washing support members

f. Embedded plates in concrete exposed to unconditioned airspace

h. Cooling tower support steel

i. Solar Panel tower support steel

k. Examine the architectural and structural drawings for other items required to be hot dipped galvanized

unless noted otherwise, anchor rods used with galvanized plates shall be galvanized

Zinc-coat all ASTM A 325 bolts nuts, and washers used in the connection of such steel. Field welded connections shall have welds protected and the exposed portions of ASTM A 490 bolts, nuts and washers shall be protected with galvanizing repair paint

2.6 FABRICATION

2.6.1 Markings

Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded . Do not locate match markings in areas that will decrease member strength or cause stress concentrations. Affix embossed tags to hot-dipped galvanized members.

2.6.2 Shop Primer

Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, galvanized surfaces, surfaces to receive sprayed-on fireproofing, surfaces to receive epoxy coatings,, or surfaces within 0.5 inch of the toe of the welds prior to welding (except surfaces on which metal decking is to be welded). Slip critical surfaces shall be primed with a Class B coating. Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 40 degrees F within 48 hours after application, unless approved otherwise by the Contracting Officer.

2.6.2.1 Cleaning

SSPC SP 6/NACE No.3, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

2.6.2.2 Primer

Apply primer to a minimum dry film thickness of 2.0 mil except provide the Class B coating for slip critical joints in accordance with the coating manufacturer's recommendations. Repair damaged primed surfaces with an additional coat of primer.

2.6.3 Hot Dip Galvanizing

All steel to be hot dip galvanized shall undergo the following surface preparation as specified by the Steel Structures Painting Council (SSPC), Volume 2

a. Remove all grease, oil, grime and foreign contaminants by thorough cleaning with an alkaline or organic solvent followed by thorough rinsing in cold water
b. Remove scale by pickling in diluted sulfuric or hydrochloric acid. Pickling shall be followed by a rinse in warm water and a second rinse in cold water. As an alternative to pickling, the steel may be white metal blast cleaned according to SSPC-SP-5

c. Dip in a flux solution of zinc ammonia chloride followed by drying at room temperature

4. Zinc Coating: The zinc coating for steel shapes and plates shall conform to ASTM A 123. Weight of zinc coating per square foot of surface for 1/8 inch and 3/16" thick steels shall average not less than 2.0 oz. with no individual thickness less than 1.8 oz. The coating weight shall average not less than 2.3 oz. with no individual thickness less than 2.0 oz. for 1/4" thick and heavier steel.

2.6.4 Fireproofing and Epoxy Coated Surfaces

Surfaces to receive sprayed-on fireproofing epoxy coatings shall be cleaned and prepared in accordance with the manufacturer's recommendations, and as specified in Section 07 81 00 SPRAY-APPLIED FIREPROOFING.

2.6.5 Surface Finishes

ASME B46.1 maximum surface roughness of 125 for sliding bearings, unless indicated otherwise.

2.7 DRAINAGE HOLES

Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be 1/2 inch and location shall be indicated on the detail drawings. Hole size and location shall not affect the structural integrity.

PART 3 EXECUTION

3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC 325. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC 201 for Category of Conventional Steel Building Structures structural steelwork.

Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro inch as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A6/A6M.

Unless otherwise noted, structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded, surfaces to be fireproofed, and contact surfaces of friction-type high-strength bolted connections shall be prepared for painting in accordance with endorsement "P" of AISC 201 and primed with the specified paint.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

3.2 INSTALLATION

3.2.1 NOT USED

3.3 ERECTION

a. Erection of structural steel, except as indicated in item b. below, shall be in accordance with the applicable provisions of AISC 325 . Erection plan shall be reviewed, stamped and sealed by professional structural engineer licensed in state of Florida.

b. For low-rise structural steel buildings (60 feet tall or less and a maximum of 2 stories), the erection plan shall conform to AISC 303 and the structure shall be erected in accordance withAISC DESIGN GUIDE 10.

c. Do not splice truss top and bottom chords except as approved by the Contracting Officer. Chord splices shall occur at panel joints at approximately the third point of the span. The center of gravity lines of truss members shall intersect at panel points unless otherwise approved by the Contracting Officer. When the center of gravity lines do not intersect at a panel point, provisions shall be made for the stresses due to eccentricity. Cumber of trusses shall be 1/8 inch in 10 feet unless otherwise indicated.

Provide for drainage in structural steel. After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

3.3.1 STORAGE

Material shall be stored out of contact with the ground in such manner and

location as will minimize deterioration.

3.4 CONNECTIONS

Except as modified in this section, connections not detailed shall be designed in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Punch, subpunch and ream, or drill bolt holes perpendicular to the surface of the member. Holes shall not be cut or enlarged by burning. Bolts, nuts, and washers shall be clean of dirt and rust, and lubricated immediately prior to installation.

Conceptual connection details with the required member design forces are shown on the drawings for bidding purposes and are applicable to all connections not designed and completely detailed on the drawings. The conceptual details are provided only to indicate the connection type required and may not fully represent the complexity of the connection as required by the final connection design for the forces they must resist. Except as noted below, the fabricator is responsible for engaging the services of a connection specialty engineer to prepare a final connection design for submission that meets the requirements of the conceptual connection details and resists the indicated design forces. Refer to the drawings and specifications for complete requirements.

By bidding this project, the fabricator acknowledges that additional connection elements may not be specifically shown in the conceptual details but may be required by the final connection design, such as stiffener plates, doubler plates, supplement/reinforcing plates or other connection material. The fabricator is responsible to include within his bid all material and labor required to conform to the intent of the conceptual details and to carry the design forces indicated, regardless of whether or not all connection elements (such as stiffener plates, doubler plates, supplement/reinforcing plates or any other connection material) required by final connection design are shown in the conceptual detail.

The Contractor shall promptly notify the Architect/Engineer whenever design of members and connections for any portion of the structure are not clearly indicated or when other questions exist about the Contract Documents. Such questions shall be resolved prior to the submission of shop drawings

3.4.1 Design and Detailing Procedure

a. Unless noted otherwise or specifically detailed on the drawings, end connections of beams, girders, and trusses shall be designed as flexible and the connection shall accommodate end rotations of the unrestrained beams. Restrained end connections, as indicated on the drawings, shall be designed for the combined effect of bending moment and shears induced by the rigidity of the connection. Forces to be used in the design are described below

b. The fabricator's licensed professional engineer shall design and submit sealed calculations documenting the design and showing details of the assembled joint with the bolts and welds required for the conditions noted below:

1. For each connection not otherwise completely detailed on the drawings
2. Where connections are encountered on the project that does not

match those assumed in the AISC Manual or other similar publication

c. Where connections are of the type than can be selected or completed using information found in tables in the AISC "Steel Construction Manual" or related publications, sealed calculations need not be submitted provided the project design conditions precisely match those assumed in the referenced publications. For conditions encountered on the project that do not conform to the AISC Manual or other similar publication, a complete design shall be prepared and submitted for engineer's review.

d. The fabricator's licensed professional engineer shall seal all design calculations

e. The Engineer reserves the right to reject all shop drawings submitted without complete design calculations if required. Failure to adhere to the requirements of this section obligates the Contractor to take responsibility for any and all resulting delays in the detailing and fabrication of structural steel

f. The fabricator, his detailer and supervising engineer shall coordinate all connection requirements with the erector. The fabricator is responsible to detail connections that contain the adjustability and all other requirements that allow the erector to erect the structural steel in conformance to all specified tolerances. The fabricator shall be responsible for providing adjustability in all connections between exterior-cladding systems, skylights, and other architectural features and the supporting structural steel as required in achieving the specified tolerances for the architectural feature as specified in the contract documents

3.4.2 Design Intent

It is the intention of the plans and specifications that shop connections be welded or bolted and that field connections be bolted, unless detailed otherwise on the drawings

3.4.3 Flexible (Simple) Beam Connections

a. All typical beam simple connections shall conform to requirements of the AISC specifications. Refer to the drawings for typical connection types

b. Seated Beam Connections and Stiffened Seated Beam Connections shall not be used unless indicated on the drawings or unless Engineer approval is obtained to verify capacity of supporting member for the resulting eccentricity. The fabricator must verify and bear responsibility that the use of such connections does not interfere with architectural or MEP requirements

c. Simple Beam Connection Capacity: Support a factored load reaction R equal to the reaction shown on the plans. Contact the Engineer if no reaction for a beam is shown on the plan. Each connection shall contain not less than the minimum number of bolts shown in the AISC connection tables for each beam size

3.4.4 Restrained (Moment) Connections

a. Refer to the drawings for Moment Connection Details

b. Design Reactions for Moment Connected Beams: Shear connections for moment-connected beams shall be designed for the factored reaction shown on the drawings

c. Design and Furnishing of Reinforcement in Moment Connected Joints: As part of the design responsibility outlined above, the fabricator shall design and furnish all additional reinforcement in moment connected joints to resist the specified design forces unless otherwise specifically detailed on the drawings. Column sections shall be investigated for web shear, web yielding, web buckling, and tension. Stiffeners and/or doubler plates shall be furnished as required by the AISC Specification Section K1

3.4.5 Tightening of Bolts in Welded Moment Connections

At moment connections where beams are complete-joint penetration welded directly to columns or girders in the field, welds shall be made after installation of erection bolts to draw the pieces together and before the final shear connection bolts are tightened. Where loose moment plates are used, such plates shall be groove welded to columns prior to connecting these plates to the beams

3.4.6 Base Plates and Bearing Plates

a. Finish: All base plates and bearing plates shall be finished in accordance with AISC Specification M2.8

b. Attachment to Column: Unless shown otherwise on the drawings, all base plates and bearing plates shall be welded all around to the column with minimum fillet welds as specified in AISC Specification Table J2.4

c. Anchor Rod Holes in Base plates: Hole sizes in base plates for anchor rods shall be made oversize as described in the AISC "Steel Construction Manual", Table 14-2

3.4.7 Trusses

3.4.7.1 1. Truss Geometry

Chord and web lines shown on truss elevations represent the centroid of the truss member unless detailed otherwise

3.4.7.2 Preassembly of Trusses

Trusses shall be preassembled in the shop to verify proper fit-up of connections

3.4.7.3 Hangers and Braces

a. Connections for all hangers and braces shall have connections designed to develop the factored axial force shown on the drawings. Contact the Engineer if no force for a member is shown on the drawings

b. Compression members composed of two or more rolled shapes separated from one another by intermittent fillers shall be connected to one another at such fillers at intervals (not to exceed 48") so that the

slenderness ratio l/r of either shape, between the fasteners, does not exceed 75% of the governing slenderness ratio of the built-up member. The least radius of gyration, r, shall be used in computing the slenderness ratio of each component part

3.4.7.4 Stiffeners

Provide stiffeners finished to bear under load concentrations where shown on the drawings

3.4.7.5 Bolts in Combination with Welds

Bolts shall not be considered as sharing the load in combination with welds, except as allowed in AISC Specification Section J1.8

3.4.8 Limitations on Use of A307 Bolts

ASTM A307 bolts shall not be used in any permanent steel-to-steel or concrete-to-steel connection.

3.4.9 High-Strength Bolts

ASTM A325 and ASTM A490 bolts shall be fully tensioned to 70 percent of their minimum tensile strength. Provide load indicator bolts in all bolted connections, except provide only load indicator washers for slip critical connections. Direct tension indicator tightening, shall be the only acceptable tightening methods. Use only direct tension indicator tightening for slip critical connections. Bolts shall be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, bolts shall then be fully tensioned, progressing from the most rigid part of a connection to the free edges.

3.4.9.1 Installation of Load Indicator Washers (LIW)

ASTM F959. Where possible, the LIW shall be installed under the bolt head and the nut shall be tightened. If the LIW is installed adjacent to the turned element, provide a flat ASTM F436 washer between the LIW and nut when the nut is turned for tightening, and between the LIW and bolt head when the bolt head is turned for tightening. In addition to the LIW, provide flat ASTM F436 washers under both the bolt head and nut when ASTM A490 bolts are used.

3.5 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.6 WELDING

AWS D1.1/D1.1M, except use only shielded metal arc welding and low hydrogen electrodes for ASTM A514/A514M steel. Do not stress relieve ASTM A514/A514M steel by heat treatment. Grind exposed welds smooth as indicated. Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

The Contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for

information only; however, procedures that are not prequalified shall be submitted for approval.

3.6.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

Remove only from finished areas.

3.7 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

3.7.1 Field Priming

Coordinate with architectural specifications, the need and ability to apply field priming. Field priming of steel exposed to the weather, or located in building areas without HVAC for control of relative humidity. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

3.8 GALVANIZING REPAIR

Provide as indicated or specified. Galvanize after fabrication where practicable. Repair damage to galvanized coatings using ASTM A780/A780M zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.9 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing, except that electric power for field tests will be furnished as set forth in Division 1. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

3.9.1 Welds

3.9.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. Welding inspectors shall visually inspect and mark welds, including fillet weld end returns.

Inspection by the Government will include proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use.

The Contractor shall inspect proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use.

3.9.1.1.1 Weld Inspection and Process Monitoring

The Testing Agency shall make the following inspections of the welds and welding processes. Welds performed in the fabricating shop may be

inspected in the field unless continuous monitoring of the welding process is herein specified or if access in the field due to other work or shop finishes makes field inspection impractical

a. Approve Welding Procedure Specifications submitted by the Contractor. Approve any changes submitted by the Contractor to any WPS that has already been approved. Obtain the Welding Procedure Qualification Record (WPQR) for each successful WPS qualification
b. Periodically verify welding electrodes to be used and other welding consumables as the job progresses

c. Periodically observe joint preparation, assembly practice, welding techniques including preheating and sequence, and the performance of welders with sufficient frequency to assure compliance with code and contract document requirements. Check preheating to assure conformance with AWS D1.1, Section 5.6. Verify procedure for control of distortion and shrinkage stresses

d. Continuously observe joint preparation and fit up, backing strips, and runout plates for welded moment connections and column splices

e. Periodically provide visual inspection of the root pass of partial and complete joint penetration welds

e. Visually inspect 100 % of welds for proper size, length, location, and weld quality in accordance with AWS D1.1 requirements. Unless specifically noted otherwise, all welding shall be considered statically loaded nontubular connections

f. Visually inspect 100% of completed shear connectors on each beam

g. Visually inspect 100% of the welds of anchors to embedded plates that are to be cast into concrete elements

h. Continuously monitor and observe joint preparation, assembly practice, welding techniques including preheating and sequence, and the performance of welders for 100% of complete and partial joint penetration welds, plug and slot welds, multiple-pass fillet welds, and single-pass fillet welds greater than 5/16 inch. Check preheating to assure conformance with AWS D1.1, Section 5.6. Verify procedure for control of distortion and shrinkage stresses

i. Periodically monitor welding of single-pass fillet welds that are less than or equal to 5/16 inch

j. Periodically monitor the welding of headed studs to floor beams

k. Periodically monitor the welding of anchors to embedded plates that are to be cast into concrete elements

3.9.1.2 Nondestructive Testing

AWS D1.1/D1.1M. Test locations shall be as indicated. If more than 20 percent of welds made by a welder contain defects identified by testing, then all welds made by that welder shall be tested by radiographic or ultrasonic testing, as approved by the Contracting Officer. When all welds made by an individual welder are required to be tested, magnetic particle testing shall be used only in areas inaccessible to either radiographic or ultrasonic testing. Retest defective areas after repair.

The costs of repairing defective welds and the costs of retesting by the Testing Agency providing services for the Owner shall be borne by the Contractor. If removal of a backing strip is required by the Testing Agency to investigate a suspected weld defect, such cost shall be borne by the Contractor

Perform nondestructive examination services using a qualified technician with the necessary equipment to perform the following:

a. Nondestructive examination conducted in accordance with the specific requirements for the item being examined including radiographic (RT), ultrasonic (UT), magnetic particle (MT), or dye-penetrant inspection (PT). Nondestructive inspection procedures shall conform to AWS D1.1

b. Interpret, record, and report results of the nondestructive tests

c. Mark for repair, any area not meeting Specification requirements. Correction of rejected welds shall be made in accordance with AWS D1.1

d. Re-examine repair areas and interpret, record, and report the results of examinations of repair welds

e. Verify that quality of welds meet the requirements of AWS D1.1

3.9.1.2.1 Fillet Welds

Provide the following:

a. MT test a minimum of 10% of the length of each fillet weld exceeding 5/16"

b. Periodic MT testing of representative fillet welds 5/16" and less but need not exceed 10% of all such welds, except as required for high rejection rates as indicated in the following paragraph

c. Increase MT testing rate for welders having a high rejection rate as required to ensure acceptable welds

3.9.1.2.2 Partial Joint Penetration (PJP) Welds, including Flare-Bevel Groove Welds

Provide the following:

a. MT test a minimum of 25% of the length of each PJP weld exceeding 5/16" effective throat

b. Periodic MT testing of representative PJP welds 5/16" and less but need not exceed 10% of all such welds, except as required for high rejection rates as indicated in the following paragraph

c. Increase MT testing rate for welders having a high rejection rate as required to ensure acceptable welds

3.9.1.2.3 Complete Joint Penetration (CJP) Welds

Provide the following:

a. All CJP welds exceeding 5/16" thickness shall be 100% UT tested per AWS D1.1 Clause 6 Part F. The Testing Agency shall review the CJP joints to determine where geometry or accessibility precludes the use

of standard scanning patterns per AWS D1.1 Clause 6 Part F. At these locations the testing Agency shall develop and submit for approval a written testing procedure in accordance with AWS D1.1 Annex S

b. Periodic MT testing of representative CJP welds 5/16" and less not to exceed 10% of all such welds, except as required for high rejection rates as indicated in the following paragraph

c. Increase MT testing rate for welders having a high rejection rate as required to ensure acceptable welds

3.9.1.2.4 Acceptance Criteria:

a. Visual, MT, PT shall be per AWS D1.1 Table 6.

b. UT testing shall be per AWS D1.1 6.13.1 and Table 6.2

3.9.1.2.5 Welds of Anchors to Embedded Plates

a. Headed Studs: Perform field bend tests according to AWS D1.1 on 2% of the studs welded to plates, but not less than one stud per plate

b. Deformed Bar Anchors: Perform MT testing on 10% of deformed bar anchors larger than #5 bar

3.9.2 Load Indicator Washers

3.9.2.1 Load Indicator Washer Compression

Load indicator washers shall be tested in place to verify that they have been compressed sufficiently to provide the 0.015 inch gap when the load indicator washer is placed under the bolt head and the nut is tightened, and to provide the 0.005 inch gap when the load indicator washer is placed under the turned element, as required by ASTM F959.

3.9.2.2 Load Indicator Gaps

In addition to the above testing, an independent testing agency as approved by the Contracting Officer, shall test in place the load indicator gapson 20 percent of the installed load indicator washers to verify that the ASTM F959 load indicator gaps have been achieved. If more than 10 percent of the load indicators tested have not been compressed sufficiently to provide the average gaps required by ASTM F959, then all in place load indicator washers shall be tested to verify that the ASTM F959 load indicator gaps have been achieved. Test locations shall be selected by the Contracting Officer.

3.9.3 NOT USED

3.9.4 High-Strength Bolts

3.9.4.1 Testing Bolt, Nut, and Washer Assemblies

Test a minimum of 3 bolt, nut, and washer assemblies from each mill certificate batch in a tension measuring device at the job site prior to the beginning of bolting start-up. Demonstrate that the bolts and nuts,

when used together, can develop tension not less than the provisions specified in AISC 360, depending on bolt size and grade. The bolt tension shall be developed by tightening the nut. A representative of the manufacturer or supplier shall be present to ensure that the fasteners are properly used, and to demonstrate that the fastener assemblies supplied satisfy the specified requirements.

3.9.4.2 Inspection

Inspection procedures shall be in accordance with AISC 360 . Confirm and report to the Contracting Officer that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

Inspection by the Government will include calibration of torque wrenches for high-strength bolts.

3.9.4.2.1 High-Strength Bolt Inspection and Process Monitoring

The Testing Agency shall perform the following inspections for connections joined with high-strength bolts. Bolting performed in the shop may be inspected in the field unless continuous monitoring of the bolting operation is specified herein:

a. Observe preinstallation verification testing of the pretensioning method to be used in accordance with the requirements of the "Specification for Structural Joints Using High-Strength Bolts"

b. Check daily the calibration of impact wrenches used in field bolted connections

c. Inspect bolt installation for 100% of high strength bolted connections according to inspection procedures outlined in the "Specification for Structural Joints Using High-Strength Bolts"

d. Monitoring of Bolting Installation

The Testing Agency shall be continuously present and monitor the bolting installation for compliance with the selected procedure for installation as specified in the "Specification for Structural Joints Using High-Strength Bolts" for joints using high-strength bolts that are designated on the plans as Pretensioned (PT) or Slip-Critical (SC) type joints and that are being installed using the calibrated wrench method or the turn-of-nut without matchmarking method of installation

3.9.4.3 Testing

The Government has the option to perform nondestructive tests on 5 percent of the installed bolts to verify compliance with pre-load bolt tension requirements. The Contractor shall allow access for the Government to perform the tests. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations shall be selected by the Contracting Officer. If more than 10 percent of the bolts tested

contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, shall be tested at the Contractor's expense. Retest new bolts after installation at the Contractor's expense.

Perform Arbitration Testing according to procedures outlined in the "Specification for Structural Joints using High-Strength Bolts" when a disagreement exists between the Testing Agency and the Fabricator as to the minimum tension of installed bolts that have been inspected according to paragraph below

3.9.5 Testing for Embrittlement

ASTM A143/A143M for steel products hot-dip galvanized after fabrication.

3.9.6 Welded Shear Studs

3.9.6.1 Inspection

Provide visual inspection of 100% of the shear stud welds

3.9.6.2 Testing

Perform bend tests on completed shear connectors attached to beams as required according to procedures outlined in AWS D1.1. In addition, perform field bend tests on an additional 2% of completed shear connectors on each beam but not less than one connector per beam

-- End of Section --

SECTION 05 30 00

STEEL DECKS
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI D100	(1991; R 2008) Cold-Formed Steel Design Manual
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2008; Errata 2008) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2012a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2010) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

FM GLOBAL (FM)

FM DS 1-28	(2002) Design Wind Loads

STEEL DECK INSTITUTE (SDI)

SDI 31	(2007) Design Manual for Composite Decks, Form Decks, and Roof Decks
SDI DDMO3	(2004; Errata 2006; Add 2006) Diaphragm Design Manual; 3rd Edition
SDI DDP	(1987; R 2000) Deck Damage and Penetrations
SDI MOC2	(2006) Manual of Construction with Steel Deck

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2010; Change 3) Structural Engineering

UNDERWRITERS LABORATORIES (UL)

UL 209	(2011) Cellular Metal Floor Raceways and Fittings
UL 580	(2006; Reprint Jul 2009) Tests for Uplift Resistance of Roof Assemblies

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

Metal Floor Deck Units

Cant Strips

Ridge and Valley Plates

Metal Closure Strips

SD-03 Product Data

Accessories

Deck Units

Galvanizing Repair Paint

Joint Sealant Material; (LEED NC)

Mechanical Fasteners

Metal Floor Deck Units

Powder-Actuated Tool Operator

Welder Qualifications

Welding Equipment

Welding Rods and Accessories; (LEED NC)

SD-04 Samples

Metal Roof Deck Units
Flexible Closure Strips

Accessories

SD-05 Design Data

Deck Units

Submit manufacturer's design calculations, or applicable published literature for the structural properties of the proposed deck units.

SD-07 Certificates

Welding Procedures

Wind Storm Resistance
Product Certification

SD-11 Closeout Submittals

Local / Regional Materials; (LEED NC)
Low Emitting Materials - Adhesives and Sealants

1.4 QUALITY ASSURANCE

1.4.1 Deck Units

Furnish deck units and accessory products from a manufacturer regularly engaged in manufacture of steel decking. Provide manufacturer's certificates attesting that the decking material meets the specified requirements.

1.4.2 Certification of Powder-Actuated Tool Operator

Manufacturer's certificate attesting that the operators are authorized to use the low velocity powder-actuated tool.

1.4.3 Qualifications for Welding Work

Follow Welding Procedures in accordance with AWS D1.1/D1.1M. Test specimens shall be made in the presence of Contracting Officer and shall be tested by an approved testing laboratory at the Contractor's expense.

Submit qualified Welder Qualifications in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. Perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, perform an immediate retest of two test welds until each test weld passes. Failure in the immediate retest will require the welder be retested after further practice or training, performing a complete set of test welds.

Submit manufacturer's catalog data for Welding Equipment and Welding Rods and Accessories.

1.4.4 Regulatory Requirements

1.4.4.1 Wind Storm Resistance

Provide roof construction assembly capable of withstanding an uplift pressure indicated in the structural drawings when tested in accordance with the uplift pressure test described in the FM DS 1-28 or as described in UL 580 and in general compliance with UFC 3-301-01.

1.4.5 Fabrication Drawings

Show type and location of units, location and sequence of connections, bearing on supports, methods of anchoring, attachment of accessories, adjusting plate details, size and location of holes to be cut and reinforcement to be provided, the manufacturer's erection instructions and other pertinent details.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver deck units to the site in a dry and undamaged condition. Store and handle steel deck in a manner to protect it from corrosion, deformation, and other types of damage. Do not use decking for storage or as working platform until units have been fastened into position. Exercise care not to damage material or overload decking during construction. The maximum uniform distributed storage load must not exceed the design live load. Stack decking on platforms or pallets and cover with weathertight ventilated covering. Elevate one end during storage to provide drainage. Maintain deck finish at all times to prevent formation of rust. Repair deck finish using touch-up paint. Replace damaged material.

1.6 DESIGN REQUIREMENTS FOR ROOF DECKS

1.6.1 Properties of Sections

Properties of metal roof deck sections must comply with engineering design width as limited by the provisions of AISI D100.

1.6.2 Allowable Loads

Indicate total uniform dead and live load for detailing purposes.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Steel Sheet

Flat rolled carbon steel sheets of structural quality, thickness not less than 0.028 inch before coating, meeting the requirements of AISI SG03-3, except as modified herein.

2.1.2 Steel Coating

ASTM A653/A653M designation G90 galvanized, or ASTM A792/A792M designation AZ55, aluminum-zinc alloy. Apply coating to both sides of sheet. Conform to UL 209 for coating on decking provided as wire raceways.

2.1.3 Mixes

2.1.3.1 Galvanizing Repair Paint for Floor Decks

Provide a high-zinc-dust content paint for regalvanizing welds in galvanized steel conforming to ASTM A780/A780M.

2.1.4 Galvanized Steel Angles for Roof Decks

Provide hot-rolled carbon steel angles conforming to ASTM A36/A36M, merchant quality, Grade Designation SAE/AISI 1023 or SAE/AISI 1025, and hot-dip galvanized in accordance with ASTM A123/A123M.

2.1.5 Joint Sealant Material for Roof Decks

Provide a nonskinning, gun-grade, bulk compound material as recommended by the manufacturer.

2.1.6 Galvanizing Repair Paint for Roof Decks

Provide a high zinc-dust content paint for regalvanizing welds in galvanized steel and shall conform to ASTM A780/A780M.

2.2 ACCESSORIES

Provide accessories of same material as deck, unless specified otherwise. Provide manufacturer's standard type accessories, as specified.

2.2.1 Adjusting Plates

Provide adjusting plates, or segments of deck units, of same thickness and configuration as deck units in locations too narrow to accommodate full size units. Provide factory cut plates of predetermined size where possible.

2.2.2 End Closures

Fabricated of sheet metal by the deck manufacturer. Provide end closures minimum 0.028 inch thick to close open ends at parapets,end walls,eaves,and openings through deck.

2.2.3 Partition Closures

Provide closures for closing voids above interior walls and partitions that are perpendicular to the direction of the configurations. sheet steel closures above typical partitions. Provide sheet steel closures above fire-resistant interior walls and partitions located on both sides of wall or partition.

2.2.4 Sheet Metal Collar

Where deck is cut for passage of pipes, ducts, columns, etc., and deck is to remain exposed, provide a neatly cut sheet metal collar to cover edges of deck. Do not cut deck until after installation of supplemental supports.

2.2.5 Cover Plates

Sheet metal to close panel edge and end conditions, and where panels change direction or butt. Polyethylene-coated, self-adhesive, 2 inch wide joint tape may be provided in lieu of cover plates on flat-surfaced decking butt joints.

Fabricate cover plates for abutting floor deck units from the specified structural-quality steel sheets not less than nominalthick before galvanizing. Provide 6 inch wide cover plates and form to match the contour of the floor deck units.

2.2.6 Roof Sump Pans

Sump pans must be provided for roof drains and must be minimum 0.075 inch thick steel, recessed type. Shape sump pans to meet roof slope by the supplier or by a sheet metal specialist. Provide bearing flanges of sump pans to overlap steel deck a minimum of 3 inch. Shape, size, and reinforce the opening in bottom of the sump pan to receive roof drain.

2.2.7 Column Closures

Sheet metal, minimum 0.0358 inch thick or metal rib lath.

2.2.8 Access Hole Covers

Sheet metal, minimum 0.0474 inch thick.

2.2.9 Hanger

Provide clips or loops for utility systems and suspended ceilings of one or more of the following types:

a. Lip tabs or integral tabs where decking is 0.0474 inch thick or more, and a structural concrete fill is used over deck.

b. Slots or holes punched in decking for installation of pigtails.

c. Tabs driven from top side of decking and arranged so as not to pierce electrical cells.

d. Decking manufacturer's standard as approved by the Contracting Officer.

2.2.10 Mechanical Fasteners

Provide mechanical fasteners, such as powder actuated or pneumatically driven fasteners, for anchoring the deck to structural supports and adjoining units that are designed to meet the loads indicated. Provide positive locking-type fasteners listed by the Steel Deck Institute and ICC-ES, as approved by the Contracting Officer.

2.2.11 Miscellaneous Accessories
Furnish the manufacturer's standard accessories to complete the deck installation. Furnish metal accessories of the same material as the deck and with the minimum design thickness as follows: saddles, 0.0474 inch welding washers, 0.0598 inch cant strip, 0.0295 inch other metal accessories, 0.0358 inch unless otherwise indicated. Accessories must include but not be limited to saddles, welding washers, fasteners, cant strips, butt cover plates, underlapping sleeves, and ridge and valley plates.

2.3 FABRICATION

Furnish one sample of each type of Metal Floor Deck Units used to illustrate the actual cross section dimensions and configuration.

Furnish sample of Metal Roof Deck Units used to illustrate actual cross section dimensions and configurations.

Furnish one sample of each type Flexible Closure Strips, 12 inch long.

2.3.1 Length of Floor Deck Units

Provide floor deck units of sufficient length to span three or more spacings where possible.

2.3.2 Roof Deck

Conform to ASTM A792/A792M or ASTM A1008/A1008M for deck used in conjunction with insulation and built-up roofing. Fabricate roof deck units of the steel design thickness required by the design drawings and galvanized in conformance with ASTM A653/A653M, G90 coating class .

2.3.2.1 Cant Strips for Roof Decks

Fabricate cant strips from the specified commercial-quality steel sheets not less than nominal 0.0359 inch thick before galvanizing. Bend strips to form a 45-degree cant not less than 5 inch wide, with top and bottom flanges a minimum 3 inch wide. Length of strips 10 feet.

2.3.2.2 Ridge and Valley Plates for Roof Decks

Fabricate plates from the specified structural-quality steel sheets, not less than nominal 0.0359 inch thick before galvanizing. Provide plates of minimum 4-1/2 inch wide and bent to provide tight fitting closures at ridges and valleys. Provide a minimum length of ridge and valley plates of 10 feet.

2.3.2.3 Metal Closure Strips23for Roof Decks

Fabricate strips from the specified commercial-quality steel sheets not less than nominal 0.0359 inch thick before galvanizing. Provide strips

from the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

2.3.3 Composite Deck

Conform to ASTM A653/A653M or ASTM A1008/A1008M for composite deck assembly. Fabricate deck used as the tension reinforcing in composite deck using the steel design thickness required by the design drawings. Zinc-coat in conformance with ASTM A653/A653M, G90 coating class.

In addition to resisting shear, provide devices to resist vertical separation between the steel deck and the concrete. Provide one of the following types of shear devices:

a. Mechanically fixed shear devices such as embossments, holes, or welded buttons.

b. Mechanically or powder-actuated devices such as inverted, triangular or L-shaped ribs

PART 3 EXECUTION

3.1 EXAMINATION

Prior to installation of decking units and accessories, examine worksite to verify that as-built structure will permit installation of decking system without modification.

3.2 INSTALLATION

Install steel deck units in accordance with SDI DDMO3 and approved shop drawings. Place units on structural supports, properly adjusted, leveled, and aligned at right angles to supports before permanently securing in place. Damaged deck and accessories including material which is permanently stained or contaminated, deformed, or with burned holes shall not be installed. Extend deck units over three or more supports unless absolutely impractical. Report inaccuracies in alignment or leveling to the Contracting Officer and make necessary corrections before permanently anchoring deck units. Locate deck ends over supports only. Ends of floor deck may be lapped or butted. Do not use unanchored deck units as a work or storage platform. Do not fill unanchored deck with concrete. Permanently anchor units placed by the end of each working day. Do not support suspended ceilings, light fixtures, ducts, utilities, or other loads by steel deck unless indicated. Distribute loads by appropriate means to prevent damage. Prepare

3.2.1 Attachment

Immediately after placement and alignment, and after correcting inaccuracies, permanently fasten steel deck units to structural supports and to adjacent deck units by welding with normal5/8 inch diameter puddle welds or fastened with screws, powder-actuated fasteners, or pneumatically driven fasteners as indicated on the design drawings and in accordance with manufacturer's recommended procedure and SDI 31. Clamp or weight deck units to provide firm contact between deck units and structural supports while performing welding or fastening. Attachment of adjacent deck units by button-punching is prohibited.

3.2.1.1 Welding

Perform welding in accordance with AWS D1.3/D1.3M using methods and electrodes recommended by the manufacturers of the base metal alloys being used. Ensure only operators previously qualified by tests prescribed in AWS D1.1/D1.1M and AWS D1.3/D1.3M make welds. Immediately recertify, or replace qualified welders, that are producing unsatisfactory welding. Conform to the recommendations of the Steel Deck Institute and the steel deck manufacturerfor location, size, and spacing of fastening. use welding washers at the connections of the deck to supports, unless absolutely necessary. Do not use welding washers at sidelaps. Holes and similar defects will not be acceptable. Lap 2 inch deck ends. Attach all partial or segments of deck units to structural supports in accordance with Section 2.5 of SDI DDMO3. . Immediately clean welds by chipping and wire brushing. Heavily coat welds, cut edges and damaged portions of coated finish with zinc-dust paint conforming to ASTM A780/A780M.

3.2.1.2 Fastening

Anchor deck to structural supports and adjoining units with mechanical fasteners as listed by the Steel Deck Institute, ICC-ES, the fastener and steel deck manufacturers, and approved by the Contracting Officer. Drive the powder-actuated fasteners with a low-velocity piston tool by an operator authorized by the manufacturer of the powder-actuated tool. Drive pneumatically fasteners with a low-velocity fastening tool and comply with the manufacturer's recommendations.

3.2.1.3 Fastening Floor Deck Units

Fasten floor deck units to the steel supporting members at ends and at all intermediate supports, both parallel and perpendicular to deck span, by welds. Do not exceed spacing of welds of 12 inch on center, with a minimum of two welds per floor deck unit at each support. Provide 3/4 inch minimum diameter fusion welds. Coordinate welding sequence and procedure with the placing of the floor deck units. Blow holes shall be cause for rejection.

Lock sidelaps between adjacent floor deck units together at intervals not exceeding the lesser of 1/2 of the span or 48 inch on center by welding or button punching for all spans.

3.2.2 Openings

Cut or drill all holes and openings required and be coordinated with the drawings, specifications, and other trades. Frame and reinforce openings through the deck in conformance with SDI DDP. Reinforce holes and openings 6 to 12 inch across by 0.0474 inch thick steel sheet at least 12 inch wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 6 inch on center. Reinforce holes and openings larger than 12 inch by steel channels or angles installed perpendicular to the steel joists and supported by the adjacent steel joists. Install steel channels or angles perpendicular to the deck ribs and fasten to the channels or angles perpendicular to the steel joists.

3.2.3 Deck Damage

SDI MOC2, for repair of deck damage.

3.2.4 Accessory Installation

3.2.4.1 Adjusting Plates

Provide in locations too narrow to accommodate full-size deck units and install as shown on shop drawings.

3.2.4.2 End Closures

Provide end closure to close open ends of cells at columns, walls, and openings in deck.

3.2.4.3 Closures Above Partitions

Provide for closing voids between cells over partitions that are perpendicular to direction of cells. Provide a one-piece closure strip for partitions 4 inch nominal or less in thickness and two-piece closure strips for wider partitions. Provide sheet metal closures above fire-rated partitions at both sides of partition with space between filled with fiberglass insulation.

3.2.4.4 Column Closures

Provide for spaces between floor decking and columns which penetrate the deck. Field cut closure plate to fit column in the field and tack weld to decking and columns.

3.2.4.5 Access Hole Covers

Provide access whole covers to seal holes cut in decking to facilitate welding of the deck to structural supports.

3.2.4.6 Hangers

Provide as indicated to support utility system and suspended ceilings. Space devices so as to provide one device per 6.25 square feet.

3.2.5 Concrete Work

Prior to placement of concrete, inspect installed decking to ensure that there has been no permanent deflection or other damage to decking. Replace decking which has been damaged or permanently deflected as approved by the Contracting Officer. Place concrete on metal deck in accordance with Construction Practice of SDI 31.

3.2.6 Preparation of Fire-Proofed Surfaces

Provide deck surfaces, both composite and noncomposite, which are to receive sprayed-on fireproofing, galvanized and free of all grease, mill oil, paraffin, dirt, salt, and other contaminants which impair adhesion of the fireproofing. Complete any required cleaning prior to steel deck installation using a cleaning method that is compatible with the sprayed-on fireproofing.

3.3 ROOF SUMP PANS

Place sump pans over openings in roof decking and fusion welded to top surface of roof decking. Do not exceed spacing of welds of 12 inch with not less than one weld at each corner. Field cut opening in the bottom of each roof sump pan to receive the roof drain as part of the work of this section.

3.4 CANT STRIPS FOR ROOF DECKS

Provide strips to be fusion welded to surface of roof decking, secured to wood nailers by galvanized screws or to steel framing by galvanized self-tapping screws or welds. Do not exceed spacing of welds and fasteners of 12 inch. Lap end joints a minimum 3 inch and secure with galvanized sheet metal screws spaced a maximum 4 inch on center.

3.5 RIDGE AND VALLEY PLATES FOR ROOF DECKS

Provide plates to be fusion welded to top surface of roof decking. Lap end joints a minimum 3 inch. For valley plates, provide endlaps to be in the direction of water flow.

3.6 CLOSURE STRIPS FOR ROOF DECKS

Provide closure strips at open, uncovered ends and edges of the roof decking and in voids between roof decking and top of walls and partitions where indicated. Install closure strips in position in a manner to provide a weathertight installation.

3.7 ROOF INSULATION SUPPORT FOR ROOF DECKS

Provide metal closure strips for support of roof insulation where rib openings in top surface of metal roof decking occur adjacent to edges and openings. Weld metal closure strips in position.

3.8 CLEANING AND PROTECTION FOR ROOF DECKS

Upon completion of the deck, sweep surfaces clean and prepare for installation of the roofing.

3.9 FIELD QUALITY CONTROL

3.9.1 Decks Not Receiving Concrete

Inspect the decking top surface for distortion after installation. For roof decks not receiving concrete, verify distortion by placing a straight edge across three adjacent top flanges. The maximum allowable gap between the straight edge and the top flanges is 1/16 inch; when gap is more than 1/16 inch, provide corrective measures or replacement. Reinspect decking after performing corrective measures or replacement.

-- End of Section --

SECTION 05 40 00

COLD-FORMED METAL FRAMING
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2007; Supp 1: 2009; Supp 2: 2010) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI S200	(2007) North American Standard for Cold-Formed Steel Framing - General Provision
AISI S201	(2007) North American Standard for Cold-Formed Steel Framing - Product Data
AISI S202	(2011) Code of Standard Practice for Cold-formed Steel Structural Framing
AISI S211	(2007) North American Standard for Cold-Formed Steel Framing - Wall Stud Design
AISI S212	(2007) North American Standard for Cold-Formed Steel Framing - Header Design
AISI S213	(2007; Suppl 1 2009) North American Standard for Cold-Formed Steel Framing - Lateral Design
AISI SG02-KIT	(2001; Supp 1 2004) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2008; Errata 2008) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1003	(2012) Standard Specification for Steel

	Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members
ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A653	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C1007	(2011a) Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories
ASTM C1513	(2013) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM C955	(2011c) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases
ASTM E119	(2012a) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E329	(2013a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM F1941	(2010) Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw Threads (UN/UNR))
ASTM F1941M	(2007) Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Metric)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Framing Components; G

a. Cross sections, plans, and/or elevations showing component types and locations for each framing application; including shop coatings and material thicknesses for each framing component.

b. Connection details showing fastener type, quantity, location, and other information to assure proper installation.

c. Drawings depicting panel configuration, dimensions, components, locations, and construction sequence if the Contractor elects to install prefabricated/prefinished frames.

SD-03 Product Data

Steel studs, joists, tracks, bracing, bridging and accessories (LEED NC)

Submit manufacturer's product information, certification, and installation instructions for each type of cold-formed metal framing and accessory indicated. Include test reports and published allowable loads for all fasteners used.

Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

SD-05 Design Data

Metal framing calculations; G

Manufacturer's material certification or data from a independent testing agency that is qualified according to ASTM E 329 indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.

SD-07 Certificates

Welds

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.3/D1.3M.

Professional Engineer Qualifications

A professional engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced I providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this project in material, design and extent

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to job site and store in adequately ventilated, dry locations. Storage area shall permit easy access for inspection and handling. If necessary to store materials outside, stack off the ground, support on a level platform, and protect from the weather as approved. Handle materials to prevent damage. Finish of the framing members shall be maintained at all times, using an approved high zinc dust content, galvanizing repair paint whenever necessary to prevent the formation of rust. Replace damaged items with new, as directed by the Contracting Officer. Steel framing and related accessories shall be stored and handled in accordance with the AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

1.4 MAXIMUM DEFLECTION

a. Exterior Studs:

Deflection Criteria	Exterior Finish
L/240 or L/360	Metal Panels

Wall deflections shall be computed on the basis that studs withstand all lateral forces independent of any composite action from sheathing materials. Studs abutting windows or louvers shall also be designed not to exceed 1/4 inch maximum deflection.

1.5 QUALITY ASSURANCE

a. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified licensed professional engineer.

b. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this project in material, design, and extent.

c. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 for testing indicated.

d. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

e. Welding Qualifications: Qualify procedures and personnel according to

the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel".

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel".

f. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E119 by, and displaying a classification label from, a testing and inspecting agency acceptable to authorities having jurisdiction.

g. AISI Specifications and Standards: Comply with:

1. AISI S100, "North American Specification for the Design of Cold-Formed Steel Structural Members".

2. AISI S200, "North American Standard for Cold-Formed Steel Framing - General Provision".

3. AISI S201, "North American Standard for Cold-Formed Steel Framing - Product Data".

4. AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

5. AISI S211, "North American Standard for Cold-Formed Steel Framing - Wall Stud Design".

6. AISI S212, "North American Standard for Cold-Formed Steel Framing - Header Design".

7. AISI S213, "North American Standard for Cold-Formed Steel Framing - Lateral Design".

1.5.1 Drawing Requirements

Submit framing components to show sizes, thicknesses, layout, material designations, methods of installation, and accessories.

1.5.2 Design Data Required

Submit metal framing calculations to verify sizes, gages, and spacing of members and connections. Show methods and practices used in installation.

PART 2 PRODUCTS

2.1 STEEL STUDS, JOISTS, TRACKS, BRACING, BRIDGING AND ACCESSORIES

Framing components shall comply with ASTM C955 and the following.

a. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content not less than 20 percent. Refer to Section 01 33 29 LEED (TM) Documentation.

b. Steel Sheet: ASTM A1003, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: ST33H or (ST230H) ST50H (ST340H) as required by structural performance.

2. Coating: G60 (Z180) for interior applications andG90 (Z275) for unconditioned spaces applications, as required by structural performance or as indicated..

c. Steel Sheet for Drift Clips: ASTM A1003, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 50 (340) or as required by structural performance.

2. Coating: G90 (Z275).

d. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch.

2. Flange Width: 1-5/8 inches.

3. Section Properties: As required by structural performance.

e. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch and matching steel studs.

2. Flange Width: 1-1/4 inches.

f. Channel (U-Section): Standard U-section of size, shape, and thickness as required by structural performance or as indicated, with a flange width of 0.500 inches with no return flange lip.

2.1.1 Studs and Joists of 16 Gage (0.0538 Inch) and Heavier

Galvanized steel, ASTM A653 and ASTM A1003, SS Grade 50, G60 G90 .

2.1.2 Studs and Joists of 18 Gage (0.0478 Inch) and Lighter

Studs and Joists of 18 Gage (0.0428 Inch) and Lighter, Track, and Accessories (All Gages): Galvanized steel, ASTM A653 and ASTM A1003, SS, Grade 50 33,000 psi G60.

2.1.3 Sizes, Gages, Section Modulus, and Other Structural Properties

Size and gage as required by structural performance.

2.2 MARKINGS

Studs and track shall have product markings stamped on the web of the section. The markings shall be repeated throughout the length of the member at a maximum spacing of 4 feet on center and shall be legible and easily read. The product marking shall include the following:

a. An ICC number.

b. Manufacturer's identification.

c. Minimum delivered uncoated steel thickness.

d. Protective coating designator.

e. Minimum yield strength.

2.3 CONNECTIONS

Screws for steel-to-steel connections shall be self-drilling, tapping screws in compliance with ASTM C1513 of the type, size and location as shown on the drawings. Electroplated screws shall have a minimum 5 micron zinc coating in accordance with ASTM F1941. Screws, bolts, and anchors shall be hot-dipped galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M as appropriate. Screws bolts, and anchors shall be hot dipped galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M as appropriate.

2.4 PLASTIC GROMMETS

Supply plastic grommets, recommended by stud manufacturer, to protect electrical wires. Prevent metal to metal contact for plumbing pipes.

PART 3 EXECUTION

3.1 FASTENING

Fasten framing members together by welding or by using self-drilling or self-tapping screws. Electrodes and screw connections shall be as required by structural performance.

3.1.1 Welds

All welding shall be performed in accordance with AWS D1.3/D1.3M, as modified by AISI SG02-KIT. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3/D1.3M. All welds shall be cleaned and coated with rust inhibitive galvanizing paint. Do not field weld materials lighter than 18 gage.

3.1.2 Screws

Screws shall be self-drilling self-tapping of the type, size, and location required by structural performance. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacings and edge distances for screws shall be as specified in AISI SG02-KIT. Screws covered by sheathing materials shall have low profile heads.

3.1.3 Anchors

Anchors shall be of the type, size, and location required by structural performance.

3.1.4 Powder-Actuated Fasteners

Powder-actuated fasteners shall be of the type, size, and location determined by the manufacturer's delegated engineer.

3.2 INSTALLATION

Install cold-formed framing in accordance with ASTM C1007 and AISI S200.

Install cold-formed steel framing according to AISI S202 and to manufacturer's written instructions unless more stringent requirements are indicated.

3.2.1 Tracks

Provide accurately aligned runners at top and bottom of partitions. Anchor tracks as indicated in design calculations. Butt weld joints in tracks or splice with stud inserts. Fasteners shall be at least 3 inches from the edge of concrete slabs.

3.2.2 Studs

Cut studs square and set with firm bearing against webs of top and bottom tracks. Position studs vertically in tracks and space as indicated in design. Do not splice studs. Provide at least two studs at jambs of doors and other openings 2 feet wide or larger. Provide jack studs over openings, as necessary, to maintain indicated stud spacing. Provide tripled studs at corners, positioned to receive interior and exterior finishes. Fasten studs to top and bottom tracks by welding or screwing both flanges to the tracks. Framed wall openings shall include headers and supporting components as shown on the drawings. Headers shall be installed in all openings that are larger than the stud spacing in a wall. In curtain wall construction, provide for vertical movement where studs connect to the structural frame. Provide horizontal bracing in accordance with the design calculations and AISI SG03-3, consisting of, as a minimum, runner channel cut to fit between and welded to the studs or hot- or cold-rolled steel channels inserted through cutouts in web of each stud and secured to studs with welded clip angles. Bracing shall be not less than the following:

LOAD	HEIGHT	BRACING
Wind load only	Up to 10 feet	One row at mid-height
	Over 10 feet	Rows 5'-0" o.c. maximum
Axial load	Up to 10 feet	Two rows at 1/3 points
	Over 10 feet	Rows 3'-4" o.c. maximum

3.2.3 Joists

Locate each joist directly above a stud. Joists shall have at least 2.50 inches of bearing on steel, and shall be reinforced over bearings where required to prevent web crippling. Splice joists over bearings only. Lap and weld splices as indicated. Provide manufacturer's standard bridging which shall not be less than the following:

CLEAR SPAN	BRIDGING
Up to 14 feet	One row near center
14 to 20 feet	Two rows at 1/3 points
20 to 26 feet	Three rows at 1/4 points
26 to 32 feet	Four rows at 1/5 points

Temporary bracing shall be provided and remain in place until work is permanently stabilized.

3.2.4 Erection Tolerances

a. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:

(1) Layout of walls and partitions: 1/4 inch from intended position;

(2) Plates and runners: 1/4 inch in 8 feet from a straight line;

(3) Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and

(4) Face of framing members: 1/4 inch in 8 feet from a true plane.

-- End of Section --

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2010) Code of Standard Practice for Steel Buildings and Bridges

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(1998; R 2004) Voluntary Specification for Anodized Architectural Aluminum

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(2012) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2010) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.6.2	(1998; R 2010) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws: Inch Series
ASME B18.6.3	(2010) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A500/A500M	(2010a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A786/A786M	(2005; R 2009) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A924/A924M	(2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B108/B108M	(2012; E 2012) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B26/B26M	(2012) Standard Specification for Aluminum-Alloy Sand Castings
ASTM C1513	(2013) Standard Specification for Steel

	Tapping Screws for Cold-Formed Steel Framing Connections
ASTM D1187/D1187M	(1997; E 2011; R 2011) Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM E488/E488M	(2010) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(Oct 2009) Alkyd Anti-Corrosive Metal Primer

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2009) Metal Bar Grating Manual

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Embedded angles and plates, installation drawings; G

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.

Submit templates, erection and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

Pre-Engineered Aluminum Canopy

Pre-Engineered Aluminum Sunshade

Decorative Metal Gates

SD-03 Product Data

Access doors; G

LEED NC: Furnish documentation relative to each material credit in accordance with the LEED GBDC.

Teflon Separator

Pre-Engineered Aluminum Canopy

Pre-Engineered Aluminum Sunshade

1.4 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.5 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Structural Carbon Steel

ASTM A36/A36M.

2.1.2 Structural Tubing

ASTM A500/A500M.

2.1.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Standard malleable iron fittings ASTM A47/A47M.

2.1.5 Metal Bar Gratings

a. Gray cast iron ASTM A48/A48M, Class 40.

b. Metal plank grating, non-slip requirement, aluminum ASTM B209, 6061-T6; steel ASTM A653/A653M, G90.

c. Metal bar type grating NAAMM MBG 531.

2.1.6 Floor Plates, Patterned

Floor plate ASTM A786/A786M. Steel plate shall not be less than 14 gage.

2.1.7 Anchor Bolts

ASTM A307. Where exposed, shall be of the same material, color, and finish as the metal to which applied.

2.1.7.1 Expansion Anchors, Sleeve Anchors, and Adhesive Anchors

Provide 3/4-inch diameter expansion anchors, sleeve anchors, or adhesive anchors. Minimum concrete embedment shall be as indicated on the drawings. Design values listed shall be as tested according to ASTM E488/E488M.

a. Minimum allowable pullout value shall be 4,000 lb.

b. Minimum allowable shear value shall be 5,000 lb.

2.1.7.2 Lag Screws and Bolts

ASME B18.2.1, type and grade best suited for the purpose.

2.1.7.3 Toggle Bolts

ASME B18.2.1.

2.1.7.4 Bolts, Nuts, Studs and Rivets

ASME B18.2.2 or ASTM A307.

2.1.7.5 Screws

ASME B18.2.1, ASME B18.6.2, ASME B18.6.3 and ASTM C1513.

2.1.7.6 Washers

Provide plain washers to conform to ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers to conform to ASME B18.21.1.

2.1.8 Aluminum Alloy Products

Conform to ASTM B209 for sheet plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 1/8 inch thick and aluminum plate or sheet at least 0.050 inch thick.

2.1.9 Teflon Separator

Description: Virgin grade PTFE sheet material; fluorocarbon-based polymer, chemical resistant, self-lubricating; 0.093 inch (3/32-inch)minimum thickness.

Size: As required to suit applications indicated.

2.1.10 Metal Bar Gratings

Design gratings to withstand a live load of 250 pounds per square foot for the span indicated with a maximum deflection of L/240.

2.2 Pre-Engineered Aluminum Canopy

Basis of Design: Dittmer Architectural Aluminum

Materials:

Aluminum: All aluminum extrusions shall be alloy 6063 heat treated to a T-6 temper.
Sheet Cladding Thickness: Minimum 1/8-inch. Provide 1/8-inch diameter, stainless steel countersunk rivets on all cladding for fastening.

Aluminum Components:
- 6" corrugated aluminum deck.
- Gutter beams (both straight and curved).
- Perimeter beam tubes - exposed (both straight and curved).
- Aluminum beams with integral gutter.
- Cladding sheets.
- Unique reveal configuration - pre-fabricated aluminum C shape 1/2"x1", see drawings.
- Flashing members.
- Downspout large debris perforated screen.
- Aluminum columns wiht integral downspout.
- Clean out plate cover.
- Extruded bullnose sunshade edge profile.
- Aluminum structural beam members.
- Intermediate aluminum tube framing for support and to prevent oil-canning.

Break Metal Flashing:

Top of Canopy: 0.032-inch or 0.040-inch thick.
Concealed: Minimum 0.040-inch thick.

Fasteners:

Deck Screws: Type 18-8 non-magnetic stainless steel sealed with a neoprene "O" ring beneath 5/8" outside dimension, conical washer.
Fascia Rivets: Size 3/16" by 1/2" grip range aluminum rivets with aluminum mandrel.
Bolts: All bolts, nuts and washers to be 18-8 non-magnetic stainless steel.

Fabrication: Use sections true to details with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture, free from defects impairing strength and durability.

Profile: As indicated.
Expansion Joints: Provide expansion joints; design structure for thermal expansion and contraction as required.

Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.3 Pre-Engineered Aluminum Sunshade

Basis of Design: Dittmer Architectural Aluminum

Materials:

Aluminum: All aluminum extrusions shall be alloy 6063 heat treated to a T-6 temper.
Sheet Cladding Thickness: Minimum 1/8-inch. Provide 1/8-inch countersunk rivets on all cladding for fastening.
Break Metal Flashing: 0.040-inch thick.
Fasteners: Type 18-8 non-magnetic stainless steel.

Fabrication: Use sections true to details with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture, free from defects impairing strength and durability.

Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.4 Decorative Metal Gates

Basis of Design: Dittmer Architectural Aluminum

Materials:

Aluminum: All aluminum extrusions shall be alloy 6063 heat treated to a T-6 temper.
Gate Frame: Extruded aluminum; 2" x 4" framing..
Profile Blades: 4" L-shaped aluminum.
Main Gate: Provide with V-track wheel system.
Secondary Gate: Provide with hinges and locking pin.
Fasteners: Type 18-8 non-magnetic stainless steel.

Fabrication: Use sections true to details with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture, free from defects impairing strength and durability.

Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.5 FABRICATION FINISHES

2.5.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, G90, as applicable.

2.5.2 Galvanize

Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.5.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.5.4 Shop Cleaning and Painting

2.5.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which

become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete shall be free of dirt and grease. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints, but coat with rust preventative applied in the shop.

2.5.4.2 Pretreatment, Priming and Painting

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.

2.5.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.5.6 Aluminum Surfaces

2.5.6.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.5.6.2 Aluminum Finishes

Unexposed sheet, plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified, provide all other aluminum items with a standard mill finish or anodized finish as indicated. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF45. Provide a polished satin finish on items to be anodized.

2.6 ACCESS DOORS

Provide flush type access doors. Provide access doors hinged to frame and with a flush-face.

Fire-Rated Access Doors: UL approved.

Descripton: Fire rated, uninsulated.
Fire Rating: As required for installations indicated.
Hinge: Concealed, self-closing.
Latch: Self-latching; provide with inside latch release.
Lock: Cylinder lock; key to building system.
Door: Minimum 16 gauge steel; flanged on our sides; integral perforated taping bead; prime finished.
Frame: Minimum 16 gauge steel; unfinished.
Size: As indicated on the Drawings.

Access Doors:

Descripton: Non-fire-rated, uninsulated.
Hinge: Concealed.

Lock: Cylinder lock; key to building system.
Door: Minimum 20 gauge galvanized steel; flanged on four sides; integral perforated taping bead; prime finished.
Frame: Minimum 26 gauge galvanized steel; unfinished.
Size: As indicated on the Drawings.

2.7 MISCELLANEOUS PLATES AND SHAPES

Provide for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings and frames. Provide with connections and fasteners. Construct to have at least 8 inches bearing on masonry at each end.

Provide angles and plates, ASTM A36/A36M, for embedment as indicated. Galvanize embedded items exposed to the elements according to ASTM A123/A123M.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners shall be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Form joints exposed to the weather shall be formed to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

Provide miscellaneous metalwork that is well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Provide continuous welding along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections of work in place and ground smooth. Provide a smooth finish on exposed surfaces of work in place and unless otherwise approved, flush exposed riveting. Mill joints where tight fits are required. Corner joints shall be coped or mitered, well formed, and in true alignment. Accurately set work to established lines and elevations and securely fastened in place. Install in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening miscellaneous metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.4 BUILT-IN WORK

Form for anchorage metal work built-in with concrete or masonry, or provide with suitable anchoring devices as indicated or as required. Furnish metal work in ample time for securing in place as the work progresses.

3.5 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.6 FINISHES

3.6.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

3.6.2 Field Preparation

Remove rust preventive coating just prior to field erection, using a remover approved by the rust preventive manufacturer. Surfaces, when assembled, shall be free of rust, grease, dirt and other foreign matter.

3.6.3 Environmental Conditions

Do not clean or paint surface when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

3.7 ACCESS PANELS

Install a removable access panel not less than 12 by 12 inches directly below each valve, flow indicator, damper, or air splitter that is located above the ceiling, other than an acoustical ceiling, and that would otherwise not be accessible.

-- End of Section --

SECTION 05 51 00

METAL STAIRS
02/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2010) Specification for Structural Steel Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(2012) Square and Hex Bolts and Screws (Inch Series)
ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.6.1	(1981; R 2008) Wood Screws (Inch Series)
ASME B18.6.3	(2010) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2012a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A1011/A1011M	(2012b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability and Ultra-High Strength
ASTM A108	(2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc

	Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2012a) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A29/A29M	(2012) Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought General Requirements for
ASTM A307	(2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A500/A500M	(2010a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A512	(2006) Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A568/A568M	(2013) Standard Specifications for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A575	(1996; E 2013; R 2013) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A6/A6M	(2013) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2009) Metal Bar Grating Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2012; Amendment 1 2012) Life Safety Code

1.2 Sustainable Design Requirements

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Iron and Steel Hardware

Steel Shapes, Plates, Bars and Strips

Metal Stair Systems; G

Aluminum Stairs

SD-03 Product Data

Structural Steel Plates, Shapes, and Bars; (LEED NC)

Structural Steel Tubing; (LEED NC)

Hot-Rolled Carbon Steel Sheets and Strips; (LEED NC)

Cold Finished Steel Bars; (LEED NC)

Hot-Rolled Carbon Steel Bars; (LEED NC)

Cold-Rolled Carbon Steel Sheets; (LEED NC)

Galvanized Carbon Steel Sheets; (LEED NC)

Cold-Drawn Steel Tubing; (LEED NC)

Steel Pan Stairs; (LEED NC)

Steel Stairs; (LEED NC)

Aluminum Framed Stairs; (LEED NC)

SD-07 Certificates

Welding Procedures

Welder Qualification

SD-08 Manufacturer's Instructions

Structural Steel Plates, Shapes, and Bars

Structural Steel Tubing

Hot-Rolled Carbon Steel Sheets and Strips

Cold Finished Steel Bars

Hot-Rolled Carbon Steel Bars

Cold-Rolled Carbon Steel Sheets

Galvanized Carbon Steel Sheets

Cold-Drawn Steel Tubing

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.4 QUALIFICATIONS FOR WELDING WORK

Submit welding procedures in accordance with AWS D1.1/D1.1M. Make test specimens in the presence of the Contracting Officer and test by an approved testing laboratory at the Contractor's expense.

Certify welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, ensure that an immediate retest of two test welds and each test weld is made and passes. Failure in the immediate retest requires that the welder be retested after further practice or training and a complete set of test welds made.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

Submit complete and detailed fabrication drawings for all iron and steel hardware, and for all steel shapes, plates, bars and strips used in accordance with the design specifications referenced in this section.

Pre-assemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and application of surface finishes, including zinc coatings.

2.2 STRUCTURAL STEEL PLATES, SHAPES AND BARS

Structural-size shapes and plates, conforming to ASTM A36/A36M, unless otherwise noted, except bent or cold-formed plates.

Steel plates - bent or cold-formed, conforming to ASTM A283/A283M, Grade C.

Steel bars and bar-size shapes, conforming to ASTM A36/A36M, unless otherwise noted for steel bars and bar-size shapes.

2.3 STRUCTURAL STEEL TUBING

Structural steel tubing, hot-formed, welded or seamless, conforming to ASTM A500/A500M, Grade B, unless otherwise noted.

2.4 HOT-ROLLED CARBON STEEL BARS

Hot-rolled carbon steel bars and bar-size shapes, conforming to ASTM A575, grade as selected by the fabricator.

Hot-rolled carbon steel bars and bar-size shapes, conforming to ASTM A36/A36M, grade as selected by the fabricator.

2.5 COLD-FINISHED STEEL BARS

Cold-finished steel bars conforming to ASTM A108, grade as selected by the fabricator.

2.6 HOT-ROLLED CARBON STEEL SHEETS AND STRIPS

Hot-rolled carbon sheets and strips conforming to ASTM A568/A568M and ASTM A1011/A1011M, pickled and oiled.

2.7 COLD-ROLLED CARBON STEEL SHEETS

Cold-rolled carbon steel sheets conforming to ASTM A1008/A1008M.

2.8 GALVANIZED CARBON STEEL SHEETS

Galvanized carbon steel sheets conforming to ASTM A653/A653M, with galvanizing conforming to ASTM A653/A653M and ASTM A924/A924M.

2.9 COLD-DRAWN STEEL TUBING

Cold drawn steel tubing conforming to ASTM A512, sunk drawn, butt-welded, cold-finished, and stress-relieved.

2.10 STEEL PIPE

Steel pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

2.11 FASTENERS

Galvanized zinc-coated fasteners in accordance with ASTM A153/A153M and used for exterior applications or where built into exterior walls or floor systems. Select fasteners for the type, grade, and class required for the installation of steel stair items.

Standard/regular hexagon-head bolts and nuts be conforming to ASTM A307, Grade A.

Square-head lag bolts conforming to ASME B18.2.1.

Machine screws cadmium-plated steel conforming to ASME B18.6.3.

Wood screws, flat-head carbon steel conforming to ASME B18.6.1.

Plain washers, round, general-assembly-grade, carbon steel conforming to ASME B18.21.1.

Lockwashers helical spring, carbon steel conforming to.

2.12 GENERAL FABRICATION

Prepare and submit metal stair systems shop drawings with detailed plans and elevations at not less than 1 inch to 1 foot with details of sections and connections at not less than 3 inches to 1 foot. Also detail placement drawings, diagrams, templates for installation of anchorage, including but not limited to, anchor bolts, and miscellaneous metal items having integral anchorage devices.

Use materials of size and thicknesses indicated or, if not indicated, of required size and thickness to produce adequate strength and durability in finished product for intended use. Work materials to dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use type of materials indicated or specified for the various components of work.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32 inch, and bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Continuously weld corners and seams in accordance with the recommendations of AWS D1.1/D1.1M. Grind smooth exposed welds and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use Phillips flathead (countersunk) screws or bolts.

Provide and coordinate anchorage of the type indicated with the supporting structure. Fabricate anchoring devices, space as indicated and required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified as fabricated from cold-finished or cold-rolled stock.

2.13 STEEL PAN STAIRS

2.13.1 General

Use welding for joining pieces together. Fabricate units so that bolts and other fastenings do not appear on finish surfaces. Make joints true and tight, and connections between parts lightproof tight. Grid smooth continuous welds where exposed.

Construct metal stair units to sizes and arrangements indicated to support a minimum live load of 100 pounds per square foot. Provide framing, hangers, columns, struts, clips, brackets, bearing plates, and other components as required for the support of stairs and platforms.

2.13.2 Stair Framing

Steel Stairs: Fabricate stringers of structural steel channels, or plates, or a combination thereof as indicated. Provide closures for exposed ends of strings.

Construct platforms of structural steel channel headers and miscellaneous framing members as indicated. Bolt headers to stringers and newels and framing members to stringers and headers.

2.13.3 Riser, Subtread, And Subplatform Metal Pans

Form metal pans of 0.1084-inch (12-gage) thick structural steel sheets, conforming to ASTM A1011/A1011M, Grade 36. Shape pans to configuration indicated.

Construct riser and subtread metal pans with steel angle supporting brackets, of size indicated, welded to stringers. Secure metal pans to brackets with rivets or welds. Secure subplatform metal pans to platform frames with welds.

2.13.4 Steel Floor Plate Treads And Platforms

Provide raised pattern steel floor plate fabricated from steel complying with ASTM A36/A36M. Provide pattern as indicated or, if not indicated, as selected from manufacturer's standard patterns.

Form treads of 1/4-inch thick steel floor plate with integral nosing and back edge stiffener. Weld steel supporting brackets to strings and treads to brackets.

Provide nosing that match treads at landings. Secure floor plates to platform framing members with welds.

2.13.5 Floor Grating Treads And Platforms at Penthouse Only

Provide floor grating treads and platforms conforming to ASTM A6/A6M, ASTM A29/A29M and NAAMM MBG 531, "Metal Bar Grating Manual." Provide pattern, spacing, and bar sizes as indicated:

a. Galvanized finish conforming to ASTM A123/A123M.

Fabricate grating treads with steel plate nosing on one edge and with steel angle or steel plate carrier at each end for string connections. Secure treads to strings with bolts.

Fabricate grating platforms with nosing that matches on grating treads at landings. Provide toe-plates at open-sided edges of floor grating to platform framing members.

2.13.6 Grating Treads

NAAMM MBG 531 steel where indicated.

2.13.7 Steel Stairs

Provide steel stairs complete with stringers, steel pan tread concrete filled, steel pan landings concrete filled, columns, handrails,guardrails

and necessary bolts and other fastenings. Shop paint steel stairs and accessories.

2.13.7.1 Design Loads

Design stairs to sustain a live load of not less than 100 pounds per square foot, or a concentrated load of 300 applied where it is most critical. Conform to AISC 360 with the design and fabrication of steel stairs, other than a commercial product. Design fire stairs to conform to NFPA 101.

2.13.7.2 Materials

Provide steel stairs of welded construction except that bolts may be used where welding is not practicable. Screw or screw-type connections are not permitted.

a. Structural Steel: ASTM A36/A36M.

c. Support metal pan for concrete fill on angle cleats welded to stringers or treads with integral cleats, welded or bolted to the stringer. Close exposed ends.

e. Before fabrication, obtain necessary field measurements and verify drawing dimensions.

f. Clean metal surfaces free from mill scale, flake rust and rust pitting prior to shop finishing. Weld permanent connections. Finish welds flush and smooth on surfaces that will be exposed after installation.

2.13.8 Soffit Clips

Provide clips with holes for attaching metal furring for plastered soffits. Space clips not more than 12 inches on center and be welded to stair treads and platforms as required.

2.13.9 Steel and Aluminum Framing For Stairs

Customize fabricated units to the dimensions and details indicated, and modified as required to fit actual dimensions of the supporting structure. Use welded construction for fabrication of steel components. Provide 14-gage steel risers Unless otherwise indicated. Arrange components to receive finish materials as indicated.

2.14 ALUMINUM FRAMED STAIRS

2.14.1 General

Use welding for joining pieces together. Fabricate units so that bolts and other fastenings do not appear on finish surfaces. Make joints true and tight, and connections between parts lightproof tight. Grid smooth continuous welds where exposed.

Construct metal stair units to sizes and arrangements indicated to support a minimum live load of 100 pounds per square foot. Provide framing, hangers, columns, struts, clips, brackets, bearing plates, and other components as required for the support of stairs and platforms.

2.14.2 Stair Framing

Aluminum Stairs: Fabricate stringers of structural aluminum channels. Provide closures for exposed ends of strings.

Construct platforms of structural channel headers and miscellaneous framing members as indicated. Bolt headers to stringers and newels and framing members to stringers and headers.

2.14.3 Riser, Tread, And Platforms

Construct riser and treads of size indicated welded to stringers.

2.14.4 Grating Treads And Platforms

Provide raised pattern steel floor plate for treads and platforms. Provide pattern selected by the Contracting Officer's Representative from manufacturer's standard patterns.

Tread and Platform Type: Serrated.

2.14.5 Aluminum Stairs

Provide steel stairs complete with stringers, steel pan tread concrete filled, steel pan landings concrete filled, columns, handrails,guardrails and necessary bolts and other fastenings. Shop paint steel stairs and accessories.

2.14.5.1 Design Loads

Design stairs to sustain a live load of not less than 100 pounds per square foot, or a concentrated load of 300 applied where it is most critical. Conform to AISC 360 with the design and fabrication of steel stairs, other than a commercial product. Design fire stairs to conform to NFPA 101.

2.14.5.2 Materials

Provide aluminum stairs of welded construction except that bolts may be used where welding is not practicable. Screw or screw-type connections are not permitted.

f. Clean metal surfaces free from mill scale, flake rust and rust pitting prior to shop finishing. Weld permanent connections. Finish welds flush and smooth on surfaces that will be exposed after installation.

2.14.6 Soffit Clips

Provide clips with holes for attaching metal furring for plastered soffits. Space clips not more than 12 inches on center and be welded to stair treads and platforms as required.

2.14.7 Steel and Aluminum Framing For Stairs

Customize fabricated units to the dimensions and details indicated, and modified as required to fit actual dimensions of the supporting structure. Use welded construction for fabrication of steel components. Provide 14-gage steel risers Unless otherwise indicated. Arrange components to receive finish materials as indicated.

PART 3 EXECUTION

3.1 STEEL AND ALUMINUM STAIRS

Provide anchor bolts, grating fasteners, washers, and all parts or devices necessary for proper installation. Provide lock washers under nuts.

3.2 FIELD WELDING

Execute procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work in compliance with AWS D1.1/D1.1M.

3.3 TOUCHUP PAINTING

Immediately after installation, clean all field welds, bolted connections, and abraded areas of the shop painted material, and repaint exposed areas with the same paint used for shop painting. Apply paint by brush or spray to provide a minimum dry-film thickness of 2 mils.

-- End of Section --

SECTION 05 51 33

METAL LADDERS
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2008) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A500/A500M	(2010a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM A924/A924M	(2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B108/B108M	(2012; E 2012) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B26/B26M	(2012) Standard Specification for Aluminum-Alloy Sand Castings
ASTM D1187/D1187M	(1997; E 2011; R 2011) Asphalt-Base Emulsions for Use as Protective Coatings for Metal

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(Oct 2009) Alkyd Anti-Corrosive Metal Primer

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.27	Fixed Ladders

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Ladders, installation drawings; G
Ladder Cages; G

SD-03 Product Data

Ladders

Ladder Cages

1.4 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.5 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Structural Carbon Steel

ASTM A36/A36M.

2.1.2 Structural Tubing

ASTM A500/A500M.

2.1.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Standard malleable iron fittings ASTM A47/A47M.

2.1.5 Aluminum Alloy Products

Conform to ASTM B209 for sheet plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 1/8 inch thick and aluminum plate or sheet at least 0.050 inch thick.

2.2 FABRICATION FINISHES

2.2.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, G90, as applicable.

2.2.2 Galvanize

Anchor bolts, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.2.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from

welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.2.4 Shop Cleaning and Painting

2.2.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean.

2.2.4.2 Pretreatment, Priming and Painting

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions.

2.2.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.2.6 Aluminum Surfaces

2.2.6.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.2.6.2 Aluminum Finishes

Unexposed plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified, provide all other aluminum items with standard mill finish. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF45.

2.3 LADDERS

Fabricate vertical ladders conforming to Section 7 of 29 CFR 1910.27. Use 2 1/2 by 3/8 inch steel flats for stringers and 3/4 inch diameter steel rods for rungs. Rungs to be not less than 16 inches wide, spaced one foot apart, plug welded or shouldered and headed into stringers. Install ladders so that the distance from the rungs to the finished wall surface will not be less than 7 inches. Provide heavy clip angles riveted or bolted to the stringer and drilled for not less than two 1/2 inch diameter expansion bolts as indicated. Provide intermediate clip angles not over 48 inches on centers.

All exterior ladders shall be constructed of aluminum; clear anodized Class 1 finish.
Fabricate aluminum ladders 1'-10" wide, unless otherwise indicated; see

drawings for additional dimensions.

2.3.1 Ladder Cages

Conform to 29 CFR 1910.27. Fabricate 2 by 1/4 inchhorizontal bands and 1 1/2 by 3/16 inch vertical bars. Provide attachments for fastening bands to the side rails of ladders or directly to the structure. Provide and fasten vertical bars on the inside of the horizontal bands. Extend cages not less than 28 inches or more than 28 inches from the centerline of the rungs, excluding the flare at the bottom of the cage, and not less than 27 inches in width. Clear the inside of the cage of projections.

All exterior ladder cages shall be constructed of aluminum; clear anodized Class 1 finish.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Provide Exposed fastenings of compatible materials, generally matching in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners will be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports must provide strength and stiffness. Formed joints exposed to the weather to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

Metalwork must be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching must produce clean true lines and surfaces. Continuously weld along the entire area of contact. Do not tack weld exposed connections of work in place. Grid smooth exposed welds. Provide smooth finish on exposed surfaces of work in place, unless otherwise approved. Where tight fits are required, mill joints. Cope or miter corner joints, well formed, and in true alignment. Install in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion anchors,and powder-actuated fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine bolts, carriage bolts and powder-actuated threaded studs for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.4 WELDING

Perform welding, welding inspection, and corrective welding, in accordance

with AWS D1.1/D1.1M for steel and AWS D1.2/D1.2M for aluminum. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.5 FINISHES

3.5.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

3.5.2 Field Preparation

Remove rust preventive coating just prior to field erection, using a remover approved by the rust preventive manufacturer. Surfaces, when assembled, must be free of rust, grease, dirt and other foreign matter.

3.5.3 Environmental Conditions

Do not clean or paint surface when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

3.6 LADDERS

Secure to the adjacent construction with the clip angles attached to the stringer. Secure to precast with not less than two 1/2 inch diameter expansion bolts. Install intermediate clip angles not over 48 inches on center. Install brackets as required for securing of ladders welded or bolted to structural steel or built into the masonry or concrete. Ends of ladders must not rest upon finished roof.

Use aluminum anchoring and stainless steel bolts typical. Use Teflon or bituminous paint separator between aluminum and steel supports, if applicable.

-- End of Section --

SECTION 05 52 00

METAL RAILINGS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(1998; R 2004) Voluntary Specification for Anodized Architectural Aluminum

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A108	(2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A27/A27M	(2010) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A283/A283M	(2012a) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A512	(2006) Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A575	(1996; E 2013; R 2013) Standard

	Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B26/B26M	(2012) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B429/B429M	(2010; E 2012) Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 521	(2001) Pipe Railing Manual

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meetings

Within 30 days of Contract Award, submit fabrication drawings to the Contracting Officer for the following items:

a. Iron and Steel Hardware

b. Steel Shapes, Plates, Bars and Strips

c. Steel Railings and Handrails

d. Aluminum Railings and Handrails

e. Anchorage and fastening systems

Submit manufacturer's catalog data, including two copies of manufacturers specifications, load tables, dimension diagrams, and anchor details for the following items:

a. Structural steel plates, shapes, and bars

b. Cold finished steel bars

c. Hot-Rolled carbon steel bars

d. Cold-Drawn steel tubing

e. Concrete inserts

f. Protective coating

g. Steel railings and handrails

h. Aluminum railings and handrails

i. Anchorage and fastening systems

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G

Iron and Steel Hardware

Steel Shapes, Plates, Bars and Strips

SD-03 Product Data

Structural Steel Plates, Shapes, and Bars; (LEED NC)

Cold-Finished Steel Bars; (LEED NC)

Hot-Rolled Carbon Steel Bars: (LEED NC)

Cold-Drawn Steel Tubing; (LEED NC)

Concrete Inserts

Protective Coating

Steel Railings and Handrails; (LEED NC)

Aluminum Railings and Handrails; (LEED NC)

Anchorage and Fastening Systems

SD-07 Certificates

Welding Procedures

Welder Qualification

SD-08 Manufacturer's Instructions

Installation Instructions

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.5 QUALITY ASSURANCE

1.5.1 Welding Procedures

Submit welding procedures testing in accordance with AWS D1.1/D1.1M made in the presence of the Contracting Officer and by an approved testing laboratory at the Contractor's expense.

1.5.2 Welder Qualification

Submit certified welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. In addition be performed on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, make an immediate retest of two test welds and ensure each test weld passes. Failure in the immediate retest will require that the welder be retested after further practice or training and make a complete set of test welds.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide complete, detailed fabrication and installation drawings for all iron and steel hardware, and for all steel shapes, plates, bars and strips used in accordance with the design specifications referenced in this section.

Pre-assemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and application of surface finishes, including zinc coatings.

2.2 GENERAL FABRICATION

Provide railings and handrails detail plans and elevations at not less than 1 inch to 1 foot. Provide details of sections and connections at not less than 3 inches to 1 foot. Also detail setting drawings, diagrams, templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchors.

Use materials of size and thicknesses indicated or, if not indicated, of required size and thickness to produce adequate strength and durability in finished product for intended use. Work materials to dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use type of materials indicated or specified for the various components of work.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ensure all exposed edges are eased to a radius of approximately 1/32 inch. Bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Weld corners and seams continuously and in accordance with the recommendations of AWS D1.1/D1.1M. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use Phillips flathead (countersunk) screws or bolts.

Provide anchorage of the type indicated and coordinated with the supporting structure. Fabricate anchoring devices and space as indicated and as required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified to be fabricated from cold-finished or cold-rolled stock.

2.3 STRUCTURAL STEEL PLATES, SHAPES AND BARS

Provide structural-size shapes and plates, except plates to be bent or cold-formed, conforming to ASTM A36/A36M, unless otherwise noted.

Provide steel plates, to be bent or cold-formed,conforming to ASTM A283/A283M, Grade C.

Provide steel bars and bar-size shapes conforming to ASTM A36/A36M, unless otherwise noted.

2.4 HOT-ROLLED CARBON STEEL BARS

Provide bars and bar-size shapes conforming to ASTM A575, grade as selected by the fabricator.

2.5 COLD-FINISHED STEEL BARS

Provide cold-finished steel bars conforming to ASTM A108, grade as selected by the fabricator.

2.6 COLD-DRAWN STEEL TUBING

Provide tubing conforming to ASTM A512, sunk drawn, butt-welded, cold-finished, and stress-relieved.

2.7 STEEL PIPE

Provide pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

2.8 CONCRETE INSERTS

Provide threaded-type concrete inserts consisting of galvanized ferrous castings, internally threaded to receive 3/4-inch diameter machine bolts; either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M, hot-dip galvanized in accordance with ASTM A153/A153M.

Provide wedge-type concrete inserts consisting of galvanized box-type

ferrous castings designed to accept 3/4-inch diameter bolts having special wedge-shaped heads, made of either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M and hot-dip galvanized in accordance with ASTM A153/A153M.

Provide carbon steel bolts having special wedge-shaped heads, nuts, washers, and shims, galvanized in accordance with ASTM A153/A153M. Provide slotted-type concrete inserts consisting of galvanized 1/8-inchthick pressed steel plate conforming to ASTM A283/A283M, made of box-type welded construction with slot designed to receive 3/4-inch diameter square-head bolt with knockout cover; and hot-dip galvanized in accordance with ASTM A123/A123M.

2.9 FASTENERS

Provide galvanized zinc-coated fasteners in accordance with ASTM A153/A153M used for exterior applications or where built into exterior walls or floor systems. Select fasteners for the type, grade, and class required for the installation of steel stair items.

2.10 PROTECTIVE COATING

Provide hot dipped galvanized steelwork as indicated in accordance with ASTM A123/A123M. Touch up abraded surfaces and cut ends of galvanized members with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.

2.11 STEEL RAILINGS AND HANDRAILS

Design handrails to resist a concentrated load of 250 lbs in any direction at any point of the top of the rail or 20 lbs per foot applied horizontally to top of the rail, whichever is more severe. NAAMM AMP 521, provide the same size rail and post. Provide pipe collars of the same material and finish as the handrail and posts.

2.11.1 Steel Handrails

Provide steel handrails, including inserts in concrete, steel pipe conforming to ASTM A53/A53M . Provide steel railings of 1 1/2 inches nominal size, hot-dip galvanized and shop painted.

a. Fabrication: Joint posts, rail, and corners by one of the following methods:

   (1) Flush-type rail fittings of commercial standard, welded and ground smooth with railing splice locks secured with 3/8 inch hexagonal-recessed-head setscrews.

   (2) Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Butt railing splices and reinforce them by a tight fitting interior sleeve not less than 6 inches long.

   (3) Railings may be bent at corners in lieu of jointing, provided bends are made in suitable jigs and the pipe is not crushed.

b. Provide removable sections as indicated.

Provide kickplates between railing posts where indicated, and consist of 1/8-inch steel flat bars not less than 6 inches high. Secure kickplates as indicated.

Provide galvanized exterior and interior railings where indicated, including pipe, fittings, brackets, fasteners, and other ferrous metal components.

2.12 ALUMINUM RAILINGS AND HANDRAILS

Provide railings and handrails consisting of 1 1/2 inch nominal schedule 40 pipe ASTM B429/B429M, 1 3/4 inch square aluminum semi-hollow tube with rounded corners ASTM B221. Provide clear anodized aluminum railings. Ensure all fasteners are Series 300 stainless steel.

a. Fabrication: Provide jointing by one of the following methods:

(1) Flush-type rail fittings, welded and ground smooth with splice locks secured with 3/8 inch recessed head set screws.

(2) Ensure all mitered and welded joints made by fitting post to top rail, intermediate rail to post, and corners, are groove welded and ground smooth. Provide butted splices, where allowed by the Contracting Officer, reinforced by a tight fitting dowel or sleeve not less than 6 inches in length. Tack weld or epoxy cement dowel or sleeve to one side of the splice.

(3) Assemble railings using slip-on aluminum-magnesium alloy fittings for joints. Fasten fittings to pipe or tube with 1/4 or 3/8 inch stainless steel recessed head setscrews. Provide assembled railings with fittings only at vertical supports or at rail terminations attached to walls. Provide expansion joints at the midpoint of panels. Provide a setscrew in only one side of the slip-on sleeve. Provide alloy fittings to conform to ASTM B26/B26M.

b. Finish: Clear Anodic Finish: AAMA 611, AA-M12C22A41.

PART 3 EXECUTION

3.1 INSTALLATION INSTRUCTIONS

Submit manufacturer's installation instructions for the following products to be used in the fabrication of railings:

a. Structural steel plates, shapes, and bars

c. Cold finished steel bars

d. Hot-Rolled carbon steel bars

e. Cold-Drawn steel tubing

f. Protective coating

h. Steel railings and handrails

i. Aluminum railings and handrails

j. Anchorage and fastening systems

Provide complete, detailed fabrication and installation drawings for all iron and steel hardware, and for all steel shapes, plates, bars and strips used in accordance with the design specifications referenced in this section.

3.2 PREPARATION

Adjust stair railings and handrails prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 8 feet on center. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

Anchor posts in concrete by means of pipe sleeves set and anchored into concrete. Provide sleeves of galvanized, standard weight, steel pipe, not less than 6 inches long, and having an inside diameter not less than 1/2-inch greater than the outside diameter of the inserted pipe post. Provide steel plate closure secured to the bottom of the sleeve, with closure width and length not less than 1-inch greater than the outside diameter of the sleeve. After posts have been inserted into sleeves, fill the annular space between post and sleeve with molten lead, sulfur, or a quick-setting hydraulic cement. Cover anchorage joint with a round steel flange welded to the post.

Anchor posts to steel with steel oval flanges, angle type or floor type as required by conditions, welded to posts and bolted to the steel supporting members.

Anchor rail ends into concrete with steel round flanges welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.

Anchor rail ends to steel with steel oval or round flanges welded to tail ends and bolted to the structural steel members.

Secure handrails to walls by means of wall brackets and wall return fitting at handrail ends. Provide brackets of malleable iron castings, with not less than 3-inch projection from the finish wall surface to the center of the pipe drilled to receive one 3/8-inch bolt. Locate brackets not more than 60 inches on center. Provide wall return fittings of cast iron castings, flush-type, with the same projection as that specified for wall brackets. Secure wall brackets and wall return fittings to building construction as follows:

For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.

For stud partition anchorage, use toggle bolts having square heads.

Install toe boards and brackets where indicated. Make splices, where required, at expansion joints. Install removable sections as indicated.

3.3 STEEL HANDRAIL

Install railings as indicated.

3.4 ALUMINUM HANDRAIL

Affix to base structure by . Provide Series 300 stainless steel bolts to anchor aluminum alloy flanges, of a size appropriate to the standard product of the manufacturer. Where aluminum or alloy fittings or extrusions are to be in contact with dissimilar metals or concrete, coat the contact surface a heavy coating of bituminous paint.

3.5 FIELD WELDING

Ensure procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work comply with AWS D1.1/D1.1M.

3.6 TOUCHUP PAINTING

Immediately after installation, clean field welds, bolted connections, abraded areas of the shop paint, and exposed areas painted with the paint used for shop painting. Apply paint by brush or spray to provide a minimum dry-film thickness of 2 mils.

-- End of Section --

SECTION 05 72 00

DECORATIVE METAL SPECIALTIES
02/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2010) Aluminum Design Manual
AA ASM-35	(2000) Specifications for Aluminum Sheet Metal Work in Building Construction, Construction Manual Series Section 5
AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes
AA PK-1	(2009) Pink Sheets: Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings & Ingot

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2008) Structural Welding Code - Aluminum

ASME INTERNATIONAL (ASME)

ASME B18.24	(2004; Addenda A 2006; R 2011) Part Identifying Number (PIN) Code System Standard for B18 Fastener Products

ASTM INTERNATIONAL (ASTM)

ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B211	(2012) Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B316/B316M	(2010) Standard Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods

ASTM D1730	(2009) Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting
ASTM G71	(1981; R 2009) Standard Guide for Conducting and Evaluating Galvanic Corrosion Tests in Electrolytes
ASTM G82	(1998; R 2009) Standard Guide for Development and Use of a Galvanic Series for Predicting Galvanic Corrosion Performance

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

CS 23.00/AWS C2.23M/NACE #12	(2003) Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel
SSPC PS 11.01	(1982; E 2004) Black (or Dark Red) Coal Tar Epoxy Polyamide Painting System

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Stainless Steel Plate

Installation Drawings; G

Shop and Field Connections

Construction Details

SD-03 Product Data

Stainless Steel Plate; (LEED NC); G

Metals for Fabrication; (LEED NC)

Maintenance Instructions

SD-04 Samples

Manufacturer's Standard Finish Charts
Aluminum Finishes
Anchorage Devices and Fasteners
Architectural Metal Items

SD-08 Manufacturer's Instructions

Cleaning Materials

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.4 DELIVERY, STORAGE, AND HANDLING

Store all Architectural metal items off the ground on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer.

Keep materials free from dirt and grease and protected from corrosion.

Store packaged materials in their original, unbroken containers in a dry area, until ready for installation.

1.5 FIELD MEASUREMENTS

Records of Existing Conditions may be provided by the Contracting Officer prior to the start of work. Submit survey data showing Existing Conditions prior to preparation of shop drawings and fabrication.

PART 2 PRODUCTS

2.1 STAINLESS STEEL PLATE

Material: Type 304 stainless steel; #4 finish; refer to Finish Legend for grain direction.

2.2 METALS FOR FABRICATION

2.2.1 Aluminum-Alloy Extrusions

Provide aluminum fabrications conforming to AA ADM, AA ASM-35, and AA PK-1.

Provide 6063, temper T5 extrusions conforming to ASTM B221 ASTM B221M.

Provide aluminum-alloy and tempered extrusions recommended by the aluminum producer with the specified finish of integral-color anodized coating having mechanical properties equal to, or exceeding, those of aluminum alloy 6063, temper T5, conforming to ASTM B221 ASTM B221M.

2.2.2 Aluminum-Alloy Sheets and Plates

Provide aluminum-alloy and tempered sheets and plates recommended by the aluminum producer with the specified finish of integral-color anodized coating having mechanical properties equal to, or exceeding, those of alloy 5005, temper H16, conforming to ASTM B209.

2.2.3 Metals for Fasteners

Provide fastener identification conforming to ASME B18.24.

Provide aluminum-alloy bolts and screws made from rod conforming to ASTM B211, alloy 2024 and temper T351.

Provide aluminum-alloy nuts made from rod conforming to ASTM B211, alloy 6061 and temper T6.

Provide aluminum-alloy washers made from sheet conforming to ASTM B209, alloy 2024 and temper T4.

Provide aluminum-alloy rivets made from rod or wire conforming to ASTM B316/B316M, alloy 6053 and temper T61.

Provide corrosion-resistant steel fasteners made of chromium-nickel steel, AISI Type 302, 303, 304, 305, or 316, with form and condition best suited for the application.

2.2.4 Shop Paint for Aluminum

Provide shop paint with an inhibitive epoxy polyamide primer conforming to SSPC PS 11.01, CS 23.00/AWS C2.23M/NACE #12, ASTM G71 and ASTM G82.

2.3 FABRICATION IN GENERAL

Submit Manufacturer's Standard Finish Charts

Submit Installation Drawings, Shop and Field Connections and Construction Details showing location, dimensions, size, and weight or gauge as applicable of each ornamental item; type and location of shop and field connections; and other pertinent construction and erection details. Show on drawings location and details of anchorage devices embedded in cast-in-place concrete and masonry construction.

2.3.1 Workmanship

Fabricate metalwork to the shape and size, with lines, angles, and curves true to form. Provide necessary rabbets, lugs, and brackets so that the work can be assembled. Conceal fasteners where practical.

Design exterior ornamental metal items to withstand expansion and contraction of the component parts at an ambient temperature of100 degrees F without causing harmful buckling, opening of joints, overstressing of fasteners, or other harmful effects.

Welded fabrication to meet requirements as specified in AWS D1.2/D1.2M. Execute all welds behind finished surfaces without distortion or discoloration of the exposed side. Clean flux from welded joints and dress all exposed and contact surfaces.

Drill or punch holes for fasteners.

Mill all joints to a close fit. Cope or miter corner joints to a, well formed shape, and true alignment with the adjacent item. Fabricate and form joints exposed to weather to prevent water intrusion.

Ensure all castings are sound and free from warp or defects that impair

their strength and appearance, with a smooth finish and sharp well-defined vertical and horizontal lines on all exposed surfaces.

2.3.2 Holes for Other Work

Provide holes where indicated for securing other work to metal work.

2.3.3 Protection of Aluminum from Dissimilar Materials

Protect aluminum surfaces that will come in contact with dissimilar metals, or masonry, concrete, or wood, with epoxy polyamide conforming to SSPC PS 11.01, and topcoated with aliphatic polyurethane conforming to ASTM G71 and ASTM G82

Prepare aluminum surfaces to be painted by the acid pickling method conforming to ASTM D1730, Type B, Method 2 or Method 3.

Apply paint to dry, clean surfaces by brush or spraying to provide a minimum dry-film thickness of 1.5 mils.

2.3.4 Aluminum Finishes

Submit samples for Aluminum Finishes, one for each type used in the project. Provide samples of standard size as used in construction. After approval, full-sized samples may be used in construction, provided each sample is clearly identified and its location recorded.

Provide a finish for exposed-to-view aluminum surfaces of architectural metal items conforming to AA DAF45 and finished as specified for each of the following items:

k. Match finish color and appearance to that of the aluminum finish sample approved for each Architectural metal item within the aluminum producer's standard color range.

2.3.4.1 Preventative Maintenance and Inspection

Perform all Preventative Maintenance and Inspection in accordance with the aluminum producer's recommended Cleaning Materials and Application Methods including precautions in the use of cleaning materials that maybe detrimental to the aluminum finish when improperly applied.

PART 3 EXECUTION

3.1 GENERAL PROVISIONS

Install decorative metal work in accordance with the approved shop drawings and descriptive data for each ornamental metal item, as specified.

Securely fasten decorative metal items plumb and true to horizontal and vertical lines and levels.

3.2 ANCHORAGE DEVICES EMBEDDED IN OTHER CONSTRUCTION

Deliver anchorage devices, such as concrete inserts, anchor bolts, and ornamental metal items having integral anchors that are to be embedded in cast-in-place concrete and masonry construction, to the project site in time for installation before the start of cast-in-place concrete operations and masonry work. Provide setting drawings, templates,

instructions, and directions for the installation of the anchorage items.

3.3 FASTENING TO CONSTRUCTION-IN-PLACE

Submit samples for each type of Anchorage Devices and Fasteners.

Provide Anchorage devices and fasteners where necessary for fastening ornamental metal items to construction-in-place. Include threaded fasteners for concrete inserts embedded in cast-in-place concrete; masonry anchorage devices and threaded fasteners for solid masonry and concrete-in-place; toggle bolts for hollow masonry and stud partitions; through bolting for masonry and wood construction; lag bolts and wood screws for wood construction; and threaded fasteners for structural steel. Provide fastening as indicated and as specified. Fastening to wood plugs in masonry or concrete-in-place is not permitted.

3.4 CUTTING AND FITTING

Perform required cutting, drilling, and fitting for the installation of ornamental metal work. Execute cutting, drilling, and fitting carefully; when required, fit in place work before fastening.

3.5 SETTING MASONRY ANCHORAGE DEVICES

Set all masonry anchorage devices in masonry or concrete-in-place construction in accordance with the anchorage device manufacturer's printed instructions. Drill anchorage holes to the recommended depth, diameter, and size recommended by the manufacturer of the particular anchorage device used. Leave drilled anchorage holes rough, not reamed, and free of drill dust.

3.6 WELDING PROCEDURES

Ensure procedures for welding, appearance, quality of welds made, and the methods used in correcting welding work conform to AWS D1.2/D1.2M.

Ground all exposed welds smooth.

3.7 THREADED CONNECTIONS

Countersink and provide flat bolt and screw heads where anchors are exposed to view, and tightly secure threaded connections so that the threads are entirely concealed by fitting, unless otherwise specified.

3.8 CLEANING

Before final acceptance, wash exposed-to-view aluminum surfaces with clean water and soap and rinse with clean water. Do not use acid solutions, steel wool, or other harsh abrasives. Remove stains that remain after cleaning or restore the finish in accordance with the aluminum producer's recommendations.

3.9 INSPECTION AND ACCEPTANCE PROVISIONS

3.9.1 Finished Ornamental Metal Work Requirements

Ornamental metal work will be rejected for any of the following deficiencies:

a. Finish of exposed-to-view aluminum surfaces having color and appearance that are outside the color and appearance range of the approved samples for aluminum finish.

b. Installed ornamental metal items having stained, discolored, abraded, or otherwise damaged exposed-to-view aluminum surfaces that cannot be removed by cleaning or repairing.

c. Installed ornamental metal items that do not match the approved sample.

d. Aluminum surfaces in contact with dissimilar materials that are not protected as specified.

3.9.2 Repair of Defective Work

Remove and/or replace defective work with ornamental metal materials that meet the requirements of this section.

3.10 MAINTENANCE INSTRUCTIONS

Submit maintenance instructions as follows:

Aluminum producer's recommended cleaning materials and application methods including precautions in the use of cleaning materials that may be detrimental to the aluminum finish when improperly applied.

-- End of Section --

SECTION 06 10 00

ROUGH CARPENTRY
02/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN FOREST & PAPER ASSOCIATION (AF&PA)

AF&PA T10	(2001) Wood Frame Construction Manual for One- and Two-Family Dwellings
AF&PA T101	(2005) National Design Specification (NDS) for Wood Construction

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

ALSC PS 20	(2010) American Softwood Lumber Standard

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M2	(2011) Standard for Inspection of Treated Wood Products
AWPA M6	(2013) Brands Used on Preservative Treated Materials

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(2012) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2010) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.5.2.1M	(2006; R 2011) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2010) Metric Round Head Square Neck Bolts
ASME B18.6.1	(1981; R 2008) Wood Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2009) Standard Specification for Zinc

	Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM D2898	(2010) Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM F1667	(2011a; E 2012) Driven Fasteners: Nails, Spikes, and Staples
ASTM F547	(2006; R 2012) Nails for Use with Wood and Wood-Base Materials

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2012) International Building Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1923	(Rev A; Notice 2) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-1924	(Rev A; Notice 2) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors
CID A-A-1925	(Rev A; Notice 2) Shield Expansion (Nail Anchors)

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fire-retardant treatment

SD-03 Product Data

Lumber; (LEED NC)
Plywood; (LEED NC)
Adhesives; (LEED NC)

SD-06 Test Reports

Preservative-treated lumber and plywood

SD-07 Certificates

Preservative treatment
Certified Wood

SD-10 Operation and Maintenance Data

Include contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

SD-11 Closeout Submittals

Recycled Content
Certified Wood
Low Emitting Materials - Adhesives and Sealants

1.4 DELIVERY AND STORAGE

Deliver materials to the site in an undamaged condition. Store, protect, handle, and install prefabricated structural elements in accordance with manufacturer's instructions and as specified. Store materials off the ground to provide proper ventilation, with drainage to avoid standing water, and protection against ground moisture and dampness. Store materials with a moisture barrier at both the ground level and as a cover forming a well ventilated enclosure. Adhere to requirements for stacking, lifting, bracing, cutting, notching, and special fastening requirements. Remove defective and damaged materials and provide new materials. Store separated reusable wood waste convenient to cutting station and area of work.

1.5 GRADING AND MARKING

1.5.1 Lumber

Mark each piece of framing and board lumber or each bundle of small pieces of lumber with the grade mark of a recognized association or independent inspection agency. Such association or agency shall be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Surfaces that are to be exposed to view shall not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

1.5.2 Plywood

Mark each sheet with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. The mark shall identify the plywood by species group or span rating, exposure durability classification, grade, and compliance with APA L870.Surfaces that are to be exposed to view shall not bear grademarks or other types of identifying marks.

1.5.3 Preservative-Treated Lumber and Plywood

The Contractor shall be responsible for the quality of treated wood products. Each treated piece shall be inspected in accordance with AWPA M2 and permanently marked or branded, by the producer, in accordance with AWPA M6. The Contractor shall provide Contracting Officer's Representative (COR) with the inspection report of an approved independent inspection agency that offered products comply with applicable AWPA Standards. The appropriate Quality Mark on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.5.4 Fire-Retardant Treated Lumber

Mark each piece in accordance with AWPA M6, except pieces that are to be natural or transparent finished. In addition, exterior fire-retardant lumber shall be distinguished by a permanent penetrating blue stain. Labels of a nationally recognized independent testing agency will be accepted as evidence of conformance to the fire-retardant requirements of AWPA M6.

1.6 SIZES AND SURFACING

ALSC PS 20 for dressed sizes of yard and structural lumber. Lumber shall be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced. Other measurements are IP or SI standard.

1.7 MOISTURE CONTENT

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products shall be as follows at the time of delivery to the job site:

a. Framing lumber and board, 19 percent maximum

b. Materials other than lumber; moisture content shall be in accordance with standard under which the product is produced

1.8 PRESERVATIVE TREATMENT

Treatment:

a. 0.25 pcf intended for above ground use.

b. 0.40 pcf intended for ground contact and fresh water use. 0.60 pcf intended for Ammoniacal Copper Quaternary Compound (ACQ)-treated foundations. 0.80 to 1.00 pcf intended for ACQ-treated pilings. All wood shall be air or kiln dried after treatment. Specific treatments shall be verified by the report of an approved independent inspection agency, or the AWPA Quality Mark on each piece. Brush coat areas that are cut or drilled after treatment with either the same preservative used in the treatment or with a 2 percent copper naphthenate solution. All lumber and woodwork shall be preservative treated. Plastic lumber shall not be preservative treated. The following items shall be preservative treated:

1. Wood framing, woodwork, and plywood up to and including the

subflooring at the first-floor level of structures having crawl spaces when the bottoms of such items are 24 inches or less from the earth underneath.

2. Wood members that are in contact with water.

3. Wood sills, soles, plates, furring, and sleepers that are less than 24 inches from the ground, furring and nailers that are set into or in contact with concrete or masonry.

4. Nailers, edge strips, crickets, curbs, and cants for roof decks.

1.9 FIRE-RETARDANT TREATMENT

Fire-retardant treated wood shall be pressure treated Treatment and performance inspection shall be by an independent and qualified testing agency that establishes performance ratings. Each piece or bundle of treated material shall bear identification of the testing agency to indicate performance in accordance with such rating. Treated materials to be exposed to rain wetting shall be subjected to an accelerated weathering technique in accordance with ASTM D2898 prior to being tested. Such items which will not be inside a building, and such items which will be exposed to heat or high humidity, shall receive exterior fire-retardant treatment. Fire-retardant-treated wood products shall be free of halogens, sulfates, ammonium phosphate, and formaldehyde. Items to be treated include the following:

a. Plywood panels in electrical and communications rooms.
b. Other areas noted.
c. All interior wood blocking.

1.10 SUSTAINABLE DESIGN REQUIREMENTS

1.10.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Wood and materials may be locally available.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Lumber

Certified Wood: Refer to Section 01 33 29 LEED DOCUMENTATION.

2.1.2 Miscellaneous Wood Members

2.1.2.1 Blocking

Interior Applications Only: Blocking shall be standard or number 2 grade and fire retardant.

Metal Blocking: 16ga galvanized metal blocking typical for all exterior applications.

2.1.3 Adhesives

Comply with applicable regulations regarding toxic and hazardous materials and as specified. Interior adhesives, sealants, primers and sealants used as filler must meet the requirements of LEED low emitting materials credit.

2.2 ROUGH HARDWARE

Unless otherwise indicated or specified, rough hardware shall be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials shall be as recommended by the product manufacturer unless otherwise indicated or specified. See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Fasteners may contain post-consumer or post-industrial recycled content. Rough hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs shall be hot-dip zinc-coated in accordance with ASTM A153/A153M. Nails and fastenings for fire-retardant treated lumber and woodwork exposed to the weather shall be copper alloy or hot-dipped galvanized fasteners as recommended by the treated wood manufacturer.

2.2.1 Bolts, Nuts, Studs, and Rivets

ASME B18.2.1, ASME B18.5.2.1M, ASME B18.5.2.2M and ASME B18.2.2.

2.2.2 Anchor Bolts

ASTM A307, size as indicated, complete with nuts and washers.

2.2.3 Expansion Shields

CID A-A-1923, CID A-A-1924, and CID A-A-1925. Except as shown otherwise, maximum size of devices shall be 3/8 inch.

2.2.4 Wood Screws

ASME B18.6.1.

2.2.5 Nails

ASTM F547, size and type best suited for purpose. For sheathing and subflooring, length of nails shall be sufficient to extend 1 inch into supports. In general, 8-penny or larger nails shall be used for nailing through 1 inch thick lumber and for toe nailing 2 inch thick lumber; 16-penny or larger nails shall be used for nailing through 2 inch thick lumber. Nails used with treated lumber and sheathing shall be hot-dipped galvanized in accordance with ASTM A153/A153M. Nailing shall be in accordance with the recommended nailing schedule contained in AF&PA T10. Where detailed nailing requirements are not specified, nail size and spacing shall be sufficient to develop an adequate strength for the connection. The connection's strength shall be verified against the nail capacity tables in AF&PA T101. Reasonable judgment backed by experience shall ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector shall be used.

2.2.6 Wire Nails

ASTM F1667.

2.2.7 Clip Angles

Steel, 3/16 inch thick, size best suited for intended use; or zinc-coated steel or iron commercial clips designed for connecting wood members.

PART 3 EXECUTION

3.1 INSTALLATION

Conform to AF&PA T10 unless otherwise indicated or specified. Select lumber sizes to minimize waste. Fit framing lumber and other rough carpentry, set accurately to the required lines and levels, and secure in place in a rigid manner. Do not splice framing members between bearing points. Set joists, rafters, and purlins with their crown edge up. Frame members for the passage of pipes, conduits, and ducts. Do not cut or bore structural members for the passage of ducts or pipes without approval. Reinforce all members damaged by such cutting or boring by means of specially formed and approved sheet metal or bar steel shapes, or remove and provide new, as approved. Provide as necessary for the proper completion of the work all framing members not indicated or specified. Spiking and nailing not indicated or specified otherwise shall be in accordance with the Nailing Schedule contained in ICC IBC; perform bolting in an approved manner. Spikes, nails, and bolts shall be drawn up tight. Use slate or steel shims when leveling joists, beams, and girders on masonry or concrete. Do not use shimming on wood or metal bearings. When joists, beams, and girders are placed on masonry or concrete, a wood base plate shall be positioned and leveled with grout. The joist, beam, or girder shall then be placed on the plate. When joists, beams, and girders are set into masonry or concrete, a pocket shall be formed into the wall. The joist, beam, or girder shall then be placed into the pocket and leveled with a steel shim.

3.2 MISCELLANEOUS

3.2.1 Wood Roof Nailers, Edge Strips, Crickets, Curbs, and Cants

Provide sizes and configurations indicated or specified and anchored securely to continuous construction.

3.2.2 Interior Wood Blocking

Provide metal blocking unless noted otherwise. Where indicated provide proper sizes and shapes at proper locations for the installation and attachment of wood and other finish materials, fixtures, equipment, and items indicated or specified.

3.2.3 Temporary Closures

Provide with hinged doors and padlocks and install during construction at exterior doorways and other ground level openings that are not otherwise closed. Cover windows and other unprotected openings with polyethylene or other approved material, stretched on wood frames. Provide dustproof barrier partitions to isolate areas as directed.

3.2.4 Temporary Centering, Bracing, and Shoring

Provide for the support and protection of masonry work during construction as specified in Section 04 20 00. Forms and centering for cast-in-place concrete work are specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3 WASTE MANAGEMENT

In accordance with the Waste Management Plan refer to Section 01 74 19. Separate and reuse scrap sheet materials larger than 2 square feet , framing members larger than 16 inches , and multiple offcuts of any size larger than 12 inches . Clearly separate damaged wood and other scrap lumber for acceptable alternative uses on site, including bracing, blocking, cripples, ties, and shims.

Separate composite wood from other wood types and recycle or reuse. Coordinate with manufacturer for take-back program and submit manufacturer's policy statement on program. Set aside scrap and return to manufacturer for recycling into new product. When such a service is not available, local recyclers shall be sought after to reclaim the materials. Fold up metal banding, flatten, and recycle.

Separate treated, stained, painted, and contaminated wood and place in designated area for hazardous materials. Dispose of according to local regulations. Do not leave any wood, shavings, sawdust, or other wood waste buried in fill or on the ground. Prevent sawdust and wood shavings from entering the storm drainage system. Compost sawdust. Do not burn scrap lumber that has been pressure treated, or lumber that is less than one year old.

-- End of Section --

SECTION 06 20 00

FINISH CARPENTRY
02/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI AWS	(2009) Architectural Woodwork Standards

ASME INTERNATIONAL (ASME)

ASME B18.6.1	(1981; R 2008) Wood Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM F547	(2006; R 2012) Nails for Use with Wood and Wood-Base Materials

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules	(2013) Standard Grading Rules for Northeastern Lumber

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003	(2002) Standard Grading Rules for Southern Pine Lumber

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17	(2004) Standard Grading Rules

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5	(2011) Western Lumber Grading Rules

1.2 SUTAINABLE DESIGN REQUIREMENTS

See Section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G; G

SD-03 Product Data

Wood; (LEED NC)

SD-04 Samples

Chair rails; G
Wood Veneer Faced Panels; G
Metal Veneer Faced Panels
Wood Base; G

SD-07 Certificates

Certified Wood

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.4 DETAIL DRAWINGS

The Contractor shall submit detail drawings showing fabricated items and special mill and woodwork items. Drawings shall indicate materials and details of construction, methods of fastening, erection, and installation.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver trim and millwork to job site in an undamaged condition. Stack materials to ensure ventilation and drainage. Protect against dampness before and after delivery. Store materials under cover in a well-ventilated enclosure and protect against extreme changes in temperature and humidity. Do not store products in building until wet trade materials are dry.

PART 2 PRODUCTS

2.1 WOOD

2.1.1 Wood Products General

Certified Wood: Refer to Section 01 33 29 LEED DOCUMENTATION.

2.1.2 Trim and Finish

Provide species and grades listed for materials to be paint finished. Provide materials that are to be transparent finished one grade higher than that listed. Provide species indicated for materials to be transparent finished. Run trim, except window stools and aprons with hollow backs.

TABLE OF GRADES FOR WOOD TO RECEIVE PAINT FINISH		
Grading Rules	Species	Interior Trim
WWPA G-5 standard grading rules	Aspen, Douglas Fir-Larch, Douglas Fir South, Engelmann Spruce-Lodgepole Pine, Engelmann Spruce, Hem-Fir, Idaho White Pine, Lodgepole Pine, Mountain Hemlock, Mountain Hemlock-Hem-Fir, Ponderosa Pine-Sugar Pine, (Ponderosa Pine-Lodgepole Pine,) White Woods, (Western Woods,) Western Cedars, Western Hemlock	All Species: C & Btr. Select (Choice & Btr Idaho White Pine) or Superior Finish. Western Red Cedar may be graded C & Btr. Select or A & Btr. per Special Western Red Cedar Rules.
WCLIB 17 standard grading rules	Douglas Fir-Larch, Hem-Fir, Mountain Hemlock, Sitka Spruce, Western Cedars, Western Hemlock	All Species: C & Btr VG, except A for Western Red Cedar
SPIB 1003 standard grading rules		
NELMA Grading Rules standard grading rules	Balsam Fir, Eastern Hemlock-Tamarack, Eastern Spruce, Eastern White Pine, Northern Pine, Northern Pine, Northern White Cedar	All Species: C-Select except C & BTR for Eastern White Pine and Norway Pine

2.2 CHAIR RAILS

Wood Species: Any species indicated, paint grade.

2.3 WOOD VENEER FACED PANELS

Grade: Premium.
Wood Veneer Species, Cut and Match: Refer to the Finish Legend.
Panel Match Method: Refer to the Finish Legend.
Panel Core Construction: Fire-retardant particleboard.

2.4 METAL VENEER FACED PANELS

Metal Veneer: Type 304 stainless steel, #4 finish; grain direction as indicated on the Finish Legend.
Panel Core Construction: Fire-retardant particleboard.

2.5 WOOD BASE

Grade: Premium.
Wood Species and Cut: Refer to the Finish Legend.

2.6 MOISTURE CONTENT OF WOOD PRODUCTS

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products at time of delivery to the job site, and when installed, shall be as follows:

a. Interior Paneling: 6 percent.

b. Interior Trim and Millwork 1-1/4 Inches Nominal or Less in Thickness: 12 percent on 85 percent of the pieces and 15 percent on remainder.

c. Moisture content of other materials shall be in accordance with the applicable standards.

2.7 HARDWARE

2.7.1 Wood Screws

ASME B18.6.1.

2.7.2 Nails

Nails shall be the size and type best suited for the purpose and shall conform to ASTM F547. Nails shall be hot-dip galvanized or aluminum when used on exterior work. For siding, length of nails shall be sufficient to extend 1-1/2 inches into supports, including wood sheathing over framing. Screws for use where nailing is impractical shall be size best suited for purpose.

2.7.3 Z-Clips

Material: Extruded aluminum; mill finish.

2.8 FABRICATION

2.8.1 Quality Standards (QS)

The terms "Premium" refer to the quality grades defined in AWI AWS. Items not specified to be of a specific grade shall be Custom grade. The AWI QS is superseded by all contract document requirements indicated or stated herein.

PART 3 EXECUTION

3.1 FINISH WORK

Provide sizes, materials, and designs as indicated and as specified. Apply primer to finish work before installing. Where practicable, shop assemble and finish items of built-up millwork. Joints shall be tight and constructed in a manner to conceal shrinkage. Miter trim and moldings at exterior angles and cope at interior angles and at returns. Material shall show no warp after installation. Install millwork and trim in maximum practical lengths. Fasten finish work with finish nails. Provide blind nailing where practicable. Set face nails for putty stopping.

3.1.1 Interior Finish Work

After installation, sand exposed surfaces smooth.

3.2 MOLDING AND INTERIOR TRIM

Molding and interior trim shall be installed straight, plumb, level and with closely fitted joints. Exposed surfaces shall be machine sanded at the mill. Molded work shall be coped at returns and interior angles and mitered at external corners. Intersections of flatwork shall be shouldered to ease any inherent changes in plane. Blind nailing shall be used to the extent practicable, and face nailing shall be set and stopped with a nonstaining putty to match the finish applied. Screws shall be used for attachment to metal; setting and stopping of screws shall be of the same quality as required where nails are used.

-- End of Section --

SECTION 06 41 16.00 10

LAMINATE CLAD ARCHITECTURAL CASEWORK
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A161.2	(1998) Decorative Laminate Countertops, Performance Standards for Fabricated High Pressure

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI AWS	(2009) Architectural Woodwork Standards

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E162	(2012a) Surface Flammability of Materials Using a Radiant Heat Energy Source
ASTM E662	(2013) Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
ASTM F547	(2006; R 2012) Nails for Use with Wood and Wood-Base Materials

COMPOSITE PANEL ASSOCIATION (CPA)

CPA A208.2	(2009) Medium Density Fiberboard (MDF) for Interior Applications

GREENGUARD ENVIRONMENTAL INSTITUTE (GEI)

GEI	Greenguard Standards for Low Emitting Products

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	Scientific Certification Systems

(SCS) Indoor Advantage

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

WDMA I.S. 1-A (2007) Architectural Wood Flush Doors

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SYSTEM DESCRIPTION

Work in this section includes laminate clad custom casework cabinets as shown on the drawings and as described in this specification. This Section includes high-pressure laminate surfacing and cabinet hardware. All exposed and semi-exposed surfaces, whose finish is not otherwise noted on the drawings or finish schedule, shall be sanded smooth and shall receive a clear finish of polyurethane.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings; G

Shop Drawings
Installation

SD-03 Product Data

Wood Materials; (LEED NC); G
Finish Schedule; G
Certification; G
Plastic Laminates; G
Cabinet Hardware; G

SD-04 Samples

Plastic Laminates; G

SD-07 Certificates

Quality Assurance
Laminate Clad Casework
Certified Wood

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content
Certified Wood
Low Emitting Materials - Paints and Coatings

1.5 QUALITY ASSURANCE

1.5.1 General Requirements

All materials, construction methods, and fabrication shall conform to and comply with the custom grade quality standards as outlined in AWI AWS, Section for laminate clad cabinets. These standards shall apply in lieu of omissions or specific requirements in this specification. Contractors and their personnel engaged in the work shall be able to demonstrate successful experience with work of comparable extent, complexity and quality to that shown and specified. Submit a quality control statement which illustrates compliance with and understanding of AWI AWS requirements, in general, and the specific AWI AWS requirements provided in this specification. The quality control statement shall also certify a minimum of ten years Contractor's experience in laminate clad casework fabrication and construction. The quality control statement shall provide a list of a minimum of five successfully completed projects of a similar scope, size, and complexity.

1.5.2 Mock-ups

Prior to final approval of shop drawings, provide a full-size mock-up of a typical floor cabinet, solid surface and plastic laminate countertops and wall cabinet, including all components and hardware necessary to illustrate a completed unit with a minimum of one door and one drawer assembly. The completed mock-up shall include countertops and back splashes where specified. The mock-up shall utilize specified finishes in the patterns and colors as indicated on the drawings. Upon disapproval, rework or remake the mock-up until approval is secured. Remove rejected units from the jobsite. Approved mock-up may remain as part of the finished work. Submit shop drawings showing all fabricated casework items in plan view, elevations and cross-sections to accurately indicate materials used, details of construction, dimensions, methods of fastening and erection, and installation methods proposed. Shop drawing casework items shall be clearly cross-referenced to casework items located on the project drawings. Shop drawings shall include a color schedule of all casework items to include all countertop, exposed, and semi-exposed cabinet finishes to include finish material manufacturer, pattern, and color.

1.5.3 Sustainable Design Certification

Product shall be third party certified by GEI Greenguard Indoor Air Quality Certified, SCS Scientific Certification Systems Indoor Advantage or equal. Certification shall be performed annually and shall be current.

1.6 DELIVERY, STORAGE, AND HANDLING

Casework may be delivered knockdown or fully assembled. Deliver all units to the site in undamaged condition, stored off the ground in fully enclosed areas, and protected from damage. The storage area shall be well ventilated and not subject to extreme changes in temperature or humidity.

1.7 SEQUENCING AND SCHEDULING

Coordinate work with other trades. Units shall not be installed in any room or space until painting, and ceiling installation are complete within the room where the units are located. Floor cabinets shall be installed before finished flooring materials are installed.

PART 2 PRODUCTS

2.1 WOOD MATERIALS

2.1.1 Certified Wood

Certified Wood: Refer to Section 01 33 29 LEED DOCUMENTATION.

2.1.2 Lumber

a. All framing lumber shall be kiln-dried Grade III to dimensions as shown on the drawings. Frame front shall be nominal 3/4 inch hardwood.

b. Standing or running trim casework components. AWI grade shall be custom. Location, shape, and dimensions shall be as indicated on the drawings.

2.1.3 Panel Products

2.1.3.1 Plywood

All plywood panels used for framing purposes shall be veneer core hardwood plywood, AWI AWS Grade AA. Nominal thickness of plywood panels shall be as indicated in this specification and on the drawings.

2.1.3.2 Medium Density Fiberboard

Medium density fiberboard shall meet the minimum standards listed in CPA A208.2.

2.2 SOLID POLYMER MATERIAL

Solid surfacing casework components shall conform to the requirements of Section 06 61 16 SOLID POLYMER (SOLID SURFACING) FABRICATIONS.

2.3 HIGH PRESSURE DECORATIVE LAMINATE (HPDL)

All plastic laminates shall meet the requirements of ANSI/NEMA LD 3 and ANSI A161.2 for high-pressure decorative laminates. Design, colors, surface finish and texture, and locations shall be as indicated on the drawings. Submit two samples of each plastic laminate pattern and color. Samples shall be a minimum of 5 by 7 inches in size. Plastic laminate types and nominal minimum thicknesses for casework components shall be as indicated in the following paragraphs.

Type IP-01, IP-05:

Manufacturer: Laminart
Color and Texture: Refer to the Finish Legend.
Fire Rating: Class A and Class 1; ASTM E84.
Location: Refer to the Finish Legend.

Type IP-02, IP-04:

Manufacturer: Nevamar Company
Color and Texture: Refer to the Finish Legend.
Surface Flammability: Less than 30; ASTM E162.
Smoke Generation: Meets ASTM E662.

Location: Refer to the Finish Legend.

Type IP-03:

Manufacturer: Wilsonart LLC
Color and Texture: Refer to the Finish Legend.
Fire Rating: Class A and Class 1; ASTM E84.
Location: Refer to the Finish Legend.

Type IP-07:

Description: Melamine; protective, heat and scratch resistant covering produced by impregnating layers of kraft paper with a melamine resin and attaching it to a wooden base.
Water Absorption: 0.3-0.6% maximum.
Location: Refer to the Finish Legend.

Type ME-01 and ME-02:

Description: Melamine; protective, heat and scratch resistant covering produced by impregnating layers of kraft paper with a melamine resin and attaching it to a wooden base.
Water Absorption: 0.3-0.6% maximum.
Location: Refer to the Finish Legend.

2.3.1 Horizontal General Purpose Standard (HGS) Grade

Horizontal general purpose standard grade plastic laminate shall be 0.048 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where postforming is not required.

2.3.2 Vertical General Purpose Standard (VGS) Grade

Vertical general purpose standard grade plastic laminate shall be 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade is intended for exposed exterior vertical surfaces of casework components where postforming is not required.

2.3.3 Horizontal General Purpose Postformable (HGP) Grade

Horizontal general purpose postformable grade plastic laminate shall be 0.042 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where post forming is required.

2.3.4 Vertical General Purpose Postformable (VGP) Grade

Vertical general purpose postformable grade plastic laminate shall be 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade is intended for exposed exterior vertical surfaces of components where postforming is required for curved surfaces.

2.3.5 Horizontal General Purpose Fire Rated (HGF) Grade

Horizontal general purpose fire rated grade plastic laminate shall be 0.048 inches (plus or minus 0.005 inches) in thickness. Laminate grade shall have a class 1, class A fire rating in accordance with ASTM E84.

2.3.6 Vertical General Purpose Fire Rated (VGF) Grade

Vertical general purpose fire rated grade plastic laminate shall be 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade shall have a class 1, class A fire rating in accordance with ASTM E84.

2.3.7 Backing Sheet (BK) Grade

Undecorated backing sheet grade laminate is formulated specifically to be used on the backside of plastic laminated panel substrates to enhance dimensional stability of the substrate. Backing sheet thickness shall be 0.020 inches. Backing sheets shall be provided for all laminated casework components where plastic laminate finish is applied to only one surface of the component substrate.

2.4 THERMOSET DECORATIVE OVERLAYS (MELAMINE)

Thermoset decorative overlays (melamine panels) shall be used for casework cabinet interior surfaces. See elevations and finish schedule for color at which locations.

2.5 CABINET HARDWARE

a. Door Hinges: European type, BHMA No. A156.9, B01602, 170 degrees of opening.

b. Cabinet Pulls: Back mounted type, BHMA No. BHMA A156.9, B02011.

c. Drawer Slide: Side mounted full-extension type, BHMA No. BHMA A156.9, Grade HD-100 with full extension and a minimum 100 pound load capacity. Slides shall include an integral stop to avoid accidental drawer removal.

d. Adjustable Shelf Support Clip:

Product and Manufacturer - Basis of Design: Item No. 282.47.402 Shelf Support, Double Pin, transparent plastic; Hafele America, Archdale, NC, or equal.

e. Shelf Standard

Product and Manufacturer - Basis of Design: KV #82 Steel Standard; Knape & Vogt Manufacturing Company, or equal.

Color: Silver

f. Shelf Bracket

Product and Manufacturer - Basis of Design: KV #182 Steel Bracket; Knape & Vogt Manufacturing Company, or equal.

Color: Silver
Bracket Length: As indicated in elevations.

2.6 FASTENERS

Nails, screws, and other suitable fasteners shall be the size and type best suited for the purpose and shall conform to ASTM F547 where applicable.

2.7 ADHESIVES, CAULKS, AND SEALANTS

2.7.1 Adhesives

Adhesives shall be of a formula and type recommended by AWI. Adhesives shall be selected for their ability to provide a durable, permanent bond and shall take into consideration such factors as materials to be bonded, expansion and contraction, bond strength, fire rating, and moisture resistance. Adhesives shall meet local regulations regarding VOC emissions and off-gassing.

2.7.1.1 Wood Joinery

Adhesives used to bond wood members shall be a Type II for interior use urea-formaldehyde resin formula or polyvinyl acetate resin emulsion. Adhesives shall withstand a bond test as described in WDMA I.S. 1-A.

2.7.1.2 Laminate Adhesive

Adhesive used to join high-pressure decorative laminate to wood shall be adhesive consistent with AWI and laminate manufacturer's recommendations.

2.7.2 Caulk

Caulk used to fill voids and joints between laminated components and between laminated components shall match laminate color, 100 percent silicone. Caulk used to fill voids between laminate or wood to gypsum board or flooring to be clear.

2.7.3 Sealant

Sealant shall be of a type and composition recommended by the substrate manufacturer to provide a moisture barrier at sink cutouts and all other locations where unfinished substrate edges may be subjected to moisture.

2.8 ACCESSORIES

2.8.1 Glass and Glazing

Glass required in laminated casework shall be referenced by type in accordance with Section 08 81 00 GLAZING. Glass shall be one of the following:

Safety glass: Clear; fully tempered; 1/4 inches thick minimum.

2.8.2 Grommets

Grommets shall be plastic material for cutouts with a diameter of 2 inches. Locations shall be as indicated on the drawings and where electrical outlets are located under countertops. Color to match countertop laminate color as best as possible or use black grommets.

2.9 FABRICATION

Verify field measurements as indicated in the shop drawings before fabrication. Fabrication and assembly of components shall be accomplished at the shop site to the maximum extent possible. Construction and fabrication of cabinets and their components shall meet or exceed the

requirements for AWI grade indicated unless otherwise indicated in this specification. Cabinet style, in accordance with AWI AWS, Section 400-G descriptions, shall be as indicated on the drawings.

2.9.1 Base and Wall Cabinet Case Body

2.9.1.1 Cabinet Components

Frame members shall be glued-together, kiln-dried hardwood lumber. Top corners, bottom corners, and cabinet bottoms shall be braced with either hardwood blocks or water-resistant glue and nailed in place metal or plastic corner braces. Cabinet components shall be constructed from the following materials and thicknesses:

a. Body Members (Ends, Divisions, Bottoms, and Tops): 3/4 inch veneer core plywood panel product.

b. Face Frames and Rails: 3/4 inch panel product.

c. Shelving: 3/4 inch veneer core plywood panel product.

d. Cabinet Backs: 1/4 inch veneer core plywood panel product.

e. Drawer Sides, Backs, and Subfronts: 1/2 inch panel product.

f. Drawer Bottoms: 1/4 inch veneer core plywood panel product.

g. Door and Drawer Fronts: 3/4-inch medium density fiberboard (MDF) panel product.

2.9.1.2 Joinery Method for Case Body Members

a. Tops, Exposed Ends, and Bottoms.

(1) Steel "European" assembly screws (1-1/2 inch from end, 5 inch on center, fasteners will not be visible on exposed parts).

(2) Doweled, glued under pressure (approx. 4 dowels per 12 inches of joint).

(3) Stop dado, glued under pressure, and either nailed, stapled or screwed (fasteners will not be visible on exposed parts).

(4) Spline or biscuit, glued under pressure.

b. Exposed End Corner and Face Frame Attachment.

(1) For mitered joint: lock miter or spline or biscuit, glued under pressure (no visible fasteners).

(2) For non-mitered joint (90 degree): butt joint glued under pressure (no visible fasteners).

(3) Butt joint, glued and nailed.

c. Cabinet Backs (Wall Hung Cabinets): Wall hung cabinet backs must not be relied upon to support the full weight of the cabinet and its anticipated load for hanging/mounting purposes. Method of back joinery and hanging/mounting mechanisms should transfer the load to

case body members. Fabrication method shall be:

(1) Full bound, captured in grooves on cabinet sides, top, and bottom. Cabinet backs for floor standing cabinets shall be side bound, captured in grooves; glued and fastened to top and bottom.

(2) Full overlay, plant-on backs with minimum back thickness of 1/2 inch and minimum No. 12 plated (no case hardened) screws spaced a minimum 3 inches on center. Edge of back shall not be exposed on finished sides. Anchor strips are not required when so attached.

(3) Side bound, captured in groove or rabbetts; glued and fastened.

d. Cabinet Backs (Floor Standing Cabinets).

(1) Side bound, captured in grooves; glued and fastened to top and bottom.

(2) Full overlay, plant-on backs with minimum back thickness of 1/2 inch and minimum No. 12 plated (no case hardened) screws spaced a minimum 3 inches on center. Edge of back shall not be exposed on finished sides. Anchor strips are not required when so attached.

(3) Side bound, placed in rabbetts; glued and fastened in rabbetts.

e. Wall Anchor Strips shall be required for all cabinets with backs less than 1/2 inch thick. Strips shall consist of minimum 1/2 inch thick lumber, minimum 2-1/2 inches width; securely attached to wall side of cabinet back - top and bottom for wall hung cabinets, top only for floor standing cabinets.

2.9.2 Cabinet Floor Base

Floor cabinets shall be mounted on a base constructed of nominal 2 inch thick lumber. Base assembly components shall be a moisture-resistant panel product. Finished height for each cabinet base shall be as indicated on the drawings. Bottom edge of the cabinet door or drawer face shall extend below the top of the base as indicated on the drawings.

2.9.3 Cabinet Door and Drawer Fronts

Door and drawer fronts shall be fabricated from 3/4 inch medium density fiberboard (MDF). All door and drawer front edges shall be surfaced with high pressure plastic laminate, color and pattern to match exterior face laminate as indicated in the elevations.

2.9.4 Drawer Assembly

2.9.4.1 Drawer Components

Drawer components shall consist of a removable drawer front, sides, backs, and bottom. Drawer components shall be constructed of the following materials and thicknesses:

2.9.4.2 Drawer Assembly Joinery Method

a. Multiple dovetail (all corners) or French dovetail front/dadoed back, glued under pressure.

b. Doweled, glued under pressure.

c. Lock shoulder, glued and pin nailed.

d. Bottoms shall be set into sides, front, and back, 1/4 inch deep groove with a minimum 3/8 inch standing shoulder.

2.9.5 Shelving

2.9.5.1 General Requirements

Shelving shall be fabricated from 3/4 inch veneer core plywood. All shelving top and bottom surfaces shall be finished with thermoset decorative overlay (melamine). Shelf edges shall be finished in a thermoset decorative overlay (melamine).

2.9.5.2 Shelf Support System

The shelf support system shall be:

a. Pin Hole Method. Holes shall be drilled on the interior surface of the cabinet side walls. Holes shall be evenly spaced in two vertical columns. The holes in each column shall be spaced at one inch increments starting six inches from the cabinet interior bottom and extending to within six inches of the top interior surface of the cabinet. Holes shall be drilled to provide a level, stable surface when the shelf is resting on the shelf pins. Hole diameter shall be coordinated with pin insert size to provide a firm, tight fit.

2.9.6 Laminate Clad Countertops

Laminate countertop substrate shall be constructed of 3/4 inch veneer core plywood. The substrate shall be moisture-resistant where countertops receive sinks, lavatories, or are subjected to liquids. All substrates shall have sink cutout edges sealed with appropriate sealant against moisture. No joints shall occur at any cutouts. A balanced backer sheet is required.

2.9.6.1 Edge Style

Front and exposed side countertop edges shall be in shapes and to dimensions as shown on the drawings. The countertop edge material shall be:

a. Post formed plastic laminate. Laminate edge shall be integral with countertop surface. Shape and profile shall be as indicated on the drawings and to dimensions as indicated on the drawings.

b. Plastic laminate Self Edge. Flat, 90 degree "self " edge. Edge must be applied before top. Laminate edge shall overlap countertop laminate and shall be eased to eliminate sharp corners.

2.9.6.2 Laminate Clad Splashes

Countertop splash substrate shall be 3/4 inch veneer core plywood. Laminate clad backsplash shall be loose, to be installed at the time of countertop installation. Side splashes shall be straight profile and provided loose, to be installed at the time of countertop installation. Back and side splash laminate pattern and color shall match the adjacent

countertop laminate.

2.9.7 Laminate Application

Laminate application to substrates shall follow the recommended procedures and instructions of the laminate manufacturer and ANSI/NEMA LD 3, using tools and devices specifically designed for laminate fabrication and application. Provide a balanced backer sheet (Grade BK) wherever only one surface of the component substrate requires a plastic laminate finish. Apply required grade of laminate in full uninterrupted sheets consistent with manufactured sizes using one piece for full length only, using adhesives specified herein or as recommended by the manufacturer. Fit corners and joints hairline. All laminate edges shall be machined flush, filed, sanded, or buffed to remove machine marks and eased (sharp corners removed). Clean up at easing shall be such that no overlap of the member eased is visible. Fabrication shall conform to ANSI A161.2. Laminate types and grades for component surfaces shall be as follows unless otherwise indicated on the drawings:

a. Base/Wall Cabinet Case Body.

(1) Exterior (exposed) surfaces to include exposed and semi-exposed face frame surfaces: HPDL Grade VGS .

(2) Interior (semi-exposed) surfaces to include interior back wall, bottom, and side walls: Thermoset Decorative Overlay (melamine).

b. Adjustable Shelving.

(1) Top and bottom surfaces: Thermoset Decorative Overlay (melamine).

(2) All edges: Thermoset Decorative Overlay (melamine).

c. Fixed Shelving.

(1) Top and bottom surfaces: Thermoset Decorative Overlay (melamine).

(2) Exposed edges: Thermoset Decorative Overlay (melamine).

d. Door, Drawer Fronts, Access Panels.

(1) Exterior (exposed) and interior (semi-exposed) faces: HPDL Grade VGS

(2) Edges: HPDL Grade VGS.

e. Drawer Assembly.

(1) All interior and exterior surfaces: Thermoset Decorative Overlay (melamine).

f. Countertops and Splashes: All exposed and semi-exposed surfaces: HPDL Grade HGS

g. Tolerances: Flushness, flatness, and joint tolerances of laminated surfaces shall meet the AWI AWS premium grade requirements.

2.9.8 Finishing

2.9.8.1 Filling

No fasteners shall be exposed on laminated surfaces.

2.9.8.2 Sanding

All surfaces requiring coatings shall be prepared by sanding with a grit and in a manner that scratches will not show in the final system.

2.9.8.3 Coatings

Types, method of application and location of casework finishes shall be in accordance with the finish schedule, drawings and Section 09 90 00 PAINTS AND COATINGS. All cabinet reveals shall be painted. Submit descriptive data which provides narrative written verification of all types of construction materials and finishes, methods of construction, etc. not clearly illustrated on the submitted shop drawings. Data shall provide written verification of conformance with AWI AWS for the quality indicated to include materials, tolerances, and types of construction. Both the manufacturer of materials and the fabricator shall submit available literature which describes re-cycled product content, operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall comply with applicable requirements for AWI AWS premium quality standards. Countertops and fabricated assemblies shall be installed level, plumb, and true to line. Cabinets and other laminate clad casework assemblies shall be attached and anchored securely to the floor and walls with mechanical fasteners that are appropriate for the wall and floor construction.

3.1.1 Anchoring Systems

3.1.1.1 Floor

Base cabinets shall utilize a floor anchoring system as detailed on the drawings. Anchoring and mechanical fasteners shall not be visible from the finished side of the casework assembly. Cabinet assemblies shall be attached to anchored bases without visible fasteners as indicated in the drawings. Where assembly abuts a wall surface, anchoring shall include a minimum 1/2 inch thick lumber or panel product hanging strip, minimum 2-1/2 inch width; securely attached to the top of the wall side of the cabinet back.

3.1.1.2 Wall

Cabinet to be wall mounted shall utilize minimum 1/2 inch thick lumber or panel product hanging strips, minimum 2-1/2 inch width; securely attached to the wall side of the cabinet back, both top and bottom. Provide wood blocking as necessary to accommodate wall cabinets.

3.1.2 Countertops

Countertops shall be installed in locations as indicated on the drawings. Countertops shall be fastened to supporting casework structure with mechanical fasteners, hidden from view. All joints formed by the countertop or countertop splash and adjacent wall surfaces shall be filled with a clear silicone caulk. Loose splashes shall be adhered to both the countertop surface perimeter and the adjacent wall surface with adhesives appropriate for the type of materials to be adhered. Joints between the countertop surface and splash shall be filled with clear silicone caulk in a smooth consistent concave bead. Bead size shall be the minimum necessary to fill the joint and any surrounding voids or cracks.

3.1.3 Hardware

Casework hardware shall be installed in types and locations as indicated on the drawings. Where fully concealed European-style hinges are specified to be used with particleboard or fiberboard doors, the use of plastic or synthetic insertion dowels shall be used to receive 3/16 inch "Euroscrews". The use of wood screws without insertion dowels is prohibited.

3.1.4 Doors, Drawers and Removable Panels

The fitting of doors, drawers and removable panels shall be accomplished within target fitting tolerances for gaps and flushness in accordance with AWI AWS premium grade requirements.

3.1.5 Plumbing Fixtures

Install sinks, sink hardware, and other plumbing fixtures in locations as indicated on the drawings and in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE .

3.1.6 Glass

Install glass and glazing in the casework using methods and materials specified in Section 08 81 00 GLAZING in locations as indicated on the drawings.

-- End of Section --

SECTION 06 61 16

SOLID POLYMER (SOLID SURFACING) FABRICATIONSAND QUARTZ SURFACING
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z124.3	Plastic Lavatories
ANSI Z124.6	Plastic Sinks

ASTM INTERNATIONAL (ASTM)

ASTM C97	(2009) Absorption and Bulk Specific Gravity of Dimension Stone
ASTM C880	(2009) Standard Test Method for Flexural Strength of Dimension Stone
ASTM D2583	(2013) Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D638	(2010) Standard Test Method for Tensile Properties of Plastics
ASTM D790	(2010) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SYSTEM DESCRIPTION

a. Work under this section includes countertops and other items utilizing solid polymer (solid surfacing) fabrication as shown on the drawings and as described in this specification. Do not change source of supply for materials after work has started, if the appearance of finished work would be affected.

b. In most instances, installation of solid polymer fabricated components and assemblies will require strong, correctly located structural

support provided by other trades. To provide a stable, sound, secure installation, close coordination is required between the solid polymer fabricator/installer and other trades to ensure that necessary structural wall support, cabinet counter top structural support, proper clearances, and other supporting components are provided for the installation of wall panels, countertops, shelving, and all other solid polymer fabrications to the degree and extent recommended by the solid polymer manufacturer.

c. Appropriate staging areas for solid polymer fabrications. Allow variation in component size and location of openings of plus or minus 1/8 inch.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G
Installation

SD-03 Product Data

Solid Surfacing; (LEED NC)
Sealants; (LEED NC)
Qualifications
Fabrications
Quartz Surfacing

SD-04 Samples

Material; G; Countertops

Counter Tops

SD-06 Test Reports

Solid Surfacing
Quartz Surfacing

SD-07 Certificates

Fabrications
Qualifications

SD-10 Operation and Maintenance Data

Clean-up

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content
Low Emitting Materials - Adhesives and Sealants

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

To ensure warranty coverage, solid polymer fabricators shall be certified to fabricate by the solid polymer material manufacturer being utilized. Mark all fabrications with the fabricator's certification label affixed in an inconspicuous location. Fabricators shall have a minimum of 5 years of experience working with solid polymer materials. Submit solid polymer manufacturer's certification attesting to fabricator qualification approval.

1.5.2 Mock-ups

Submit Detail Drawings indicating locations, dimensions, component sizes, fabrication and joint details, attachment provisions, installation details, and coordination requirements with adjacent work. Prior to final approval of shop drawings, provide a full-size mock-up of a typical countertop where multiple units are required. The mock-up shall include all solid polymer components required to provide a completed unit. The mock-up shall utilize finishes in patterns and colors indicated on the drawings. Should the mock-up not be approved, re-work or remake it until approval is secured. Remove rejected units from the jobsite. Approved mock-up may remain as part of the finished work. Detail Drawings

1.6 DELIVERY, STORAGE, AND HANDLING

Do not deliver materials to project site until areas are ready for installation. Deliver components and materials to the site undamaged, in containers clearly marked and labeled with manufacturer's name. Materials shall be stored indoors and adequate precautions taken to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation, for duration of project.

1.7 WARRANTY

Provide manufacturer's warranty of ten years against defects in materials, excluding damages caused by physical or chemical abuse or excessive heat. Warranty shall provide for material and labor for replacement or repair of defective material for a period of ten years after component installation.

PART 2 PRODUCTS

2.1 MATERIAL

Type SP-01: Solid Surfacing

Product and Manufacturer - Basis of Design: Corian Solid Surface; DuPont Company, or equal.

Description: Cast, nonporous, filled polymer, not coated, laminated or of composite construction with through body colors meeting ANSI Z124.3 or ANSI Z124.6, having minimum physical and performance properties specifi
Tensile Strength: 6,000 psi, ASTM D638
Flexural Strength: 10,000 psi, ASTM D790.
Stain Resistance: Passes, ANSI Z124.3 and ANSI Z124.6.
Water Absorption - Long Term: Maximum 0.65 for 1/2-inch thick sheet, ASTM D570.

Flammability: Class 1 and Class A, ASTM E84.

Type WS-01 Quartz Surfacing

Product and Manufacturer - Basis of Design: Silestone; North Star Surfaces, LLC, or equal.

Description: Engineered quartz crafted from minerals.
Hardness: 60-65, ASTM D2583
Tensile Strength: 5, 620, ASTM C880
Water Absorption (after 24 hours, percent, maximum): 0.04, ASTM C97
Flammability: Class 1, ASTM E84

2.1.1 Material Patterns and Colors

Refer to the Finish Legend. Pattern and color shall occur and be consistent in appearance, throughout the entire depth, thickness, of solid polymer material.

2.1.2 Surface Finish

Exposed finished surfaces and edges shall receive a uniform appearance. Exposed surface finish shall be as indicated on the drawings.

2.2 ACCESSORY PRODUCTS

Accessory products, as specified below, shall be manufactured by the solid polymer manufacturer or shall be products approved by the solid polymer manufacturer for use with the solid polymer materials being specified.

2.2.1 Joint Adhesive

Manufacturer's standard one- or two-part adhesive kit to create inconspicuous, nonporous joints.

2.2.2 Sealant

Manufacturer's standard mildew-resistant, FDA-compliant, NSF 51-compliant (food zone - any type), UL-listed silicone sealant in colors matching components.

2.2.3 Conductive Tape

Manufacturer's standard aluminum foil tape, with required thickness, for use with cutouts near heat sources.

2.2.4 Insulating Felt Tape

Manufacturer's standard for use with conductive tape in insulating solid surface material from adjacent heat source.

2.2.5 Mounting Hardware

Provide mounting hardware, including sink/bowl clips, inserts and fasteners for attachment of undermount sinks and lavatories.

2.3 FABRICATIONS

Components shall be factory or shop fabricated to sizes and shapes

indicated, to the greatest extent practical, in accordance with approved Shop Drawings and manufacturer's requirements. Provide factory cutouts for sinks, lavatories, and plumbing fixtures where indicated on the drawings. Contours and radii shall be routed to template, with edges smooth. Defective and inaccurate work will be rejected. Submit product data indicating product description, fabrication information, and compliance with specified performance requirements for solid polymer, joint adhesive, sealants, and heat reflective tape. Both the manufacturer of materials and the fabricator shall submit a detailed description of operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.

2.3.1 Joints and Seams

Form joints and seams between solid polymer components using manufacturer's approved seam adhesive. Joints shall be inconspicuous in appearance and without voids to create a monolithic appearance.

2.3.2 Edge Finishing

Rout and finish component edges to a smooth, uniform appearance and finish. Edge shapes and treatments, including any inserts, shall be as detailed on the drawings. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

2.3.3 Counter Top Splashes

Fabricate backsplashes and end splashes from 1/2 inch thick solid surfacing material to be in conformance with dimensions and shapes as indicated on the drawings. Backsplashes and end splashes shall be provided for all counter tops at locations indicated on the drawings. Backsplashes shall be shop fabricated and be loose, to be field attached.

2.3.4 Counter Tops

Fabricate all solid surfacing and solid polymer counter top components from 1/2 inch thick material. Edge details, dimensions, locations, and quantities shall be as indicated on the Drawings. Counter tops shall be complete with 4 inch high backsplash and side splash at all locations where indicated on the drawings. Attach 2 inch wide reinforcing strip of polymer material under each horizontal counter top seam. Submit a minimum 1 foot wide by 6 inch deep, full size sample for each type of counter top shown on the project drawings. The sample shall include the edge profile and backsplash as detailed on the project drawings. Solid polymer material shall be of a pattern and color as indicated on the drawings. Sample shall include at least one seam. Approved sample shall be retained as standard for this work.

2.3.4.1 Counter Top With Sink

a. Stainless Steel. Countertops with sinks shall include cutouts to template as furnished by the sink manufacturer. Manufacturer's standard sink mounting hardware for stainless steel rimless installation shall be provided. Seam between sink and counter top shall be sealed with silicone sealant. Sink, faucet, and plumbing requirements shall be in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Components

Install all components and fabricated units plumb, level, and rigid. Make field joints between solid polymer components using solid polymer manufacturer's approved seam adhesives, to provide a monolithic appearance with joints inconspicuous in the finished work. Attach metal or vitreous china sinks and lavatory bowls to counter tops using solid polymer manufacturer's recommended clear silicone sealant and mounting hardware. Solid polymer sinks and bowls shall be installed using a color-matched seam adhesive. Plumbing connections to sinks and lavatories shall be made in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.1.2 Silicone Sealant

Use a clear, silicone sealant or caulk to seal all expansion joints between solid polymer components and all joints between solid polymer components and other adjacent surfaces such as walls, floors, ceiling, and plumbing fixtures. Sealant bead shall be smooth and uniform in appearance and shall be the minimum size necessary to bridge any gaps between the solid surfacing material and the adjacent surface. Bead shall be continuous and run the entire length of the joint being sealed.

3.1.3 Plumbing

Make plumbing connections to sinks and lavatories in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2 CLEAN-UP

Components shall be cleaned after installation and covered to protect against damage during completion of the remaining project items. Components damaged after installation by other trades will be repaired or replaced at the General Contractor's cost. Component supplier will provide a repair/replace cost estimate to the General Contractor who shall approve estimate before repairs are made. Submit a minimum of six copies of maintenance data indicating manufacturer's care, repair and cleaning instructions. Maintenance video shall be provided,if available. Maintenance kit for matte finishes shall be submitted.

-- End of Section --

SECTION 07 17 00

BENTONITE WATERPROOFING
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1557	(2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Bentonite waterproofing
Waterstop
Warranty certificate

SD-08 Manufacturer's Instructions

Application
Protection
Corrections

SD-11 Closeout Submittals

Warranty

Submit 10 year "No-Dollar-Limit" warranty for labor and materials.

1.3 DELIVERY, STORAGE, AND HANDLING

Do not place bentonite waterproofing materials in flooded areas or during precipitation. Provide bentonite materials with manufacturer's labels intact, identifying the materials. Keep materials dry prior to use with polyethylene or canvas covering for sides and top and chocks or skids underneath, of sufficient height to maintain separation from ground water. Protect materials from moisture. Remove materials which show evidence of damage, deterioration, or contamination.

1.4 QUALITY ASSURANCE

Qualification of Applicator: Applicator shall be approved, in writing, by the waterproofing materials manufacturer for the installation of waterprofing materials under conditions and for applications indicated.

1.5 WARRANTY

Waterproofing Material and Labor Warranty: Upon installation completion and manufacturer acceptance of the work required by this section, the waterproofing materials manufacturer will provide to the project Owner, a written ten (10) year non-prorated warranty, covering both materials and labor. Issuance of Manufacturer's Waterproofing Warranty requires the following: (1) Waterproofing System products and drainage composite products shall have been provided by a single manufacturer; (2) Installation of waterproofing products and prefabricated drainage composite by Manufacturer's Approved Applicator in full accordance with manufacturer's quality assurance program requirements; (3) Installation inspected by an approved and trained Independent Inspection Firm participating with the waterproofing manufacturer's Certified Inspection Program; (4) In Division 3 work, Waterstop-RX must be installed in all applicable concrete cold pour construction joints, including around applicable penetrations. Manufacturer's warranty shall be independent from any other warranties made by the Contractor under requirements of the Contract Documents and may run concurrent with the other warranties.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Bentonite Waterproofing

Under Concrete Slabs:

Product and Manufacturer: Ultraseal SP; CETCO, Colloid Environmental Technologies Company, or equal.

Description: 100-mil (2.3 mm) thick composite membrane consisting of a active-polymer core (APC) integrally bonded to a geomembrane liner using a proprietary mechanical process.

Vertical Walls Below Grade:

Product and Manufacturer: Ultraseal BT; CETCO, Colloid Environmental Technologies Company, or equal.

Description: 200-mil (4.7 mm) thick composite membrane consisting of a active-polymer core (APC) encapsulated by a geomembrane liner and a geotextile using a proprietary mechanical process.

2.2 Accessories

Provide accessories as recommended by manufacturer for a complete and waterproof system. Accessories include, but are not limited to, the following:

Bentonite Seal: Bentoseal; trowelable consistency, bentonite compound, specifically formulated for application at joints and penetrations; or equal.

Termination Bar: Minimum 1-inch wide aluminum bar with pre-punched holes on 12-inch centering for fastening.

Fasteners for Termination Bar: 300 Series stainless steel.

Seam Tape: SeamTape; 2" wide butyl rubber sealant tape; or equal.

Transition Tube: Hyrdobar Tubes; granular bentonite clay (sodium bentonite), minimum 85 percent montmorillonite (hydrated aluminum silicate), with a minimum of 90 percent passing a 20-mesh sieve; or equal.

Waterstop: Waterstop RX; flexible strip of bentonite waterproofing compound in cartridge or coil form, designed specifically for vertical and horizontal joints in concrete construction; or equal.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Examine surfaces prior to treatment, eliminating irregularities and removing loose and foreign material. Remove form tie rods. Point cracks and honeycombs in concrete surfaces. Surfaces of finished patches shall be flush with adjacent concrete surfaces. Allow cement mortar to dry for minimum of 72 hours prior to application of bentonite waterproofing.

3.2 APPLICATION

Apply bentonite waterproofing where indicated, in accordance with manufacturer's printed instructions.

3.3 PROTECTION

Provide protection to waterproofing during backfilling and compaction as recommended by manufacturer of bentonite materials. If backfill is not immediately applied, protect waterproofing against precipitation by covering temporarily with polyethylene sheet. Replace damaged waterproofing before and during backfilling and compaction. Compact backfill to at least 85 percent of ASTM D1557 maximum density.

3.4 CORRECTIONS

Repair leaks and defective areas in accordance with manufacturer's recommendations.

-- End of Section --

SECTION 07 21 13

BOARD AND BLOCK INSULATION
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1621	(2010) Compressive Properties of Rigid Cellular Plastics
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2012) Standard Test Methods for Water Vapor Transmission of Materials

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Rigid Insulation Board; (LEED NC)
Adhesives; (LEED NC)

Accessories

SD-08 Manufacturer's Instructions

Rigid Insulation Board
Adhesives

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content
Low Emitting Materials - Adhesives and Sealants

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials to the site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type, grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

1.4.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

PART 2 PRODUCTS

2.1 RIGID INSULATION BOARD

Products and Manufacturers: Subject to compliance with requirements, available products and manufacturers that may be incorporated into the Work include, but are not limited to, the following:

Thermax; The Dow Chemical Company
Rmax TSX-8510; RMax, Inc.
Hunter Xci 286; Hunter Panels

Rigid insulation shall be tested to be suitable for use in walls and ceilings without a thermal barrier. Insulation shall comly with Special Approval Paragraph FBC 2603.9 Florida Building Code.

Thickness: 2 inches.

2.1.1 Thermal Resistance

R-Value: 6.5 per inch of thickness.

Exterior Wall Insulation R-Value: Minimum 13.0.

2.1.2 Fire Protection Requirement

a. Flame spread index of 25 or less when tested in accordance with ASTM E84.

b. Smoke developed index of less than 450 when tested in accordance with ASTM E84.

2.1.3 Other Material Properties

Provide thermal insulating materials with the following properties:

a. Rigid cellular plastics: Compressive Resistance at Yield: Not less than 20 pounds per square inch (psi) when measured according to ASTM D1621.

b. Water Vapor Permeance: Not more than 0.03 Perms or less when measured according to ASTM E96/E96M.

c. Water Adsorption: Less than than 1 percent by volume when measured in accordance with ASTM C209

2.2 ACCESSORIES

2.2.1 Adhesives

Adhesives and Tape: Types recommended by insulation manufacturer for applications indicated.

2.2.2 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

Before installing insulation, ensure that all areas that will be in contact with the insulation are dry and free of projections which could cause voids, compressed insulation, or punctured vapor retarders. If installing perimeter or under slab insulation, check that the fill is flat, smooth, dry, and well tamped. If moisture or other conditions are found that do not allow the proper installation of the insulation, do not proceed but notify the Contracting Officer's Representative of such conditions.

3.2 INSTALLATION

3.2.1 Insulation Board

Install and handle insulation in accordance with the manufacturer's installation instructions. Keep material dry and free of extraneous materials. Observe safe work practices.

All joints fully sealed with manufacturer tape. Foam core of insulation must be fully encapsulated with foil facer or foil manufacturer's foil tape.

3.2.2 Continuity of Insulation

Butt tightly against adjoining boards, studs, rafters, joists, sill plates, headers and obstructions. Provide continuity and integrity of insulation at corners, wall to ceiling joint, roof, and floor. Avoid creating any thermal bridges or voids.

3.3 INSTALLATION ON WALLS

3.3.1 Attachment to Concrete Walls

a. As recommended by the insulation manufacturer.

b. Butt all edges of insulation and seal edges with tape.

-- End of Section --

SECTION 07 21 16

MINERAL FIBER BLANKET INSULATION
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C518	(2010) Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C665	(2012) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C930	(2012) Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories
ASTM D3833/D3833M	(1996; R 2011) Water Vapor Transmission of Pressure-Sensitive Tapes
ASTM E136	(2012) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211	(2013) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
NFPA 70	(2014) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Insulation; (LEED NC)
Adhesives; (LEED NC)
Accessories

SD-08 Manufacturer's Instructions

Insulation

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content
Low Emitting Materials - Adhesives and Sealants

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials to site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type, grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

1.4.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

1.5 SAFETY PRECAUTIONS

1.5.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) in accordance with 29 CFR 1910.134.

1.5.2 Smoking

Do not smoke during installation of blanket thermal insulation.

1.5.3 Other Safety Concerns

Consider other safety concerns and measures as outlined in ASTM C930.

PART 2 PRODUCTS

2.1 INSULATION

Thermal Batt Insulation: ASTM C665, Type I, blankets without membrane coverings; Class A, membrane-faced surface with a flame spread of 25 or less, except a flame spread rating of 25 or less and a smoke developed rating of 150 or less when tested in accordance with ASTM E84.

Sound Attenuation Blanket Insulation: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

Thermal Resistance: R-Value mnimum 3.1 per inch per ASTM C518.
Thickness: As indicated.
Thickness: As indicated.

Semi Rigid Curtain Wall Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.

Density: Nominal density of 8 lb/cu. ft.
Thermal Resistance: R-Value minimum 4.2 per inch per ASTM C518.
Thickness: As indicated.

2.1.1 Thermal Resistance Value (R-VALUE)

As indicated

2.1.2 Recycled Materials

Provide Thermal Insulation containing recycled materials to the extent practicable, provided the material meets all other requirements of this section. The minimum required recycled materials content by weight are:

Rock Wool: 75 percent slag
Fiberglass: 20 to 25 percent glass cullet

2.1.3 Prohibited Materials

Do not provide asbestos-containing materials.

2.2 BLOCKING

Wood, metal, unfaced mineral fiber blankets in accordance with ASTM C665, Type I, or other approved materials. Use only non-combustible materials meeting the requirements of ASTM E136 for blocking around chimneys and heat producing devices.

2.3 PRESSURE SENSITIVE TAPE

As recommended by the vapor retarder manufacturer and having a water vapor permeance rating of one perm or less when tested in accordance with ASTM D3833/D3833M.

2.4 ACCESSORIES

2.4.1 Adhesives

As recommended by the insulation manufacturer.

2.4.2 Mechanical Fasteners

Impailing Pins: Corrosion resistant type as recommended by the insulation manufacturer. Provide with self-locking, galvanized steel retaining washers.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

Before installing insulation, ensure that areas that will be in contact with the insulation are dry and free of projections which could cause voids, compressed insulation, or punctured vapor retarders. If moisture or other conditions are found that do not allow the workmanlike installation of the insulation, do not proceed but notify Contracting Officer of such conditions.

3.2 PREPARATION

3.2.1 Blocking at Access Doors

Prior to installation of insulation, install permanent blocking to prevent insulation from slipping over, clogging, or restricting air flow through soffit vents at eaves.

3.2.2 Blocking Around Heat Producing Devices

Install non-combustible blocking around heat producing devices to provide the following clearances:

a. Recessed lighting fixtures, including wiring compartments, ballasts, and other heat producing devices, unless these are certified by the manufacturer for installation surrounded by insulation: 3 inches from outside face of fixtures and devices or as required by NFPA 70 and, if insulation is to be placed above fixture or device, 24 inches above fixture.

b. Vents and vent connectors used for venting the products of combustion, flues, and chimneys other than masonry chimneys: Minimum clearances as required by NFPA 211.

3.3 INSTALLATION

3.3.1 Insulation

Install and handle insulation in accordance with manufacturer's instructions. Keep material dry and free of extraneous materials. Ensure personal protective clothing and respiratory equipment is used as required. Observe safe work practices.

3.3.1.1 Electrical wiring

Do not install insulation in a manner that would sandwich electrical

wiring between two layers of insulation.

3.3.1.2 Continuity of Insulation

Install blanket insulation to butt tightly against adjoining blankets and to studs, rafters, joists, sill plates, headers and any obstructions. Provide continuity and integrity of insulation at corners, wall to ceiling joints, roof, and floor. Avoid creating thermal bridges.

3.3.1.3 Installation at Bridging and Cross Bracing

Insulate at bridging and cross bracing by splitting blanket vertically at center and packing one half into each opening. Butt insulation at bridging and cross bracing; fill in bridged area with loose or scrap insulation.

3.3.1.4 Insulation without Affixed Vapor Retarder

Provide snug friction fit to hold insulation in place. Stuff pieces of insulation into cracks between trusses, joists, studs and other framing, such as at attic access doors, door and window heads, jambs, and sills, band joists, and headers.

3.3.1.5 Sizing of Blankets

Provide only full width blankets when insulating between trusses, joists, or studs. Size width of blankets for a snug fit where trusses, joists or studs are irregularly spaced.

-- End of Section --

SECTION 07 22 00

ROOF AND DECK INSULATION
08/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1177/C1177M	(2008) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C1289	(2013) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D226/D226M	(2009) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D312	(2000; R 2006) Standard Specification for Asphalt Used in Roofing
ASTM D41/D41M	(2011) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM 4470	(2010) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/
FM P9513	(2002) Specialist Data Book Set for Roofing Contractors; contains 1-22 (2001), 1-28 (2002), 1-29 (2002), 1-28R/1-29R (1998), 1-30 (2000), 1-31 (2000), 1-32 (2000), 1-33 (2000), 1-34 (2001), 1-49 (2000), 1-52 (2000), 1-54 (2001)

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir	(2012) Building Materials Directory

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roof insulation system

Taper cants and crickets

Show location and spacing of materials required for securing insulation . Show a complete description of the procedures for the installation of each phase of the system indicating the type of materials, thicknesses, identity codes, sequence of laying insulation, location of ridges and valleys, special methods for cutting and fitting of insulation, and special precautions. The drawings shall be based on field measurements.

SD-03 Product Data

Fasteners

Roof insulation system; (LEED NC)

Include minimum thickness of insulation for steel and concrete decks and fastener pattern for insulation on steel decks.

SD-06 Test Reports

Flame spread and smoke developed ratings

Submit in accordance with ASTM E84.

SD-07 Certificates

Installer qualifications

SD-08 Manufacturer's Instructions

Nails and fasteners

Roof insulation, including field of roof and perimeter attachment requirements.

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.4 MANUFACTURER'S CERTIFICATE

Submit certificate from the insulation manufacturer attesting that the installer has the proper qualifications for installing tapered roof insulation systems.

Certificate attesting that the expanded perlite or polyisocyanurate insulation contains recovered material and showing estimated percent of recovered material. Certificates of compliance for felt materials.

1.5 QUALITY ASSURANCE

1.5.1 Insulation on Steel and concrete Decks

Roof insulation shall have a flame spread rating not greater than 75 and a smoke developed rating not greater than 150, exclusive of covering, when tested in accordance with ASTM E84. Insulation bearing the UL label and listed in the UL Bld Mat Dir as meeting the flame spread and smoke developed ratings will be accepted in lieu of copies of test reports. Compliance with flame spread and smoke developed ratings will not be required when insulation has been tested as part of a roof construction assembly of the type used for this project and the construction is listed as fire-classified in the UL Bld Mat Dir or listed as Class I roof deck construction in the FM APP GUIDE. Insulation tested as part of a roof construction assembly shall bear UL or FM labels attesting to the ratings specified herein.

1.5.2 Local/Regional Materials

See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Roof insulation and materials may be locally available.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery

Deliver materials to site in manufacturer's unopened and undamaged standard commercial containers bearing the following legible information:

a. Name of manufacturer;

b. Brand designation;

c. Specification number, type, and class, as applicable, where materials are covered by a referenced specification; and

Deliver materials in sufficient quantity to allow continuity of the work.

1.6.2 Storage and Handling

Store and handle materials in a manner to protect from damage, exposure to open flame or other ignition sources, and from wetting, condensation or moisture absorption. Store in an enclosed building or trailer that provides a dry, adequately ventilated environment. Replace damaged material with new material.

1.7 ENVIRONMENTAL CONDITIONS

Do not install roof insulation during inclement weather or when air temperature is below 40 degrees F and interior humidity is 45 percent or greater, or when there is visible ice, frost, or moisture on the roof deck.

1.8 PROTECTION OF PROPERTY

1.8.1 Special Protection

Provide special protection approved by the insulation manufacturer, or avoid heavy traffic on completed work when ambient temperature is above 80 degrees F.

PART 2 PRODUCTS

2.1 ROOF INSULATION

2.1.1 Insulation Types

Roof insulation system shall be one or an assembly of a maximum of three of the following materials and compatible with attachment methods for the specified insulation and roof membrane:

Rigid Roof Insulation: Polyisocyanurate board; ASTM C1289 Type II, fibrous felt or glass mat membrane both sides, except minimum compressive strength shall be 20 pounds per square inch (psi).

R-Value: 5.0-6.0 per inch thickness.
Minimum Overall Average Roof R-Value: 21.0

Insulation Thickness: 3.5" min insulation at drain sloping up 1/4" per foot.

2.1.2 Recovered Materials

Provide thermal insulation materials containing recycled materials to the extent practical. The required minimum recycled material content for the listed materials are:

2.1.3 Insulation Thickness

As necessary to provide a thermal resistance (R value) of 21.0 minimum or more. Thickness shall be based on the "R" value for aged insulation. Insulation over steel decks shall satisfy both specified R value and minimum thickness for width of rib opening recommended in insulation manufacturer's published literature.

2.1.4 Tapered Rigid Roof Insulation

One layer of the tapered roof insulation assembly shall be factory tapered to a slope of not less than 1/4 inch per foot. Provide starter and filler blocks as required to provide the total thickness of insulation necessary to meet the specified slope and thermal conductance. Mitered joints shall be factory fabricated and shall consist of two diagonally cut boards or one board shaped to provide the required slopes. Identify each piece of tapered insulation board by color or other identity coding system, allowing the identification of different sizes of tapered insulation board required to complete the roof insulation system.

2.1.5 Cants and Tapered Edge Strips

Provide preformed cants and tapered edge strips of the same material as the roof insulation; or, when roof insulation material is unavailable, provide pressure-preservative treated wood, wood fiberboard, or rigid perlite board cants and edge strips as recommended by the roofing manufacturer, unless otherwise indicated. Face of cant strips shall have incline of 45 degrees and vertical height of 4 inches. Taper edge strips at a rate of one to 1 1/2 inch per foot down to approximately 1/8 inch thick.

2.2 PROTECTION BOARD

For use as a protection board for hot-mopped, torched-down, or adhesively-applied roofing membrane over roof insulation.

2.2.1 Glass Mat Gypsum Roof Board

ASTM C1177/C1177M, 0 Flame Spread and 0 Smoke Developed when tested in accordance with ASTM E84, 500 psi, Class A, non-combustible, 1/4 inch thick, 4 by 8 feet board size.

2.3 BITUMENS

2.3.1 Asphalt Primer

ASTM D41/D41M.

2.3.2 Asphalt

ASTM D312, Type III or IV. Asphalt flash point, finished blowing temperature, and equiviscous temperature (EVT) for mop and for mechanical spreader application shall be indicated on bills of lading or on individual containers.

2.4 MOISTURE CONTROL2.4.1 Organic Roofing

ASTM D226/D226M, Type I.

2.5 FASTENERS

Flush-driven through flat round or hexagonal steel or plastic plates. Steel plates shall be zinc-coated, flat round not less than 1 3/8 inch diameter or hexagonal not less than 28 gage. Plastic plates shall be high-density, molded thermoplastic with smooth top surface, reinforcing ribs and not less than 3 inches in diameter.

2.5.1 Fasteners for Steel Decks

Approved hardened penetrating fasteners or screws conforming to FM 4470 and listed in FM APP GUIDE for Class I roof deck construction. Quantity and placement to withstand a minimum uplift pressure of 90 psf conforming to FM APP GUIDE.

2.5.2 Fasteners for Poured Concrete Decks

Approved hardened fasteners or screws to penetrate deck at least one inch but not more than 1 1/2 inches, conforming to FM 4470, and listed in

FM APP GUIDE for Class I roof deck construction. Quantity and placement to withstand an uplift pressure of 90 psf conforming to FM APP GUIDE.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

3.1.1 Surface Inspection

Surfaces shall be clean, smooth, and dry. Check roof deck surfaces, including surfaces sloped to roof drains and outlets, for defects before starting work.

The Contracting Officer will inspect and approve the surfaces immediately before starting installation. Prior to installing insulation, perform the following:

b. Examine steel decks to ensure that panels are properly secured to structural members and to each other and that surfaces of top flanges are flat or slightly convex.

3.1.2 Surface Preparation

Correct defects and inaccuracies in roof deck surface to eliminate poor drainage and hollow or low spots and perform the following:

a. Install wood nailers the same thickness as insulation at eaves, edges, curbs, walls, and roof openings for securing cant strips, gravel stops, gutters, and flashing flanges. On decks with slopes of one inch per foot or more, install wood nailers perpendicular to slope for securing insulation . Space nailers in accordance with approved shop drawings.

b. Fill or cover cracks or knot holes larger than 1/2 inch in diameter in wood decks as necessary to form an unyielding surface.

c. Cover steel decks with a layer of insulation board of sufficient thickness to span the width of a deck rib opening, and conforming to fire safety requirements. Secure with piercing or self-drilling, self-tapping fasteners of quantity and placement conforming to FM APP GUIDE. Insulation joints parallel to ribs of deck shall occur on solid bearing surfaces only, not over open ribs.

3.2 INSULATION INSTALLATION

Apply insulation in two layers with staggered joints when total required thickness of insulation exceeds 1/2 inch. Lay insulation so that continuous longitudinal joints are perpendicular to direction of roofing and end joints of each course are staggered with those of adjoining courses. When using multiple layers of insulation, joints of each succeeding layer shall be parallel and offset in both directions with respect to layer below. Keep insulation 1/2 inch clear of vertical surfaces penetrating and projecting from roof surface.

3.2.1 Special Precautions for Installation of Foam Insulation

3.2.1.1 Polyisocyanurate Insulation

Where polyisocyanurate foam board insulation is provided, install 1/2 inch

thick wood fiberboard, glass mat gypsum roof board, or 3/4 inch thick expanded perlite board insulation over top surface of foam board insulation. Stagger joints of insulation with respect to foam board insulation below.

3.2.2 Cant Strips

Where indicated, provide cant strips at intersections of roof with walls, parapets, and curbs extending above roof. Wood cant strips are not allowed. Fit cant strips flush against vertical surfaces. Where possible, nail cant strips to adjoining surfaces. Where cant strips are installed against non-nailable materials, install in heavy mopping of asphalt or set in a heavy coating of asphalt roof cement .

3.2.3 Tapered Edge Strips

Where indicated, provide edge strips in the right angle formed by junction of roof and wood nailing strips that extend above level of roof. Install edge strips flush against vertical surfaces of wood nailing strips. Where possible, nail edge strips to adjoining surfaces. Where installed against non-nailable materials, install in heavy mopping of asphalt or set in heavy coating of asphalt roof cement .

3.3 PROTECTION

3.3.1 Protection of Applied Insulation

Completely cover each day's installation of insulation with the finished roofing specified in 07 52 00 Modified Bituminous Membrane Roofing on same day. Do not permit phased construction. Protect open spaces between insulation and parapets or other walls and spaces at curbs, scuttles, and expansion joints, until permanent roofing and flashing are applied. Do not permit storing, walking, wheeling, or trucking directly on insulation or on roofed surfaces. Provide smooth, clean board or plank walkways, runways, and platforms near supports, as necessary, to distribute weight to conform to indicated live load limits of roof construction . Exposed edges of the insulation shall be protected by cutoffs at the end of each work day or whenever precipitation is imminent. Cutoffs shall be 2 layers of bituminous-saturated felt set in plastic bituminous cement set in roof cement. Fill all profile voids in cut-offs to prevent entrapping of moisture into the area below the membrane. Cutoffs shall be removed when work is resumed.

3.3.2 Damaged Work and Materials

Restore work and materials that become damaged during construction to original condition or replace with new materials.

3.4 INSPECTION

The Contractor shall establish and maintain an inspection procedure to assure compliance of the installed roof insulation with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Quality control shall include, but not be limited to, the following:

a. Observation of environmental conditions; number and skill level of insulation workers; start and end time of work.

b. Verification of certification, listing or label compliance with FM P9513.

c. Verification of proper storage and handling of insulation and vapor retarder materials before, during, and after installation.

d. Inspection of vapor retarder application, including edge envelopes and mechanical fastening.

e. Inspection of mechanical fasteners; type, number, length, and spacing.

f. Coordination with other materials, cants, sleepers, and nailing strips.

g. Inspection of insulation joint orientation and laps between layers, joint width and bearing of edges of insulation on deck.

h. Installation of cutoffs and proper joining of work on subsequent days.

i. Continuation of complete roofing system installation to cover insulation installed same day.

-- End of Section --

SECTION 07 27 00.45 10

BUILDING AIR BARRIER SYSTEM
05/12

PART 1 GENERAL

1.1 CONTRACTOR RESPONSIBILITY

The Contractor is responsible for the construction of an air barrier system that is contiguous and connected across the six surfaces of the building envelope meeting the performance requirements as outlined in this specification.

Perform a building air tightness test and thermography test to demonstrate that the building envelope is properly sealed and insulated. The testing shall be performed in accordance with the procedures outlined in this specification.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1060	(2011a) Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
ASTM D4541	(2009; E 2010) Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E1186	(2003; R 2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
ASTM E1827	(2011) Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
ASTM E779	(2010) Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 6781	(1983) Thermal Insulation - Qualitative Detection of Thermal Irregularities in Building Envelopes - Infrared Method

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control

approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Building Air Tightness Test Procedures; G
Thermography Test Procedures

SD-06 Test Reports

Test Report
Building Air Tightness Test
Thermography Test Report

SD-07 Certificates

Air Barrier Inspector
Building Air Tightness Test Technician

1.4 ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS

This section includes administrative and procedural requirements for accomplishing an airtight building enclosure that controls infiltration or exfiltration of air.

a. Coordinate between the trades, the proper scheduling and sequencing of the work, preconstruction meetings, inspections, tests, and related actions including inspection and test reports.

b. Ensure that all penetrations through the air barrier system, and all paths of air infiltration or exfiltration, are sealed airtight.

1.4.1 Air Barrier System

The airtight components of the building enclosure and the joints, junctures and transitions between materials, products, and assemblies forming the airtightness of the building enclosure are called the air barrier system.

1.4.2 Air Barrier System Characteristics

Ensure that the intent of constructing the building enclosure with a continuous air barrier system to control air leakage into or out of the conditioned space is achieved. The air barrier system shall have the following characteristics:

a. Continuous with all joints sealed.

b. Structurally supported to withstand positive and negative air pressures applied to the building enclosure.

c. Connection shall be made between:

(1) Foundation and walls
(2) Walls and windows
(3) Walls and doors
(4) Different wall systems

(5) Walls and roof
(6) Walls and roof over unconditioned space
(7) Walls, floors, and roofs across construction, control, and expansion joints.
(8) Walls, floors, and roofs to utility, pipe and duct penetrations.

1.4.3 Inspection and Testing Services

Inspection and testing services are required to verify compliance with requirements specified or indicated. The inspection and testing agency shall submit a certified written test report, in duplicate, of each inspection, test, or similar service to the Contractor with duplicate copies to the Contracting Officer's Representative not later than 10 days after each test.

Written reports of each inspection and test or similar service shall include all the report items described in ASTM E1827. Additionally, the report shall also include the following information:

a. Date of Issue
b. Project title and number
c. Name, address, and telephone number of testing agency
d. Dates and locations of samples and tests or inspections
e. Names of individuals making the inspection or test
f. Designation of the Work and test method
g. Identification of product and Specification Section
h. Complete inspection or test data
i. Test results and an interpretation of test results
j. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements
k. Name and signature of laboratory inspector
l. Recommendations on retesting

1.5 BUILDING AIR TIGHTNESS TEST TECHNICIAN RESPONSIBILITIES

The testing technician shall have 2 years experience in air tightness testing using the specified testing standard. Technician duties include:

a. Describe the test procedures, test apparatus, and analysis method.

b. Perform the Building Air Tightness Test.

c. Perform the Thermography Test.

d. Participate in identifying deficiencies in the building construction upon failure of a test to meet the specified leakage rate.

e. Submit a report of each air tightness test whether successful or not not later than 10 days after the test.

f. Submit a report of each thermography test identifying problem areas not later than 10 days after the test.

1.6 QUALITY CONTROL

Engage the services of an experienced air barrier inspector to oversee the sequencing and installation of the air barrier component materials and assemblies, to oversee the proper joining and sealing of the materials and assemblies, to oversee the sealing of penetrations of the air barrier

materials and assemblies, and to instruct the subcontractors on the above.

1.6.1 Qualifications

The inspector shall have 2 years experience in the installation of air barrier materials and assemblies including the experience in joining and sealing various components, and sealing of penetrations of air barriers. The inspector shall have experience coordinating and instructing subcontractors involved in the installation joining an sealing of air barrier materials and components.

1.6.2 Documentation and Reporting

Installers shall document the entire installation process on daily job site reports. These reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results.

1.7 CONTRACTOR RESPONSIBILITIES

1.7.1 Coordination of Sub-Contractor(s)

Provide coordination between the Sub-Contractors involved in the construction of the air barrier system, coordinate the sequence of construction to ensure continuity of the air barrier system joints, junctures, penetrations, and transitions between materials and assemblies of materials and products from substructure to walls to roof. Provide quality assurance procedures, testing and verification as specified. Facilitate inspections, tests, and other quality control services specified elsewhere in the Contract Documents and required by the Contracting Officer's Representative.

1.7.2 Pre-Construction Conferences

Organize pre-construction conferences between the sub-contractors involved in the construction of or penetration of the air barrier system and the air barrier inspector to discuss where each sub-contractor begins and ends, the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, penetrations and transitions between materials, products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.

1.7.3 Construction Mock-Up

Build a construction mock-up of every joint, juncture, and transition between materials, products, and assemblies of products specified in the different sections to be installed. Work will not begin until the mock-up is satisfactory to the Contracting Officer's Representative.

1.8 AIR BARRIER SYSTEM PERFORMANCE REQUIREMENTS

The air leakage of the entire building shall meet the air requirements as specified in paragraph BUILDING AIR TIGHTNESS TEST.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 REPAIR AND PROTECTION

Upon completion of inspection, testing, or sample taking and similar services, repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

3.2 TESTING AND INSPECTION

The following qualitative and quantitative tests and inspections shall be conducted in the presence of the Contracting Officer's Representative during installation of the air barrier system.

a. Qualitative Testing and Inspection:

(1) Provide a Daily Report of Observations with a copy to the Contracting Officer's Representative.

(2) Ensure continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.

(3) Ensure structural support of the air barrier system to withstand design air pressures.

(4) Ensure masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.

(5) Ensure site conditions for application temperature, and dryness of substrates are within guidelines.

(6) Ensure substrate surfaces are properly primed.

(7) Ensure laps in materials are at least a 2-inch minimum, shingled in the correct direction or mastic applied on exposed edges with no fishmouths.

(8) Ensure that mastic is applied on cut edges.

(9) Ensure that a roller has been used to enhance adhesion.

(10) Measure application thickness of liquid applied materials to manufacturer's specifications for the specific substrate.

(11) Ensure that the correct materials are installed for compatibility.

(12) Ensure proper transitions for change in direction and structural support at gaps.

(13) Ensure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

b. Quantitative Tests:

(1) Provide written test reports of all tests performed with a copy to the Contracting Officer's Representative.

(2) Determine the bond strength of coatings to substrate in accordance with ASTM D4541.

3.3 BUILDING AIR TIGHTNESS TEST

A building air tightness test shall follow the guidance in the U.S. Army Corps of Engineers Air Leakage Test Protocol for Measuring Air Leakage in Buildings. This protocol is available on the Whole Building Design Guide website- http://www.wbdg.org/references/pa_dod_energy.php. The fan pressurization test to determine final compliance with the airtightness requirement shall be conducted when all components of the air barrier system have been installed and inspected, and have passed any intermediate testing procedures as detailed in the construction drawings and specifications. The test may be conducted before finishes that are not part of the air barrier system have been installed. For example, if suspended ceiling tile, interior gypsum board, or cladding systems are not part of the air barrier system, the test may be conducted before they are installed.

3.3.1 Test Requirements

Perform the air leakage test in accordance with ASTM E779; submit detailed test methods and procedures indicating the test apparatus, and the analysis methods to be employed for the Building Air Tightness Test not later than 60 days after Notice to Proceed with the following additions and exceptions::

a. The test consists of measuring the flow rates required to establish a minimum of 12 positive and 12 negative building pressures. The lowest test pressure shall be 3.75 psi; the highest test pressure shall be 11.25 psi; and there must be at least 3.75 psi difference between the lowest and highest test pressures.

b. Measure the test pressure in a representative location such that pressures in the extremities of the enclosure can be shown to not exceed 10 percent of the measured test pressure. At least 12 bias pressure readings must be taken across the envelope and averaged over at least 20 seconds each before and after the flow rate measurements. None of the bias pressure readings must exceed 30 percent of the minimum test pressure when testing in both directions.

c. Where it can be shown that it is impossible to test in both directions, then the building may be tested in the positive direction only, provided the bias pressure does not exceed 10 percent of the minimum test pressure.

d. The mean value of the air leakage flow rate calculated from measured data at 0.3 in wg shall not exceed 0.25 cu ft/minute per square foot of envelope area and the upper confidence limit as defined by ASTM E779. Reference measurements at standard conditions of 14.696 psi and 68 degrees F. The envelope area is to be supplied and confirmed by the Designer of Record (DOR).

e. Conduct the test with ventilation fans and exhaust fans turned off and the outdoor air inlets and exhaust outlets sealed (by dampers or masking). Provide a responsible HVAC technician with the authority to place the HVAC system in the correct mode for the pressure test. The test technician shall have unhindered access to mechanical rooms, air handlers, exhaust fans, and outdoor air and exhaust dampers.

f. Ensure that all windows in the enclosure are kept closed. Prohibit entry and exit through doors in the test enclosure during the test. Discard data collected while the pressures and flows are affected by a door opening and closing.

g. Report the results of the Building Air Tightness Test. Perform a diagnostic evaluation in accordance with ASTM E1186, whether the building achieves the air tightness requirement or not. Use the diagnostic evaluation to assist in identifying and eliminating air leakage so the building meets the requirement upon retesting. Also, express the testing results in terms of the Equivalent Leakage Area (EqLA) at 11.25 psi. The EqLA is the equivalent area of a flat plate that leaks the same amount as the building envelope at 11.25 psi.

3.4 THERMOGRAPHY TEST

Test the building envelope using Infrared Thermography technology. The thermography testing shall be completed in accordance with the requirements of ASTM C1060 and ISO 6781. The Contracting Officer's Representative will witness the testing. Testing shall occur just before the building air tightness test. Testing shall also occur during the air tightness test so that areas of building air leaks are detected. If the building air tightess test is failed, thermographic testing shall be repeated just before and during subsequent air tightness tests until the air tightness test is successful.

3.4.1 Thermography Test Procedures

Submit detailed test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed not later than 60 days after Notice to Proceed.

3.4.2 Thermography Test Report

Provide a report. The report shall include thermographs in color and a color temperature scale to define the temperature indicated by the various colors. The report shall identify the high temperature reading, the outdoor air temperature, the building indoor air temperature, and the wind speed and direction. The report shall note any areas of compromise in the building envelope, and shall note all actions required and taken to correct those areas.

3.4.3 Final Test

Final thermography test report shall demonstrate the problem areas have been corrected. Submit the complete test and analysis for review and approval.

-- End of Section --

SECTION 07 27 15

SELF-ADHERING SHEET MEMBRANE AIR BARRIERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E2178	(2013) Standard Test Method for Air Permeance of Building Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Self-adhering sheet membrane air barrier

Submit material description and physical properties, application details, and recommendations regarding shelf life, application procedures, and precautions on flammability and toxicity.

1.3 PREINSTALATION CONFERENCE

Prior to starting application of materials, arrange and attend a conference to ensure a clear understanding of drawings and specifications. Give the Contracting Officer's Representative 7 days advance written notice of the time and place of meeting. Ensure that the mechanical and electrical subcontractor, flashing and sheetmetal subcontractor, and other trades that may perform other types of work on or over the membrane after installation, attend this conference.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials in manufacturer's original, unopened containers, with labels intact and legible. Containers of materials covered by a referenced specification number shall bear the specification number, type, and class of the contents. Deliver materials in sufficient quantity to continue work without interruption. Store and protect materials in accordance with manufacturer's instructions, and use within their indicated shelf life. When hazardous materials are involved, adhere to special precautions of the manufacturer, unless precautions conflict with local, state, and federal regulations. Promptly remove from the site materials or incomplete work adversely affected by exposure to moisture or freezing. Store materials on pallets and cover from top to bottom with canvas tarpaulins.

1.5 ENVIRONMENTAL CONDITIONS

Apply barrier materials within the weather conditions and the range of ambient and substrate temperatures specified by the materials manufacturer. Do not apply to a wet substrate.

PART 2 PRODUCTS

2.1 SELF-ADHERING SHEET MEMBRANE AIR BARRIER

Product and Manufacturer: Perm-A-Barrier Wall Membrane; Grace Construction Products, Carlisle, Henry, or equal.

Thickness: 3/16-inch, nominal.

Air Permeance (In Place): 0.0002 cfm/square foot; ASTM E2178

2.2 AUXILLARY MATERIALS

Provide transition membrane materials, flexible membrane and wall flashing, primers, sealant, and other materials required for a complete installation.

PART 3 EXECUTION

3.1 PREPARATION

Examine conditions of substrates, areas and other conditions under which materials will be applied for compliance with requirements. Verify that surfaces and conditions are suitable prior to commencing work of this section. Notify the contractor in writing of circumstances detrimental to the proper completion of the work. Do not proceed with installation until unsatisfactory conditions have been corrected. Coordinate work with that of other trades to ensure that components to be incorporated into the air barrier system are available when needed. Inspect and approve surfaces immediately before application of materials. Remove laitance, loose aggregate, sharp projections, grease, oil, dirt, curing compounds, and other contaminants which could adversely affect the complete bonding of the fluid-applied membrane to the concrete surface.

3.2 INSTALLATION

Install materials in accordance with manufacturer's instructions and recommendations.

-- End of Section --

SECTION 07 27 26

FLUID-APPLIED MEMBRANE AIR BARRIERS
02/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E96/E96M	(2012) Standard Test Methods for Water Vapor Transmission of Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fluid-applied membrane air barrier

Submit material description and physical properties, application details, and recommendations regarding shelf life, application procedures, and precautions on flammability and toxicity.

1.3 PREWATERPROOFING PREINSTALATION CONFERENCE

Prior to starting application of air barrier system, arrange and attend a conference to ensure a clear understanding of drawings and specifications. Give the Contracting Officer's Representative 7 days advance written notice of the time and place of meeting. Ensure that the mechanical and electrical subcontractor, flashing and sheetmetal subcontractor, and other trades that may perform other types of work on or over the membrane after installation, attend this conference.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials in manufacturer's original, unopened containers, with labels intact and legible. Containers of materials covered by a referenced specification number shall bear the specification number, type, and class of the contents. Deliver materials in sufficient quantity to continue work without interruption. Store and protect materials in accordance with manufacturer's instructions, and use within their indicated shelf life. When hazardous materials are involved, adhere to special precautions of the manufacturer, unless precautions conflict with local, state, and federal regulations. Promptly remove from the site materials or incomplete work adversely affected by exposure to moisture or freezing. Store materials on pallets and cover from top to bottom with canvas tarpaulins.

1.5 ENVIRONMENTAL CONDITIONS

Apply air and vapor barrier within the weather conditions and the range of ambient and substrate temperatures specified by the materials manufacturer. Do not apply to a wet substrate.

1.6 COMMISSIONING

Refer to Section 01 91 13 Commissioning.

PART 2 PRODUCTS

2.1 FLUID-APPLIED MEMBRANE AIR BARRIER

Product and Manufacturer: Perm-A-Barrier Liquid; Grace Construction Products, Tremco, Henry, or equal.

Air Permeance: 0.00012 cfm/square foot at 75Pa pressure difference

Water Vapor Transmission: 0.05 perms max, ASTM E96/E96M

2.2 AUXILLARY MATERIALS

Provide sealants, transition and flashing membrane materials, primers, mastic, and other materials required for a complete installation.

PART 3 EXECUTION

3.1 PREPARATION

examine conditions of substrates, areas and other conditions under which air barrier systems will be applied for compliance with requirements. Verify that surfaces and conditions are suitable prior to commencing work of this section. Notify the contractor in writing of circumstances detrimental to the proper completion of the work. Do not proceed with installation until unsatisfactory conditions have been corrected. Coordinate work with that of other trades to ensure that components to be incorporated into the air barrier system are available when needed. Inspect and approve surfaces immediately before application of materials. Remove laitance, loose aggregate, sharp projections, grease, oil, dirt, curing compounds, and other contaminants which could adversely affect the complete bonding of the fluid-applied membrane to the concrete surface.

3.1.1 Cracks and Joints

Prepare visible cracks and joints in substrate to receive fluid-applied membrane in accordance with manufacturer's requirements.

3.2 INSTALLATION

Install air barrier materials in accordance with manufacturer's instructions and recommendations.

Remove any masking materials after installation. Clean spillage and soiling on adjacent construction using cleaning agents and procedures recommended by manufacturer of the affected construction. Protect membranes to avoid damage from other trades, and construction materials during subsequent operations. Schedule work so that the air and vapor

barrier system is covered as soon as possible after installation.

-- End of Section --

SECTION 07 42 13

METAL WALL PANELS
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM-105	(2005; Errata 2005) Aluminum Design Manual
AA ASD1	(2009) Aluminum Standards and Data

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2010; Change 2010; Change 2011; Errata 2011; Change 2011) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See Section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 DEFINITIONS

Metal Wall Panel: Metal wall panels, attachment system components and accessories necessary for a complete weather-tight wall system.

1.4 DESCRIPTION OF WALL PANEL SYSTEM

Manufactured insulated metal wall panel.

Aluminum composite material panel.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sample Warranty

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Submit Manufacturer's catalog data for the following items:

Aluminum Composite Material Panels; (LEED NC)

Manufactured Insulated Metal Wall Panels; (LEED NC)

Factory Color Finish

Closure Materials

Sealants and Caulking; (LEED NC)

Accessories

SD-04 Samples

Submit as required each of the following samples:

Aluminum Composite Material Panels, 12 inches long by actual panel width; G

Manufactured Insulated Metal Wall Panels 12 inches long by actual panel width; G

Aluminum Composite Material Column Covers, 12 inches long by actual panel width; G

Color chart and chips

Submit manufacturer's color charts and chips, approximately 4 by 4 inches, showing full range of colors, textures and patterns available for wall panels with factory applied finishes.

SD-08 Manufacturer's Instructions

Include detailed maintenance instructions, application and installation instructions and standard manufacturer drawings altered as required by these specifications.

Installation of Aluminum Composite Material Wall Panels

Installation of Manufactured Insulated Metal Wall Panels

Installation of Aluminum Composite Material Column Covers, 12 inches long by actual panel width;

Maintenance Instructions

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content
Low Emitting Materials - Adhesives and Sealants

1.6 QUALITY ASSURANCE

1.6.1 Installation Drawings

Installation shop drawings for wall panels, flashing, accessories, and anchorage systems must indicate completely dimensioned structural frame and erection layouts, openings in the wall, special framing details, and construction details at corners, building intersections and flashing, location and type of mastic and metal filler strips.

Drawings shall show interface with surrounding conditions accurately as well as placement of sealants and attachment anchors.

1.6.2 Single Source

Obtain each type of metal wall panels, clips, closure materials and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.6.3 Manufacturer's Maintenance Instructions

Provide manufacturer's detailed written instructions including copies of Material Safety Data Sheets for maintenance and repair materials.

1.7 DELIVERY, HANDLING, AND STORAGE

Deliver and protect package components, sheets, metal wall panels, and other manufactured items to prevent damage or deformation during transportation and handling.

Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

Stack and store metal wall panels horizontally on platforms or pallets, covered with suitable weather-tight and ventilated covering to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

Retain strippable protective covering on metal wall panel until actual

installation.

1.8 PROJECT CONDITIONS

1.8.1 Field Measurements

Verify locations of wall framing and opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.

1.8.2 Weather Limitations

Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into wall system or building.

1.9 WARRANTY

Warranty must conform to the Sample Warranty as reviewed and approved by the Contracting Officer's Representative.

1.9.1 Warranty

Finish Warranty: Furnish manufacturer's minimum 20 year finish warranty for the insulated wall panels and aluminum composite material panels. The warranty period is to be no less than twenty (20) years from the date of Government acceptance of the work. The warranty is to be issued directly to the Government. The warranty is to provide that if within the warranty period the metal wall panel system shows evidence of corrosion, perforation, rupture or excess weathering due to deterioration of the wall panel finish resulting from defective materials the correction of the defective workmanship is to be the responsibility of the metal wall panel system manufacturer.

Installers Warranty for Aluminum Composite Material Panels Warranty: The fabricator and installer shall warrant the panel installation for a period of 1 year that the fabrication and installation workmanship will be free from defects.

PART 2 PRODUCTS

2.1 MANUFACTURED INSULATED METAL WALL PANELS

Product and Manufacturer: Thermalspan 300, 300 Minor Rib Insulated Exterior Wall Panel System; Kingspan USA, Deland, FL, or equal.

Notice of Acceptance: NOA 09-0506.04; expiration date 09.25.13

Panel Thickness: 2 inches.

Joint Configuration: Interlocking parallel tongue and groove.
Insulation Core: Foamed-in-place or Laminated polyisocyanurate with nominal density of 2.3 - 2.6 lbs./cu.ft.

Material:

Exterior: Minimum 26 gauge stuffo embossed steel, AZ50 Galvalume/ Zincalume.
Interior: Minimum 26 gauge stucco embossed steel, AZ50 Galvalume/

Zincalume.

Exterior Finish: High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF or FEVE resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

Color: To be selected by Contracting Officer's Representative from manufacturer's full color line.

Interior Finish: Manufacturer's standard finish.

Color: To be selected by the Contracting Officer's Representative from manufacturer's full color line.

2.2 ALUMINUM COMPOSITE MATERIAL PANELS

Product and Manufacturer: Reynobond Aluminum Composite Material (ACM); Alcoa Architectural Products, Eastman, GA or equal.

Notice of Acceptance: Provide one of the following fabricator's NOA certification or NOA certification from other equal fabricators.

Miller Clapperton Partnership Inc.: NOA 09-0520.09; expiration date July 1, 2014

Kistler McDougall Corp.: NOA 12-0625.12 (small missile impact), NOA 12-0625.13 (large missile impact); expiration date

Core: Polyethylene Core (PE)
Panel Thickness: 4mm
Face Sheet Thickness: 0.020 inches.

Panel Finish: High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF or FEVE resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

Color: Match Contracting Officer's Representative's sample.

2.3 ALUMINUM COMPOSITE MATERIAL COLUMN COVERS

Product and Manufacturer: Reynobond Aluminum Composite Material (ACM); Alcoa Architectural Products, Eastman, GA or equal.

Core: Polyethylene Core (PE)
Panel Thickness: 4mm
Face Sheet Thickness: 0.020 inches.

Panel Finish: High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF or FEVE resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

Color: Match Contracting Officer's Representative's sample.

2.4 FABRICATION

Unless approved otherwise, fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated and specified performance requirements. Comply with indicated profiles and with dimensional and structural requirements. See section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements.

2.4.1 Sheet Metal Accessories

Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: fabricate nonmoving end seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA 1793.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA 1793 or by metal wall panel manufacturer for application, but not less than thickness of metal being secured.

2.5 PANEL MATERIALS

2.5.1 Aluminum Sheet

a. Aluminum Sheet conforming to ASTM B209, AA ASD1 and AA ADM-105.

2.5.2 Factory Color Finish

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes. Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

All panels are to receive a factory-applied Kynar 500/Hylar 5000 finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat.

Provide exterior finish color as selected by the Contracting Officer from the manufacturer's standard color chart.

2.6 MISCELLANEOUS METAL FRAMING

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M and specified in Section 05 40 00 COLD-FORMED METAL FRAMING unless other wise indicated.

2.6.1 Fasteners for Miscellaneous Metal Framing

Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 1 inch with other properties required to fasten miscellaneous metal framing members to supporting members and substrates in accordance with the wall panel manufacturer's and ASCE 7 requirements.

2.7 FASTENERS

2.7.1 General

2.7.1.1 Exposed Fasteners

Provide corrosion resistant fasteners for wall panels, made of 300 series corrosion resisting stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads.

Fasteners for accessories must be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately 3/32 inch thick.

2.7.1.2 Hidden Fasteners

Provide corrosion resistant fasteners recommended by the manufacturer to meet the performance requirements and design loads.

2.7.1.3 Screws

Screws to be 300 - series stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

2.7.1.4 Attachment Clips

Fabricate clips from aluminum. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.8 ACCESSORIES

2.8.1 General

All accessories must be compatible with the metal wall panels. Sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the wall panels. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips must be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

2.8.2 Joint Sealants

2.8.2.1 Sealants and Caulking

Provide sealants approved by the panel manufacturer.

2.9 SHEET METAL FLASHING AND TRIM

2.9.1 Fabrication

All flashing exposed to view shall be prefinish to match finish type and color for adjacent metal panels.

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.10 REPAIR OF FINISH PROTECTION

Repair paint for color finish enameled wall panel must be compatible paint of the same formula and color as the specified finish furnished by the wall panel manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of the Work.

Examine primary and secondary wall framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal wall panel manufacturer, UL, ASTM, ASCE 7 and as required for the geographical area where construction will take place.

Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

Submit to the Contracting Officer's Representative a written report, endorsed by Installer, listing conditions detrimental to performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment. Miscellaneous framing installation, including sub-purlins, girts, angles, furring, and other miscellaneous wall panel support members and anchorage must be according to metal wall panel manufacturer's written instructions.

3.3 INSTALLATION

Install panels in a fully watertight manner.

Provide full length metal wall panels, from sill to eave as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement in accordance with panel manufacturer's instructions and recommendations.

Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Bent, chipped, or defective sheets shall not be applied.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated eave, and sill.

Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

Field cutting metal wall panels by torch is not permitted.

3.3.1 Aluminum Wall Panels

Use stainless-steel fasteners for exterior surfaces .

3.3.2 Anchor Clips

Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

3.3.3 Metal Protection

Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

3.4 FASTENER INSTALLATION

Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

3.5 FLASHING, TRIM AND CLOSURE INSTALLATION

3.5.1 General Requirements

Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams to form permanently watertight and weather resistant.

3.6 WORKMANSHIP

Make lines, arises, and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections which might affect the application. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight.

3.7 ACCEPTANCE PROVISIONS

3.7.1 Erection Tolerances

Erect metal wall panels straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions.

3.7.2 Repairs to Finish

Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials. Finished repaired surfaces must be uniform and free from variations of color and surface texture.

Repaired metal surfaces that are not acceptable to the project requirements and/or Contracting Officer's Representative are to be immediately removed and replaced with new material.

3.8 CLEAN-UP AND DISPOSAL

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces must be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

Collect and place scrap/waste materials in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site; transport demolished materials from government property and legally dispose of them.

-- End of Section --

SECTION 07 52 00

MODIFIED BITUMINOUS MEMBRANE ROOFING
05/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/SPRI ES-1	(2003) Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2010; Change 2010; Change 2011; Errata 2011; Change 2011) Minimum Design Loads for Buildings and Other Structures

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.24	(2006) Roofing - Safety Requirements of Low-Sloped Roofs

ASPHALT ROOFING MANUFACTURER'S ASSOCIATION (ARMA)

ARMA 410BUR88	(2001) Manual of Roof Maintenance and Repair
ARMA 460LSR97	(2002) NRCA/MRCA Repair Manual for Low Slope Membrane Roof Systems
ARMA PMBRG98	(1998) Quality Control Guideline for the Application of Polymer Modified Bitumen Roofing

ASTM INTERNATIONAL (ASTM)

ASTM E1980	Standard practice for calculating solar reflectance index of horizontal and low-sloped opaque surfaces
ASTM C1153	(2010) Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
ASTM C1289	(2013) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D2170/D2170M	(2010) Kinematic Viscosity of Asphalts (Bitumens)

ASTM D312	(2000; R 2006) Standard Specification for Asphalt Used in Roofing
ASTM D4073	(2006) Standard Test Method for Tensile-Tear Strength of Bituminous Roofing Membranes
ASTM D41/D41M	(2011) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D4402	(2006) Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
ASTM D4586	(2007) Asphalt Roof Cement, Asbestos-Free
ASTM D5147/D5147M	(2011a) Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material
ASTM D6163	(2000; R 2008) Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements
ASTM D6164/D6164M	(2011) Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements
ASTM E108	(2011) Fire Tests of Roof Coverings

FM GLOBAL (FM)

FM 4470	(2010) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA Details	(2003) NRCA Roof Perimeter Flashing Systems Construction Details for Class 1 Roof Construction

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

UNDERWRITERS LABORATORIES (UL)

UL 790	(2004; Reprint Oct 2008) Standard Test Methods for Fire Tests of Roof Coverings
UL RMSD	(2012) Roofing Materials and Systems

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 DESCRIPTION OF ROOF MEMBRANE SYSTEM

Minimum three-ply SBS modified bitumen roof membrane consisting of modified bitumen base sheet ,interply sheet and cap sheet. Modified bitumen roof membrane must be set in hot asphalt.

All work must follow the NRCA guidelines and standards stated within this Section.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roof plan; G drawing depicting wind loads and boundaries of enhanced perimeter and corner attachments of roof system components, as applicable

SD-03 Product Data

Modified Bitumen Sheets (LEED NC)

Sample Warranty certificate (LEED NC)

Submit all data required by Section 07 22 00 ROOF AND DECK INSULATION, together with requirements of this section. Include in data written acceptance by the roof membrane manufacturer of the products and accessories provided. Products must be as listed in the applicable wind uplift and fire rating classification listings, unless approved otherwise by the Contracting Officer.

SD-05 Design Data

Wind Uplift Calculations; G

Provide Engineering calculations, signed, sealed, and dated by a qualified Engineer validating the wind resistance per ASCE 7, ASTM D4073, and ANSI/SPRI ES-1 of non-rated roof system.

SD-07 Certificates

Provide evidence that products used within this specification are manufactured in the United States.

Qualification of Manufacturer

Certify that the manufacturer of the modified bitumen membrane meets requirements specified under paragraph entitled "Qualification of Manufacturer."

Qualification of Applicator

Certify that the applicator meets requirements specified under paragraph entitled "Qualification of Applicator."

Qualification of Engineer of Record

Certify that the Engineer of Record is fully qualified, competent, and currently licensed to practice in the project jurisdiction.

Wind Uplift Resistance classification, as applicable

Fire Resistance classification

Submit the roof system assembly wind uplift and fire rating classification listings.

SD-08 Manufacturer's Instructions

Modified Bitumen Membrane Application

Flashing

Temperature Limitations for Asphalt

Base Sheet attachment, including pattern and frequency of mechanical attachments required in field of roof, corners, and perimeters to provide for the specified wind resistance.

Fasteners

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications. Explicitly identify in writing, differences between manufacturer's instructions and the specified requirements.

SD-11 Closeout Submittals

Warranty
Information Card
Instructions To Personnel

Include copies of Material Safety Data Sheets for maintenance/repair materials.

Submit 20 year "No-Dollar-Limit" warranty for labor and materials.

1.5 QUALITY ASSURANCE

1.5.1 Qualification of Manufacturer

Modified bitumen sheet roofing system manufacturer must have a minimum of 5 years experience in manufacturing modified bitumen roofing products.

1.5.2 Qualification of Applicator

Roofing system applicator must be approved, authorized, or licensed in writing by the modified bitumen sheet roofing system manufacturer and have a minimum of five years experience as an approved, authorized, or licensed applicator with that manufacturer and be approved at a level capable of providing the specified warranty. The applicator must supply the names, locations and client contact information of five projects of similar size and scope that the applicator has constructed using the manufacturer's roofing products submitted for this project within the previous three years.

1.5.3 Qualification of Engineer of Record

Engineer of Record must be approved, authorized, and currently licensed by the state of Florida, and have a minimum of five years experience as an approved Engineer for manufacturers of similar roof systems. Engineer of Record must supply the names and locations of five projects of similar size and scope for which he has provided engineering calculations using the manufacturer's products submitted for this project within the previous three years. Engineer of Record must provide certified engineering calculations for:

Wind uplift requirementsin accordance with Local and State codes

ASCE 7,in accordance with International Building Code.

1.5.4 Fire Resistance

Complete roof covering assembly must:

a. Be Class A rated in accordance with ASTM E108, FM 4470, or UL 790; and

b. Be listed as part of Fire-Classified roof deck construction in UL RMSD, or Class I roof deck construction in FM APP GUIDE.

FM or UL approved components of the roof covering assembly must bear the appropriate FM or UL label.

1.5.5 Wind Uplift Resistance

The complete roof system assembly shall be rated and installed to resist wind loads indicated and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Non-rated systems must not be installed, except as approved by the Contracting Officer. Submit licensed engineer's Wind uplift calculations and substantiating data to validate any non-rated roof system.

1.5.6 Preroofing Conference

After approval of submittals and before performing roofing and insulation system installation work, hold a preroofing conference to review the following:

a. Drawings, including Roof Plan, specifications and submittals related to the roof work

Field inspection and verification of all existing conditions, including all fire safety issues, existing structure, and existing

materials, including concealed combustibles, which may require additional protection during installation.

b. Roof system components installation

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roof structure, and roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representatives to roof manufacturer

d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing

e. Quality control, (ARMA PMBRG98) plan for the roof system installation

f. Safety requirements

Coordinate preroofing conference scheduling with the Contracting Officer. The conference must be attended by the Contractor, the Contracting Officer's designated personnel, and personnel directly responsible for the installation of roofing and insulation, flashing and sheet metal work, mechanical and electrical work, other trades interfacing with the roof work, designated safety personnel trained to enforce and comply with ASSE/SAFE A10.24, Fire Marshall, and representative of the roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.5.7 Commissioning

Refer to Section 01 91 13 Commissioning.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery

Deliver materials in manufacturers' original unopened containers and rolls with labels intact and legible. Mark and remove wet or damaged materials from the site. Where materials are covered by a referenced specification, the container must bear the specification number, type, and class, as applicable. Labels or bill of lading for roofing asphalt must indicate asphalt type, FP, FBT, and EVT, that is, the temperature at which the viscosity is either 125 centistokes when tested in accordance with ASTM D2170/D2170M or 75 centipoise when tested in accordance with ASTM D4402. Deliver materials in sufficient quantity to allow work to proceed without interruption.

1.6.2 Storage

Protect materials against moisture absorption and contamination or other damage. Avoid crushing or crinkling of roll materials. Store roll materials on end on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer. Do not store roll materials in buildings under construction until concrete, mortar, and plaster work is finished and dry. Maintain roll materials at temperatures above 50 degrees F for 24

hours immediately before application. Do not store materials outdoors unless approved by the Contracting Officer. Completely cover felts stored outdoors, on and off roof, with waterproof canvas protective covering. Do not use polyethylene sheet as a covering. Tie covering securely to pallets to make completely weatherproof. Provide sufficient ventilation to prevent condensation. Do not store more materials on roof than can be installed the same day and remove unused materials at end of each days work. Distribute materials temporarily stored on roof to stay within live load limits of the roof construction.

Maintain a minimum distance of 35 foot for all stored flammable materials, including materials covered with shrink wraps, craft paper and/or tarps from all torch/welding applications.

Immediately remove wet, contaminated or otherwise damaged or unsuitable materials from the site. Damaged materials may be marked by the Contracting Officer.

1.6.3 Handling

Prevent damage to edges and ends of roll materials. Do not install damaged materials in the work. Select and operate material handling equipment to prevent damage to materials or applied roofing.

1.7 ENVIRONMENTAL REQUIREMENTS

Do not install roofing system when air temperature is below 40 degrees F, during any form of precipitation, including fog, or when there is ice, frost, moisture, or any other visible dampness on the roof deck. Follow manufacturer's printed instructions for Cold Weather Installation.

1.8 HOT-MOPPED ASPHALT APPLIED MODIFIED BITUMEN MEMBRANE SAFETY

1.9 SEQUENCING

Coordinate the work with other trades to ensure that components which are to be secured to or stripped into the roofing system are available and that permanent flashing and counter flashing, per NRCA Details, and are installed as the work progresses. Ensure temporary protection measures are in place to preclude moisture intrusion or damage to installed materials. Application of roofing must immediately follow application of insulation as a continuous operation. Coordinate roofing operations with insulation work so that all roof insulation applied each day is covered with roof membrane installation the same day.

1.10 WARRANTY

Provide roof system material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard membrane manufacturer warranty as required to comply with the specified requirements. Minimum manufacturer warranty shall have no dollar limit, cover full system water-tightness, and shall have a minimum duration of 20 years.

1.10.1 Roof Membrane Manufacturer Warranty

Furnish the roof membrane manufacturer's 20-year no dollar limit roof system materials and installation workmanship warranty, including flashing, insulation in compliance with ASTM C1289, and accessories

necessary for a watertight roof system construction. Provide warranty directly to the Government and commence warranty effective date at time of Government's acceptance of the roof work. The warranty must state that:

a. If within the warranty period the roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, blisters, splits, tears, delaminates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the roof system assembly and correction of defective workmanship are the responsibility of the roof membrane manufacturer. All costs associated with the repair or replacement work are the responsibility of the roof membrane manufacturer.

b. When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others does not void the warranty.

c. Damage to the roofing system caused by sustained winds having a velocity of or
less is covered by the warranty.

d. Upon completion of installation, and acceptance by the Contracting Officer and Roofing System Engineer of Record, the manufacturer must supply the appropriate warranty to the Owner.

e. Installer must submit a minimum two year warranty to the membrane manufacturer from the date of acceptance, with a copy to the Contracting Officer and Roofing System Engineer of Record.

1.10.2 Roofing System Installer Warranty

The roof system installer must warrant for a period of two years that the roof system, as installed, is free from defects in installation workmanship, to include the roof membrane, flashing, insulation, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Write the warranty directly to the Government. The roof system installer is responsible for correction of defective workmanship and replacement of damaged or affected materials. The roof system installer is responsible for all costs associated with the repair or replacement work.

1.10.3 Continuance of Warranty

Repair or replacement work, ARMA 410BUR88, ARMA 460LSR97 that becomes necessary within the warranty period and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the roof membrane manufacturer warranty for the remainder of the manufacturer warranty period.

1.11 CONFORMANCE AND COMPATIBILITY

The entire roofing and flashing system must be in accordance with specified and indicated requirements, including fire and wind resistance (ANSI/SPRI ES-1) requirements. Work not specifically addressed and any deviation from specified requirements must be in general accordance with recommendations of the NRCA Roofing and Waterproofing Manual, membrane

manufacturer published recommendations and details, and compatible with surrounding components and construction. Submit any deviation from specified or indicated requirements to the Contracting Officer for approval prior to installation.

1.12 SUSTAINABILITY REQUIREMENTS

Coordinate with Section 01 33 29 LEED(tm) DOCUMENTATION.

1.12.1 Local/Regional Materials

Contractor shall select materials so that a minimum of 20 percent (by dollar value) of materials and products for the project are extracted, harvested, or recovered, as well as manufactured, regionally within a 500 mile radius of the project site, per requirement in Section 01 33 29.

PART 2 PRODUCTS

2.1 MODIFIED BITUMINOUS MEMBRANE ROOFING

Modified Bituminous Membrane Roofing System Over Steel Deck and Insulation:

System and Manufacturer - Basis of Design: Johns Manville Modified Bitumen Roofing System; Johns Manville Corporation, or equal.

Notice of Acceptance Number: 13-0129.19

Expiration Date: 07/19/16

Modified Bituminous Membrane Roofing System Over Concrete Decks:

System and Manufacturer - Basis of Design: Johns Manville Modified Bitumen Roofing System; Johns Manville Corporation, or equal.

Notice of Acceptance Number: 13-0129.05

Expiration Date: June 28, 2016

2.2 MODIFIED BITUMEN SHEETS AND FIBERGLASS FELT MATERIALS

Furnish a combination of specified materials that comprise the modified bitumen manufacturer's standard system of the number and type of plies specified. Materials provided must be suitable for the service and climatic conditions of the installation. Modified bitumen sheets must be watertight and visually free of pinholes, particles of foreign matter, non-dispersed raw material, factory splices, or other conditions that might affect serviceability. Polymer modifier must comply with ARMA PMBRG98 and be uniformly dispersed throughout the sheet. Edges of sheet must be straight and flat.

a. SBS Base Sheet: DynaBase, ASTM D6164/D6164M Type I , Grade S, minimum 118 mils thick.

b. SBS Interply Sheet: DynaLastic 180S, ASTM D6163, Type I , Grade S, minimum 91 mils thick.

c. Membrane Cap Sheet: DynaGlas FR CR, ASTM D6163; Type I, Grade G, minimum 165 mils thick at selvage edge,

and as required to provide specified fire safety rating.

Solar Reflectance Index: Not less than 78 when calculated according to ASTM E1980, based on testing identical products by a qualified testing agency.

2.3 BASE FLASHING

Membrane manufacturer's modified bitumen membrane flashing system compatible with the roof membrane specified and as recommended in membrane manufacturer's published literature. Flashing membranes must meet or exceed the properties of the material standards specified for the modified bitumen base, interply and cap sheet, except that flashing membrane thickness must be as recommended by the membrane manufacturer.

2.4 PITCH PANS

Not allowed for use on this project. Provide reinforced liquid flashing system, Soprema Alsans, Manville PermaFlash or equal liquid flashing system installed at all penitration type details and locations where base flashing membrane is not suitable.

2.5 LIQUID MEMBRANE FLASHING

Membrane manufacturer's liquid membrane flashing compatible with the roof membrane specified and as recommended in membrane manufacturer's published literature.

2.6 ASPHALT

ASTM D312, Type III or IV, in accordance with modified bitumen membrane manufacturer requirements and compatible with the slope conditions of the installation.

2.7 MEMBRANE SURFACING

Provide modified bitumen roof membrane cap sheet with factory-applied granule surfacing of light color as selected from membrane manufacturer's standard colors. Provide modified bitumen membrane manufacturer's recommended field-applied protective coating of white color.

2.8 PRIMER

ASTM D41/D41M, or other primer compatible with the application and as approved in writing by the modified bitumen membrane manufacturer.

2.9 MODIFIED BITUMEN ROOF CEMENT

ASTM D4586, Type II for vertical surfaces, Type I for horizontal surfaces, compatible with the modified bitumen roof membrane and as recommended by the modified bitumen membrane manufacturer.

2.10 GALVANIZED METAL CANTS

Provide cants constructed of 16 gauge galvanized steel sheet by ARBS Alternative Roof Blocking Systems, or equal.

2.11 FASTENERS AND PLATES

Provide coated, corrosion-resistant fasteners as recommended by the modified bitumen sheet manufacturer's printed instructions and meeting the requirements of FM 4470 and FM APP GUIDE for Class I roof deck construction and the wind uplift resistance specified. For fastening of membrane or felts to wood materials, provide fasteners driven through 1 inch diameter metal discs, or one piece composite fasteners with heads not less than 1 inch in diameter or 1 inch square with rounded or 45 degree tapered corners.

2.11.1 Masonry or Concrete Walls and Vertical Surfaces

Use hardened steel nails or screws with flat heads, diamond shaped points, and mechanically deformed shanks not less than 1 inch long for securing felts, modified bitumen sheets, metal items, and accessories to masonry or concrete walls and vertical surfaces. Use power-driven fastenersonly when approved in writing by the Contracting Officer's Representative.

2.12 PRE-MANUFACTURED ACCESSORIES

Pre-manufactured accessories must be manufacturer's standard for intended purpose, compatible with the membrane roof system and approved for use by the modified bitumen membrane manufacturer.

Flashing Termination Bars: Manufacturer's standard stainless-steel or aluminum bars, prepunched; attached with noncorrosive fasteners.

Refer to 07 60 00 for 24ga stainless steel for all sheet metal flashing.

2.13 WALK SURFACE

Roof walk surface shall be an additional layer of roofing material.

2.14 ROOF INSULATION BELOW MODIFIED BITUMEN MEMBRANE SYSTEM

Specified in Section 07 22 00 ROOF AND DECK INSULATION.

2.15 ROOF MOUNTED EQUIPMENT

Refer to FBC chapter 15 requirements for roof mounted equipment including anchorage for high wind hurricane zones and clearance requirements for reroofing.

PART 3 EXECUTION

3.1 EXAMINATION

Ensure that the following conditions exist prior to application of the roofing materials:

a. Drains, curbs, cants, control joints, expansion joints, perimeter walls, roof penetrating components, and equipment supports are in place.

b. Surfaces are rigid, clean, dry, smooth, and free from cracks, holes, and sharp changes in elevation. Joints in the substrate are sealed to prevent dripping of bitumen into building or down exterior walls.

c. The plane of the substrate does not vary more than 1/4 inchwithin an area 10 by 10 foot when checked with a10 foot straight edge placed anywhere on the substrate.

d. Substrate is sloped as indicated to provide positive drainage.

e. Walls and vertical surfaces are constructed to receive counter flashing, and will permit mechanical fastening of the base flashing materials.

f. Provide metal nailers; treated wood nailers may be used as permitted only where approved by Contracting Officer.

g. Protect all combustible materials and surfaces which may contain concealed combustible or flammable materials. All fire extinguishing equipment has been placed as specified.

h. Verify all Fire Watch personnel assignments.

i. Cants are securely fastened in place in the angles formed by walls and other vertical surfaces. The angle of the cant is 45 degrees and the height of the vertical leg is not less than 3-1/2 inch.

j. Roof deck and framing are sloped as indicated to provide positive drainage.

3.2 PREPARATION

3.2.1 Protection of Property

3.2.1.1 Protective Coverings

Install protective coverings at paving and building walls adjacent to hoists, tankers, and kettles prior to starting the work. Lap protective coverings not less than 6 inch, secure against wind, and vent to prevent collection of moisture on covered surfaces. Keep protective coverings in place for the duration of the roofing work.

3.2.1.2 Bitumen Stops

Provide felt bitumen stops or other means to prevent bitumen drippage at roof edges, openings, and vertical projections before hot mopped application of the roofing membrane.

3.2.2 Equipment

3.2.2.1 Mechanical Application Devices

Mount mechanical application devices on pneumatic-tired wheels. Use devices designed and maintained to operate without damaging the insulation, roofing membrane, or structural components.

3.2.2.2 Flame-Heated Equipment

Do not place flame-heated equipment on roof. Provide and maintain a fire extinguisher adjacent to flame-heated equipment and on the roof.

3.2.2.3 Electric-Heated Equipment

Provide adequate electrical service as required by manufacturer of

electrical equipment to ensure against damage to equipment and property and to ensure proper application of roofing materials.

3.2.3 Heating of Asphalt

Break up solid asphalt on a surface free of dirt and debris. Heat asphalt in kettle designed to prevent contact of flame with surfaces in contact with the asphalt. Kettles must have visible working thermometer and thermostatic controls set to the temperature limits specified herein. Keep controls in working order and calibrated. Use immersion thermometer, accurate within a tolerance of plus or minus 1.8 degrees F, to check temperatures of the asphalt frequently. When temperatures exceed maximums specified, remove asphalt from the site. Do no permit cutting back, adulterating, or fluxing of asphalt.

3.2.3.1 Temperature Limitations for Asphalt

Heat and apply asphalt at the temperatures specified below unless specified otherwise by manufacturer's printed application instructions. Use thermometer to check temperature during heating and application. Have kettle attended constantly during heating process to ensure specified temperatures are maintained. Do not heat asphalt above its finished blowing temperature (FBT). Do not heat asphalt between 500 and 525 degrees F for longer than four consecutive hours. Do not heat asphalt to the flash point (FP). Apply asphalt and embed membrane sheets when temperature of asphalt is within plus or minus 25 degrees F of the equiviscous temperature (EVT) but not less than 400 degrees F. Before heating and application of asphalt refer to the asphalt manufacturer's label or bill of lading for FP, FBT, and EVT of the asphalt used.

3.2.4 Priming of Surfaces

Prime all surfaces to be in contact with adhered membrane materials. Apply primer at the rate of 0.75 gallon per 100 sq. ft. or as recommended by modified bitumen sheet manufacturer's printed instructions to promote adhesion of membrane materials. Allow primer to dry prior to application of membrane materials to primed surface. Avoid flammable primer material conditions in torch applied membrane applications.

3.2.4.1 Priming of Concrete and Masonry Surfaces

After surface dryness requirements have been met, coat concrete and masonry surfaces which are to receive membrane materials uniformly with primer.

3.2.4.2 Priming of Metal Surfaces

Prime flanges of metal components to be embedded into the roof system prior to setting in bituminous materials or stripping into roofing system.

3.2.5 Membrane Preparation

Unroll modified bitumen membrane materials and allow to relax a minimum of 30 minutes prior to installation. In cold weather, adhere to membrane manufacturer's additional recommendations for pre-installation membrane handling and preparation. Inspect for damage, pinholes, particles of foreign matter, non-dispersed raw material, factory splices, or other conditions that might affect serviceability. Edges of seams must be straight and flat so that they may be seamed to one another without

forming fish mouths or wrinkles. Discard damaged or defective materials.

3.2.6 Substrate Preparation

Apply membrane to clean, dry surfaces only. Don not apply membrane to surfaces that have been wet by rain or frozen precipitation within the previous 12 hours. Provide cleaning and artificial drying with heated blowers or torches as necessary to ensure clean, dry surface prior to membrane application.

3.3 APPLICATION

Apply roofing materials as specified herein unless approved otherwise by the Contracting Officer. Keep roofing materials dry before and during application. Complete application of roofing in a continuous operation. Begin and apply only as much roofing in one day as can be completed that same day. Maintain specified temperatures for asphalt. Provide temporary roofing and flashing as specified herein prior to application of permanent roofing system.

3.3.1 Phased Membrane Construction

Phased application of membrane plies is prohibited unless otherwise approved by the Contracting Officer and supported by the membrane manufacturer's written application instructions. If cap sheet installation is delayed, thoroughly clean the applied membrane material surface and dry immediately prior to cap sheet installation. Priming of the applied membrane surface may be required at the discretion of the Contracting Officer prior to cap sheet installation.

3.3.2 Temporary Roofing and Flashing

Provide watertight temporary roofing and flashing where considerable work by other trades, such as installing is to be performed on the roof or where construction scheduling or weather conditions require protection of the building's interior before permanent roofing system can be installed. Do not install temporary roofing over permanently installed insulation. Provide rigid pads for traffic over temporary roofing.

3.3.2.1 Removal

Completely remove temporary roofing and flashing before continuing with application of the permanent roofing system.

3.3.3 Application Method

3.3.3.1 Hot Asphalt Application of Modified Bitumen Membrane

Apply membrane immediately following application of hot asphalt. Apply hot asphalt within 6 foot of roll. Do not work ahead with asphalt. Asphalt must be completely fluid, with mop temperatures within the asphalt's EVT range, but not less than 400 degrees F, at the instant membrane comes into contact with asphalt. Application of bitumen between layers must be such as to provide full, continuous, uniform coverage and complete contact of hot asphalt with the sheet above and below. Embed sheets in asphalt. As sheets are being rolled into hot asphalt, immediately and thoroughly apply uniform positive pressure by squeegee, roll, or broom to ensure full adhesion and lap seal, eliminate trapped air and to provide tight, smooth laminations. Avoid excessive extrusion of

asphalt at lap areas. Control asphalt bleed out to approximately 25.4 mm 1 inch maximum.

3.3.4 Modified Bitumen Base Sheet

Fully adhere base sheets in accordance with membrane manufacturer's printed instructions. Roll and broom in the base sheet to ensure full contact with the hot asphalt application. On nailable substrates, mechanically fasten base sheet in conformance with specified wind resistance requirements and membrane manufacturer's printed instructions, and to include increased fastening frequency in corner and perimeter areas. Drive fasteners flush with no dishing or cupping of fastener plate. Where applicable, mechanically fasten base sheet in conjunction with insulation to the substrate, in accordance with membrane manufacturers printed instructions. Apply sheets in a continuous operation. Apply sheets with side laps at a minimum of 2 inch unless greater side lap is recommended by the manufacturer's standard written application instructions. Provide end laps of not less than 6 inch and staggered a minimum of 36 inch. Apply sheets at right angles to the roof slope so that the direction of water flow is over and not against the laps . Extend base sheets approximately 2 inch above the top of cant strips at vertical surfaces and to the top of cant strips elsewhere. Trim base sheet to a neat fit around vent pipes, roof drains, and other projections through the roof. Application must be free of ridges, wrinkles, and buckles.

3.3.5 Modified Bitumen Membrane Application

Ensure proper sheet alignment prior to installation. Apply membrane layers perpendicular to slope of roof in shingle fashion to shed water, including application on areas of tapered insulation that change slope direction. Bucking or backwater laps are prohibited. Fully adhere membrane sheets to underlying substrate materials. Provide minimum 3 inch side laps and minimum 6 inch end laps and as otherwise required by membrane manufacturer. Stagger end laps minimum 36 inch. Offset side laps between membrane layers a minimum of 12 inch. Offset end laps between membrane layers a minimum of 36 inch. Install all membrane layers the same workday, unless supported otherwise by roof membrane manufacturer application instructions and approved by the Contracting Officer. Provide tight smooth laminations of each membrane layer without wrinkles, ridges, buckles, kinks, fishmouths, or voids. Ensure full membrane adhesion and full lap seals. Rework to seal any open laps prior to application of subsequent membrane layers. The completed membrane application must be free of surface abrasions, air pockets, blisters, ridges, wrinkles, buckles, kinks, fishmouths, voids, or open seams.

3.3.5.1 Cap Sheet Installation

Underlying applied membrane must be inspected and repaired free of damage, holes, puncture, gouges, abrasions, and any other defects, and free of moisture, loose materials, debris, sediments, dust, and any other conditions required by the membrane manufacturer prior to cap sheet installation. Do not apply cap sheet if rain or frozen precipitation has occurred within the previous 24 hours. Align cap membrane and apply by the specified method with the proper side and end lap widths. Set cap sheet in hot asphalt or torch apply as recommended by the modified bitumen membrane manufacturer. Cut at a 45 degree angle across selvage edge of cap membrane to be overlapped in end lap areas prior to applying overlapping cap membrane. Apply matching granules in any areas of bitumen

bleed out while the asphalt is still hot. Minimize traffic on newly installed cap sheet membrane.

3.3.6 Membrane Flashing

Apply two-ply modified bitumen strip flashing and sheet flashing in the angles formed where the roof deck abuts walls, curbs, ventilators, pipes, and other vertical surfaces, and where necessary to make the work watertight. Apply membrane flashing in accordance with the roof membrane manufacturers printed instructions and as specified. Cut at a 45 degree angle across terminating end lap area of cap membrane prior to applying adjacent overlapping cap membrane. Press flashing into place to ensure full adhesion and avoid bridging. Ensure full lap seal in all lap areas. Mechanically fasten top edge of modified bituminous base flashing 150 mm (6 inches) on center through minimum 1 inch diameter tin caps with fasteners of sufficient length to embed minimum one inch into attachment substrate. Apply matching granules in any areas of asphalt bleed out while the asphalt is still hot. Apply membrane liner over top of exposed metal blocking and to overlap top edge of base flashing installation at curbs, parapet walls, expansion joints and as otherwise indicated to serve as waterproof lining under sheet metal flashing components. Metal flashing per SMACNA 1793 guidelines and standards is specified under Section 07 60 00 FLASHING AND SHEET METAL. Do not set metal flashing in hot asphalt.

3.3.6.1 Membrane Strip Flashing

Set primed flanges of metal flashing in full bed of modified bituminous cement material and securely fasten through to attachment substrate. Strip-in with membrane flashing so that strip extends not less than 4 inch beyond outer edge of flange. Where multiple membrane stripping plies are installed, extend each additional stripping ply minimum 4 inch beyond edge of previous ply.

3.3.6.2 Membrane Flashing at Roof Drain

Roof drains are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Flashing for roof drains, is specified in Section 07 60 00 FLASHING AND SHEET METAL. Extend membrane sheets to edge of drain bowl opening at the roof drain deck flange in accordance with membrane manufacturer's printed application instructions. Securely clamp membrane sheets and metal roof drain flashing and strip flashing in the flashing clamping ring. Secure clamps so that sheets and metal flashing are free from wrinkles and folds. Trim stripping must be flush with inside of clamping ring.

3.3.6.3 Pre-fabricated Curbs

Securely anchor prefabricated curbs to nailer or other base substrate and flash with modified bitumen membrane.

3.3.6.4 Set-On Accessories

Where pipe or conduit blocking, supports and similar roof accessories are set on the membrane, adhere walkpad material to bottom of accessories prior to setting on roofing membrane. Specific method of installing set-on accessories must permit normal movement due to expansion, contraction, vibration, and similar occurrences without damaging roofing membrane. Do not mechanically secure set-on accessories through roofing membrane into roof deck substrate.

3.3.6.5 Lightning Protection

Do not penetrate with roof membrane or base flashing membrane with conductor cable or other device not approved in advance by owner and architect.

Flash and attach lightning protection system components to the roof membrane in a manner acceptable to the roof membrane manufacturer. Do not penetrate roof membrane or base flashing membrane with conductor cable or other device not approved in advance by Contracting Officer.

3.3.7 Roof Walk Surface

Install walk surface at roof access points and where otherwise indicated for traffic areas and for access to mechanical equipment, in accordance with the modified bitumen sheet roofing manufacturer's printed instructions. Provide minimum 6 inch separation between adjacent walkpads to accommodate drainage.

3.3.8 Field Applied Surfacing

After completion of roof membrane and flashing installation, and correction of tears, gouges, and other deficiencies in the installed work, apply specified surfacing.

3.3.9 Correction of Deficiencies

Where any form of deficiency is found, additional measures will be taken as deemed necessary by the Contracting Officer to determine the extent of the deficiency and corrective actions must be performed as directed by the Contracting Officer.

3.3.10 Clean Up

Remove debris, scraps, containers and other rubbish and trash resulting from installation of the roofing system from job site each day.

3.4 CORRECTION OF DEFICIENCIES

Where any form of deficiency is found, additional measures must be taken as deemed necessary by the Contracting Officer to determine the extent of the deficiency and corrective actions must be as directed by the Contracting Officer.

3.5 PROTECTION OF APPLIED ROOFING

At the end of the day's work and when precipitation is imminent, protect applied modified bitumen roofing system from water intrusion.

3.5.1 Water Cutoffs

Straighten insulation line using loose-laid cut insulation sheets and seal the terminated edge of modified bitumen roofing system in an effective manner. Seal off flutes in metal decking along the cutoff edge. Remove the water cut-offs to expose the insulation when resuming work, and remove the insulation sheets used for fill-in.

3.5.2 Temporary Flashing for Permanent Roofing

Provide temporary flashing at drains, curbs, walls and other penetrations and terminations of roofing sheets until permanent flashing can be applied. Remove temporary flashing before applying permanent flashing.

3.5.3 Temporary Walkways, Runways, and Platforms

Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards, mats or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to live load limits of roof construction. Use rubber-tired equipment for roofing work.

3.6 FIELD QUALITY CONTROL

Perform field tests in the presence of the Contracting Officer. Notify the Contracting Officer one day before performing tests.

3.6.1 Construction Monitoring

During progress of the roof work, Contractor must make visual inspections as necessary to ensure compliance with specified parameters. Additionally, verify the following:

a. Materials comply with the specified requirements.

b. Materials are not installed in adverse weather conditions.

All materials are properly stored, handled and protected from moisture or other damages.

c. Equipment is in working order. Metering devices are accurate.

d. Substrates are in acceptable condition, in compliance with specification, prior to application of subsequent materials.

(1) Nailers and metal blocking only are provided where indicated and as needed.

Insulation substrate is smooth, properly secured to its substrate, and without excessive gaps prior to membrane application.

(2) The proper number, type, and spacing of fasteners are installed.

Membrane heating, hot mopping, or adhesive application is provided uniformly and as necessary to ensure full adhesion of roll materials. Asphalt is heated and applied within the specified temperature range.

The proper number and types of plies are installed, with the specified overlaps.

Applied membrane surface is inspected, cleaned, dry, and repaired as necessary prior to cap sheet installation.

(3) Lap areas of all plies are completely sealed.

Membrane is fully adhered without ridges, wrinkles, kinks, fishmouths, or other voids or delaminations.

Installer adheres to specified and detailed application parameters.

Associated flashing and sheet metal are installed in a timely manner in accord with the specified requirements.

Temporary protection measures are in place at the end of each work shift.

3.6.1.1 Manufacturer's Inspection

Manufacturer's technical representative must visit the site a minimum of three times during the installation for purposes of reviewing materials installation practices and adequacy of work in place.

Inspections must occur during the first 20 squares of membrane installation, at mid-point of the installation, and at substantial completion, at a minimum. Additional inspections must not exceed one for each 100 squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer. After each inspection, submit a report, signed by the manufacturer's technical representative to the Contracting Officer within 3 working days. Note in the report overall quality of work, deficiencies and any other concerns, and recommended corrective action.

3.6.2 Samples of Roofing

Take samples per ASTM D5147/D5147M, sized 4-inch by 40-inch cut across width of modified bitumen sheets as directed by the Contracting Officer. Cut samples will be examined by the Contracting Officer for specified number of plies, proper lap width, complete lap seal, full uniform adhesive compound application and adhesion, full bond between plies, harmful foreign materials, presence of moisture, and wet insulation. Where cuts are not retained by the Contracting Officer or disposed, set cut strip back in cut area in bed of modified bitumen cement. Repair area of cut with new minimum two-ply modified bitumen membrane patch.

3.6.3 Roof Drain Test

After completing roofing, but prior to Government acceptance, perform the following test for watertight integrity. Plug roof drains and fill with water to edge of drain sump for 8 hours. Do not plug secondary overflow drains at the same time as adjacent primary drain. To ensure some drainage from roof, do not test all drains at same time. Measure water at beginning and end of the test period. When precipitation occurs during test period, repeat test. When water level falls, remove water, thoroughly dry, and inspect installation; repair or replace roofing at drain to provide for a properly installed watertight flashing seal. Repeat test until there is no water leakage.

3.7 INFRARED INSPECTION

Eight months after completion of the roofing system, the Contractor must inspect the roof surface using infrared (IR) scanning as specified in ASTM C1153. Where the IR inspection indicates moisture intrusion, wet insulation and damaged or deficient materials or construction must be

replaced in a manner to provide watertight construction and maintain the specified roof system warranties.

3.8 INSTRUCTIONS TO PERSONNEL

Furnish written and verbal instructions on proper maintenance procedures to designated Government personnel. Furnish instructions by a competent representative of the modified bitumen membrane manufacturer and include a minimum of 4 hours on maintenance and emergency repair of the membrane. Include a demonstration of membrane repair, and give sources of required special tools. Furnish information on safety requirements during maintenance and emergency repair operations.

3.9 INFORMATION CARD

For each roof, furnish a typewritten information card for facility Records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved 0.039 inch thick aluminum card for exterior display. Card must be 8 1/2 by 11 inch minimum. Information card must identify facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, membrane, number of plies, method of application, manufacturer, insulation and cover board system and thickness; presence of tapered insulation for primary drainage, presence of vapor retarder; date of completion; installing contractor identification and contact information; membrane manufacturer warranty expiration, warranty reference number, and contact information. The card must be a minimum size of 8 1/2 by 11 inch. Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

-- End of Section --

SECTION 07 60 00

FLASHING AND SHEET METAL
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2013a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM D1970/D1970M	(2012) Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

1.2 GENERAL REQUIREMENTS

Finished sheet metalwork will form a weathertight construction without waves, warps, buckles, fastening stresses or distortion, which allows for expansion and contraction. Sheet metal mechanic is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades. Coordinate installation of sheet metal items used in conjunction with roofing with roofing work to permit continuous roofing operations.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Scuppers; G

Cap flashing

SD-03 Product Data

Submit manufacturer's catalog data for the following items.

Metal Downspout Protectors; G

SD-11 Closeout Submittals

Quality Control Plan

Submit for sheet metal work in accordance with paragraph entitled "Field Quality Control."

1.4 DELIVERY, HANDLING, AND STORAGE

Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the job site. Remove from the site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until immediately before installation.

PART 2 PRODUCTS

2.1 MATERIALS

Do not use galvanized steel. Use any metal listed by SMACNA Arch. Manual for a particular item, unless otherwise specified or indicated. Conform to the requirements specified and to the thicknesses and configurations established in SMACNA Arch. Manual for the materials. Different items need not be of the same metal

Furnish sheet metal items in 8 to 10 foot lengths. Single pieces less than 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 12 inch legs. Provide accessories and other items essential to complete the sheet metal installation. Provide accessories made of the same or compatible materials as the items to which they are applied. Fabricate sheet metal items of the materials specified below and to the gage, thickness, or weight shown in Table I at the end of this section. Provide sheet metal items with mill finish unless specified otherwise. Where more than one material is listed for a particular item in Table I, each is acceptable and may be used except as follows:

2.1.1 Exposed Sheet Metal Items

Must be of the same material. Consider the following as exposed sheet metal: flashings and related accessories.

2.1.2 Stainless Steel

ASTM A240/A240M, Type 316, 2D Finish, fully annealed, dead-soft temper.

Provide 24 gauge stainless steel for all sheet metal flashing.

2.1.3 Cap Flashing

Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, fasten and seal watertight. Shop fabricate interior and exterior corners. Fabricate from the following.

Stainless Steel: Minimum 0.025 inch thick.

2.1.4 Metal Scuppers

Fabricate scuppers to dimensions indicated. Fabricate from the following materials:

Stainless Steel: Minimum 0.019 inch thick.

2.1.5 Counterflashing

Shop fabricate interior and exterior corners. Where roof base flashing is provided, use 2-piece counterflashing on walls with metal panel, curtainwall, stucco or similar durable finishes.

Stainless Steel: Minimum 0.019 inch thick.

2.1.6 Metal Downspout Protectors

Product and Manufacturer - Basis of Design: Down Spout Protectors; Pioneer Dock Equipment

Metal and Gauge: Minimum 10 gauge.
Finish: Manufacturer's standard finish; color to be selected by Contracting Officer's Representative.

2.1.7 Flexible Flashing

Self-adhering, high-temperature sheet; minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

Thermal Stability: ASTM D1970/D1970M; stable after testing at 240 degrees F.

2.1.8 Fasteners

Unless otherwise indicated use the same metal, Type 316 stainless steel, or a metal compatible with the item fastened. Use stainless steel fasteners to fasten dissimilar materials.

2.1.8.1 Sealant

Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Workmanship

Make lines and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793, Architectural Sheet Metal Manual. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.2 Nailing

Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inch. Confine nailing of flashing to one edge only. Space nails evenly not over 3 inch on center and approximately 1/2 inch from edge unless otherwise specified or indicated. Face nailing will not be permitted. Where sheet metal is applied to other than wood surfaces, include in shop drawings, the locations for sleepers and nailing strips required to secure the work.

3.1.3 Cleats

Provide cleats for sheet metal 18 inch and over in width. Space cleats evenly not over 12 inch on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 2 inch wide by 3 inch long and of the same material and thickness as the sheet metal being installed. Secure one end of the cleat with two nails and the cleat folded back over the nailheads. Lock the other end into the seam. Where the fastening is to be made to concrete or masonry, use screws and drive in expansion shields set in concrete or masonry. Pretin cleats for soldered seams.

Provide continuous cleats in 22 gauge material; all fasteners shall be stainless steel.

3.1.4 Bolts, Rivets, and Screws

Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection.

3.1.5 Seams

Straight and uniform in width and height with no solder showing on the face.

3.1.5.1 Flat-lock Seams

Finish not less than 3/4 inch wide.

3.1.5.2 Lap Seams

Finish soldered seams not less than one inch wide. Overlap seams not soldered, not less than 3 inch.

3.1.5.3 Loose-Lock Expansion Seams

Not less than 3 inch wide; provide minimum one inch movement within the joint. Completely fill the joints with the specified sealant, applied at

not less than 1/8 inch thick bed.

3.1.5.4 Flat Seams

Make seams in the direction of the flow.

3.1.6 Soldering

Where soldering is specified, apply to terne-coated stainless steel items. Pretin edges of sheet metal before soldering is begun.

3.1.6.1 Edges

Scrape or wire-brush the edges of lead-coated material to be soldered to produce a bright surface. Flux brush the seams in before soldering. Treat with soldering acid flux the edges of stainless steel to be pretinned.

3.1.7 Protection from Contact with Dissimilar Materials

3.1.7.1 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.7.2 Wood or Other Absorptive Materials

Paint surfaces that may become repeatedly wet and in contact with metal with two coats of aluminum paint.

3.1.8 Expansion and Contraction

Provide expansion and contraction joints at not more than 40 foot intervals for other metals. Provide an additional joint where the distance between the last expansion joint and the end of the continuous run is more than half the required interval. Space joints evenly.

3.1.9 Counterflashing

Except where indicated or specified otherwise, insert counterflashing in reglets located from 9 to 10 inch above roof decks, extend down vertical surfaces over upturned vertical leg of base flashings. Fold the exposed edges of counterflashings 1/2 inch. Provide end laps in counterflashings not less than 3 inch and make it weathertight with plastic cement. Do not make lengths of metal counterflashings exceed 10 feet. Form the flashings to the required shapes before installation. Factory-form the corners not less than 12 inch from the angle. Secure the flashings in the reglets with lead wedges and space not more than 18 inch apart. Fill caulked-type reglets or raked joints which receive counterflashing with caulking compound. Install counterflashing to provide a spring action against base flashing. Where bituminous base flashings are provided, extend down the counter flashing as close as practicable to the top of the cant strip. Factory form counter flashing to provide spring action against the base flashing.

3.1.10 Metal Scuppers

Line interior of scupper openings with sheet metal. Fully weld scuppers

water tight.

3.1.11 Metal Cap Flashing

Provide cap flashing using stainless steel sheets 8 or 10 feet long joined by a 3/4 inch locked seam. Terminate outer edges in edge strips. Install with sealed joints as indicated.

3.2 CLEANING

Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub-clean. Free the exposed metal surfaces of dents, creases, waves, scratch marks, and solder or weld marks.

3.3 REPAIRS TO FINISH

Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items which cannot be repaired.

3.4 FIELD QUALITY CONTROL

Establish and maintain a Quality Control Plan for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Remove work that is not in compliance with the contract and replace or correct. Include quality control, but not be limited to, the following:

a. Verification that specified material is provided and installed.
b. Inspection of sheet metalwork, for proper size(s) and thickness(es), fastening and joining, and proper installation.

3.4.1 Procedure

Submit for approval prior to start of roofing work. Include a checklist of points to be observed. Document the actual quality control observations and inspections. Furnish a copy of the documentation to the Contracting Officer's Representative at the end of each day.

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES

Sheet Metal Items	Stainless Steel, inch
Downspouts and leaders	.015
Downspout clips and anchors	-

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES	
Sheet Metal Items	Stainless Steel, inch
Downspout straps, 2-inch	.050
Leader heads	.015
Scupper lining	.015
Flashings:	
Base	.040
Cap Flashing and Splice Covers	.015

TABLE II. SHEET METAL JOINTS			
TYPE OF JOINT			
Flashings			
Base	One inch flat locked, soldered; sealed; 3 inch lap for expansion joint	--	--
Cap-in reglet	3 inch lap	--	Seal groove with joint sealing compound.
Reglets	Butt joint	--	Seal reglet groove with joint sealing compound.

-- End of Section --

SECTION 07 61 15.00 20

ALUMINUM STANDING SEAM ROOFING
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 620	(2002) Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Aluminum Substrates

ALUMINUM ASSOCIATION (AA)

AA ADM-105	(2005; Errata 2005) Aluminum Design Manual
AA ASM-35	(2000) Specifications for Aluminum Sheet Metal Work in Building Construction, Construction Manual Series Section 5

AMERICAN FOREST & PAPER ASSOCIATION (AF&PA)

AF&PA T101	(2005) National Design Specification (NDS) for Wood Construction

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM D1654	(2008) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D1970/D1970M	(2012) Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2247	(2011) Testing Water Resistance of Coatings in 100% Relative Humidity

ASTM D2565	(1999; R 2008) Xenon Arc Exposure of Plastics Intended for Outdoor Applications
ASTM D4214	(2007) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D522	(1993a; R 2008) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2008) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2009) Evaluating Degree of Blistering of Paints
ASTM D968	(2005; R 2010) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM E1592	(2005; R 2012) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E330	(2002; R 2010) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM G152	(2006) Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2004; R 2010) Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA Details	(2003) NRCA Roof Perimeter Flashing Systems Construction Details for Class 1 Roof Construction

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 DEFINITIONS

1.3.1 Field-Formed Seam

Seams of panels so configured that when adjacent sheets are installed the seam is sealed utilizing mechanical or hand seamers. Crimped (45 degree bend), roll formed (180 degree bend), double roll formed (2 - 180 degree bend), and roll and lock systems are types of field-formed seam systems.

1.3.2 Snap Together Seam

Panels so configured that the male and female portions of the seam interlock through the application of foot pressure or tamping with a mallet. Snap-on cap configurations are a type of snap together system.

1.3.3 Pre-Formed

Formed to the final, less field-formed seam, profile and configuration in the factory.

1.3.4 Field-Formed

Formed to the final, less field-formed seam, profile and configuration at the site of work prior to installation.

1.3.5 Roofing System

The roofing system is defined as the assembly of roofing components, including roofing panels, flashing, fasteners, and accessories which, when assembled properly result in a watertight installation.

1.4 SYSTEM DESCRIPTION

1.4.1 Design Requirements

a. Provide continuous length panels with no joints or seams, except where indicated. Individual panels shall be removable for replacement of damaged material.

b. There shall be no exposed or penetrating fasteners except where shown on the approved shop drawings. Fasteners into wood shall be stainless steel sheet metal screws with full length threads. Fasteners into steel shall be stainless steel or cadmium plated stainless steel screws inserted into predrilled holes. Length and diameter of screws shall be sufficient to meet the design loads with a suitable factor of safety for the material to which the roofing components are attached. Calculate fastener capacity in accordance with AISI SG03-3, AA ADM-105 or AF&PA T101 as applicable.

c. Roof panel standing seam shall include a capillary break and be mechanically locked closed by the manufacturer's locking tool. The seam shall include a continuous sealant when required by the manufacturer to withstand the rainfall and wind specified in paragraph entitled "Manufacturer's Requirements."

d. Roof panel anchor clips shall be concealed and designed to allow for thermal movement of the panels, except where specific fixed points are indicated.

e. The system shall resist the positive and negative loads specified herein in accordance with "Sheet Building Sheathing Design Guide" of the AA ADM-105. Determine capacity in accordance with principles of ASTM E330 modified as follows:

(1) Test panels shall be production material of the type proposed for use. Use either full length or partial length panels with attachment representative of the main part of the roof.

(2) Test specimens shall be five panels wide, span one or more supports, and shall have no end or edge attachment or seals that will restrict crosswise movement of the panels under load. Do not bridge longitudinal seams with tape or film that can restrict separation.

(3) Panels shall be tested to failure. Report load at failure.

f. Panels shall support walking loads without excessive distortion or telegraphing of the structural supports. Panels shall support a 250 pound load concentrated on a four square inch area at the center of the panel without buckling or permanent distortion.

1.4.2 Performance Requirements

1.4.2.1 Uniform Wind Uplift Load Capacity

Installed roof system shall withstand negative wind uplift pressures complying with the following criteria.

Design Code: ASCE 7-10, Method 2 for Components and Cladding.

Safety Factor:

In no instance shall the safety factor be taken to be less than 1.67 for any roof or wall zone.

Risk Category: II
Wind Speed: 150 mph
Exposure Category: C

The ultimate capacity of the panel system shall be determined based on performance testing in accordance with ASTM E1592. The allowable load carrying capacity shall be calculated in accordance with AISI S100 section D6.2.1, except the provisions of Section D6.2.1a of Appendix A shall NOT be applicable for this project.

1.4.2.2 Uniform Positive Load Capacity

Uniform positive load capacity shall be determined in accordance with AISI S100.

The installed roof system shall be capable of resisting the following positive uniform roof loads: Roof Live Load of 20 psf.

Installed roof system shall carry positive uniform design loads with a maximum system deflection of L/180 as measured at the rib (web) of the panel.

1.4.2.3 Wind Uplift Classification

The panel system shall be listed as a Class 90 windstorm rated system, as determined by UL 580.

1.4.2.4 Fire Resistance Classification

The panel system shall be listed as a Class A Roof Covering, as determined by UL 790.

1.4.2.5 Air infiltration

The panel system shall be tested in accordance with ASTM E1680 and not exceed an air leakage rate of 0.0060 cfm/sq ft at a minimum test static air pressure difference of 20.0 psf.

1.4.2.6 Water Infiltration

The panel system shall be tested in accordance with ASTM E1646 and exhibit No Leakage at static water exposure of 6.2 Gal/Hr and a test static air pressure difference of 20.0 psf for 15 minutes.

1.4.2.7 Static Water Pressure Head Water Infiltration.

The panel system shall be tested in accordance with ASTM E2140, and pass with no leakage. The test specimen must include a panel end lap condition and successfully withstand being submerged under 6" of water for 6 hours.

The panel system shall be tested in accordance with the FBC TAS 114 Appendix G, and pass with no leakage. The test specimen must successfully withstand being submerged under 6" of water for 168 hours.

1.4.2.8 Dynamic Pressure Water Penetration

The panel system shall be tested in accordance with AAMA 501.1, and pass with no water penetration, other than condensation, when exposed to 8" per hour of dynamic rain and 70 mph wind velocities for not less than five (5) minutes duration. No water penetration, other than condensation, when exposed to 8" per hour of dynamic rain and 100 mph wind velocities for not less than five (1) minutes duration

The panel system shall be tested in accordance with FBC TAS 100, and pass with no water penetration, other than condensation, when exposed to 8.8" per hour of dynamic rain and 110 mph wind velocities for not less than five (5) minutes duration.

1.4.2.9 Missile Impact Test and Cyclic Wind Pressure Test

The panel system shall be tested in accordance with ASTM E1886. The tested system shall be of identical profile and material type as the specified panel for this project; thicker gauge and/or narrow width panels than those tested will be acceptable. The anchor clip spacing for this project shall be based on E1592 requirements, but shall not exceed that of the E1886 test report.

The panel system shall be tested in accordance with FBC Test Protocols TAS 201 and TAS 203. The tested system shall be of identical profile and material type as the specified panel for this project; thicker gauge and/or narrow width panels than those tested will be acceptable. The

anchor clip spacing for this project shall be based on E1592 requirements, but shall not exceed that of the TAS 201 test reports.

1.4.2.10 Thermal Expansion and Contraction

Completed metal roofing and flashing system shall be capable of withstanding expansion and contraction of components caused by changes in temperature without buckling, or reducing performance ability.

The design temperature differential shall be not less than 220 degrees Fahrenheit.

Interface between panel and clip shall provide for unlimited thermal movement in each direction along the longitudinal direction.

Resistance to Wear Through, Replication of Thermal Movement: An assembled test specimen at least three panels wide spanning three or more supports shall be subjected to 100,000 cycles of movement, ½" in each direction for a total of 1" of movement. Upon completion, the panel shall show no signs of wear through the panel nor shall the contact surfaces between the clip and the panel show more than 25% loss in metal thickness.

1.4.2.11 Deflection

Panel deflection shall not exceed L/180.

1.4.2.12 Structural Performance

The structural performance test methods and requirements shall be in accordance with ASTM E1592.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roofing panels; G

Submit drawings as necessary to supplement the instructions and diagrams. Drawings shall include design and erection drawings containing an isometric view of the roof showing the design uplift pressures and dimensions of edge, ridge and corner zones. Show typical and special conditions including flashings, accessory installation, materials and thicknesses, all dimensions, anchoring methods, sealant locations, sealant tape locations, fastener layout, sizes, spacing, provisions for thermal movement, terminations, penetrations, and attachments. Details of installation shall be in accordance with the manufacturer's Standard Instructions and details or the SMACNA 1793. The manufacturer's technical engineering department shall approve the drawings before they are submitted.

Independent third party, and/or installer shop drawings are not acceptable. The owner of the warranty shall provide the project

customized shop drawings.

SD-03 Product Data

Aluminum Standing Seam Roofing; (LEED NC); G

Roofing panels; (LEED NC)

Closures

Accessories

Underlayment

Sample warranty certificate

Submit for all materials to be provided. Submit data sufficient to indicate conformance to specified requirements.

SD-04 Samples

Roofing panels

Submit a 12 inch long section of typical panel in color specified .

When colors are not indicated, submit samples of not less than six different manufacturer's standard colors for selection.

Accessories

Submit each type of accessory item used in the project including, but not limited to: each type of anchor clip, closures, fasteners and leg clamps.

SD-05 Design Data

Load calculations

SD-06 Test Reports

Structural performance

Panel finish

Submit reports of the tests required by this section.

Manufacturer's field inspection

Submit manufacturer's technical representative's inspection reports as required in paragraph entitled "Manufacturer's Field Inspection."

SD-07 Certificates

Technical representative

Qualification of Installer

Submit documentation proving the installer is factory-trained, has

the specified experience and is authorized by the manufacturer to install the products specified.

Coil stock compatibility

Provide certification of coil compatibility with roll forming machinery to be used for forming panels without warping, waviness, and rippling not part of panel profile; to be done without damage, abrasion or marking of finish coating.

SD-08 Manufacturer's Instructions

Sealant

Submit manufacturer's sealant requirements for making the standing seam watertight when subjected to 5 inches of rainfall per hour simultaneous with mph winds.

Installation manual

Submit manufacturer's printed installation manual/instructions and standard details.

SD-11 Closeout Submittals

Information card

For each roofing installation, submit a typewritten card or photoengraved aluminum card containing the information listed on Form 1 located at the end of this section.

Local/Regional Materials
Recycled Content

1.6 LOAD CALCULATIONS

Submit load calculations for the following by a structural engineer registered as a Professional Engineer in any jurisdiction verifying that the system supplied meets the design loads indicated. Coordinate calculations with manufacturer's test results.

a. Wind load uplift design pressure at roof locations specified in paragraph entitled "Wind Loads."

b. Clip spacing and allowable load per clip calculations.

c. The fastening of clips to structure or intermediate support spacing.

d. Intermediate support spacing and fastening to structure when required.

e. Allowable panel span at anchorage spacing indicated.

f. Safety factor used in determining loading.

1.7 QUALITY ASSURANCE

1.7.1 Preroofing Conference

After submittals are received and approved but before roofing work,

including associated work, is preformed, the Contracting Officer will hold a preroofing conference to review the following:

a. The drawings and specifications

b. Procedure for on site inspection and acceptance of the roofing substrate and pertinent structural details relating to the roofing system

c. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing

d. Safety requirements.

The preroofing conference shall be attended by the Contractor and personnel directly responsible for the roofing installation, mechanical and electrical work, and the roofing manufacturer's technical representative. Conflicts among those attending the preroofing conference shall be resolved and confirmed in writing before roofing work, including associated work, is begun. Prepare written minutes of the preroofing conference and submit to the Contracting Officer.

1.7.2 Manufacturer's Technical Representative

The representative shall have authorization from manufacturer to approve field changes and be thoroughly familiar with the products and with installations in the geographical area where construction will take place. The manufacturer's representative shall be an employee of the manufacturer with at least 5 years experience in installing the roof system. The representative shall be available to perform field inspections and attend meetings as required herein, and as requested by the Contracting Officer.

1.7.3 Qualification of Installer

The roofing system installer shall be factory-trained, approved by the metal roofing system manufacturer to install the system, and shall have a minimum of three years experience as an approved applicator with that manufacturer. The applicator shall have applied five installations of similar size and scope to this project within the previous 3 years.

1.7.4 Single Source

Provide roofing panels, clips, closures and other accessories from a single manufacturer.

1.7.5 Manufacturer

The SSMRS shall be the product of a metal roofing industry recognized SSMRS manufacturer who has been in the practice of manufacturing SSMRS for a period of not less than 5 years and who has been involved in at least 5 projects similar in size and complexity to this project.

Financial Certification: Provide the building owner with a signed and notarized (sealed) affidavit by an officer of the panel system manufacturer which confirms a current minimum corporate asset-to-liability ratio of not less than 3:1 for the panel manufacturer, or its parent corporation. Financial support information and affidavit must be dated

within 30 days prior to the product submittal. (This financial requirement ensures the manufacturer will be in business for the length of the long term warranty, as well as have the ability to reconcile a possible claim.)(

1.8 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle preformed panels, bulk roofing products and other manufactured items in a manner to prevent damage or deformation.

1.8.1 Delivery

Provide adequate packaging to protect materials during shipment. Do not uncrate materials until ready for use except for inspection. Immediately upon arrival of materials at jobsite, inspect materials for damage, dampness, and staining. Replace damaged or permanently stained materials that cannot be restored to like-new condition with new material. If materials are wet, remove moisture, restack and protect panels until used.

1.8.2 Handling

Handle material carefully to avoid damage to surfaces, edges and ends.

1.8.3 Storage

Stack materials stored on the site on platforms or pallets and cover with tarpaulins or other suitable weathertight coverings which prevent water trapping or condensation. Store panels so that water which might have accumulated during transit or storage will drain off. Do not store the panels in contact with materials that might cause staining, such as mud, lime, cement, fresh concrete or chemicals. Protect stored panels from wind damage.

1.9 Warranty

Manufacturer's standard 20 year roof system weather tightness warranty.

The warranty shall cover all responsibility and liability for any damage or failures caused by wind gusts up to the design wind indicated.

Design Wind Speed: 150 mph.

Manufacturer's standard 20 year finish warranty covering checking, crazing, peeling, chalking, fading, and adhesion of the pre-painted sheet metal materials.

The warranty shall include coverage within 1,500 feet from a salt water environment. The building owner is responsible for regularly washing the roof area with fresh water is accordance with AAMA 609 & 610-09. A written log of this maintenance will be kept by the building and made available upon request.

Alternate manufacturers are subject to full compliance with specification requirements, and shall be submitted for approval as follows:

Alternate manufacturers must submit for approval, ten (10) days prior to bid date, and provide the following: manufacturer's literature; all test reports to certify compliance with the design and performance

requirements; sample warranties; certification of quality criteria and installer qualifications; and a list of five (5) similar projects in size and scope of work.

No substitutions will be permitted after the bid date of this project.

Factory Formed Panels: Fabricate and finish metal roof panels and accessories at the factory to the greatest extent possible.

Site Formed Panels: Panels in excess of shippable length shall be formed on-site. Site formed panels shall meet each of the following requirements:

Panels shall be formed on heavy duty factory type roll formers with no fewer than 16 forming stations to improve quality and minimize oil canning.
Panels shall be of identical profile and characteristics as factory formed panels and specimens used as the basis of performance tests.
Sealant shall be factory applied in a separate factory formed snap on cap. Site/field applied seam sealant is unacceptable. Seam caps may be shipped in 45 feet or less length and lap spliced over full length panels in accordance with manufacturer's system details.
Site roll forming equipment shall be owned and maintained by the panel manufacturer and operated by the panel manufacturer's trained full time experienced technician. The installer is responsible for handling panels from the roll forming equipment. Contractor owned and operated roll forming equipment is not acceptable under any circumstances.

PART 2 PRODUCTS

2.1 ROOFING PANELS - MANUFACTURED ROOF PANELS

2.1.1 Aluminum Standing Seam Roofing

Product and Manufacturer - Basis of Design: Series 300 Standing Seam Metal Roof; Innovative Metals Company, Inc. (IMETCO), Norcross, GA, or equal.

Notice of Acceptance Number: 12-0720.08

Expiration Date: 09/27/17

Provide factory curved and welded trim to eliminate unattractive and potentially leaky field segmented trim and to eliminate field cutting and lapping to reduce the amount of overlap joints.

2.1.2 Material

Aluminum alloy 3003, 3004, 3005, or 3105 with H14 or H24 heat treatment, per ASTM B209 and ASTM B209M.

2.1.2.1 Thickness

0.040 inch minimum.

Standing Seam Panel Width: 16"

2.1.2.2 Texture

Smooth surface.

2.1.2.3 Configuration

Vertical-Rib, Standing-Seam Metal Roof Panels with separate mechanically field crimped batten seam cap: Formed with vertical ribs at panel edges, pencil beads and an intermediate stiffening rib symmetrically spaced between ribs; designed for 2-direction installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, attaching a separate batten seam cap and mechanically seaming panels together.

2.1.2.4 Prefinished Coating System

Exposed FInish: Two-coat fluoropolymer; AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Coating system shall provide nominal 1.0 mil dry film thickness, consisting of primer and color coat.

Color: To match Contracting Officer's Representative's sample from IMETCO standard colors.

Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.2 ACCESSORIES

All curved trim in plan or elevation view shall be factory formed by welding sheet aluminum sections and finishing with a post-applied finish so that all exposed trim shall be in continuous ten foot lengths. The face of any arched trim shall not have a drip edge or flat hem, and shall utilize a 1/8 inch stainless steel rivet painted to match the finish.

The Radius of the arched trim sections shall be as indicated on the project drawings.

Aluminum sheet material shall be minimum .050" thickness.

All curved trim must be post painted after any required welding and painted to match the standing seam metal roof system with the applicable paint code from the manufacturer.

All curved trim must be provided by the standing seam metal roof manufacturer and included in all warranties.

Sheet metal flashings, trim, moldings, closure strips, caps, preformed crickets, equipment curbs, and other similar sheet metal accessories provided in conjunction with preformed metal panels shall be of the same material and finish as panels, except that such items which will be concealed after installation may be provided without the finish if they are aluminum or stainless steel. Provide ridge and rib closures, as specified. Metal shall be of thickness not less than that of panels. Molded closure strips shall be closed-cell synthetic rubber, neoprene, or polyvinyl chloride premolded to match configurations of preformed metal

panels. Thermal spacer blocks and other thermal barriers at concealed fasteners shall be as recommended by the roofing panel manufacturer.

2.2.1 Closures

2.2.1.1 Ridge Closure

Metal-clad foam or metal closure with foam secondary closure matching panel configuration for installation on surface of roof panel between panel ribs at ridge and headwall roof panel flashing conditions and terminations. Foam material shall not absorb water.

2.2.1.2 Head Closures

Factory formed to panel widths; provide with neoprene insert.

2.2.2 Fasteners

Series 300 stainless steel exposed fasteners including screws are to be finished to match color of roof panels with composite metal and neoprene composition washers. Fasteners for attachment to structural supports and fasteners for attachment of panels shall be as approved and in accordance with manufacturer's recommendation. Unless specified otherwise herein, fasteners shall be either self-tapping screws, bolts and nuts, or self-locking bolts. Design fastening system to withstand design loads indicated.

2.2.2.1 Screws

Provide not less than No. 14 diameter for self-tapping type and not less than No. 12 diameter for self-drilling and self-tapping.

2.2.2.2 Bolts

Provide not less than 1/4 inch diameter, shouldered or plain shank as required, with proper nuts.

2.2.3 Sealant

Elastomeric type containing no oil or asphalt. Exposed sealant shall cure to a rubberlike consistency. Concealed sealant shall be the non-hardening type. Seam sealant shall be factory-applied, non-skinning, non-drying, and shall conform to the roofing manufacturer's recommendations. Silicone-based sealants shall not be used in contact with finished metal panels and components unless approved otherwise by the Contracting Officer.

2.2.4 Sealant Tape

Polyvinyl chloride closed cell foam tape or composed of 99 percent solids in a base of butyl polyisobutylene rubber with the following properties and characteristics:

a. Webbing and Elongation: 100 percent minimum at 77 degrees F

b. Adhesion: Excellent to surfaces used

c. U-V light exposure: No effect

d. Ozone: No effect

e. Weathering: 1000 hours in QUV Test Apparatus - Excellent, no cracking, bleeding, or significant changes.

f. Moisture Transmission: 0.05 to 0.15 grams per 100 square inches in 24 hours.

g. Service Temperature Tests: Bending over 1/2 inchmandrel at minus 60 degrees F with no cracking. Expose sealed typical metal lap joint to plus 350 degrees F for 24 hours with no significant loss of original properties.

h. Reaction to Metals: Non-corrosive to metals

2.3 UNDERLAYMENT

Self-Adhering with reinforcing scrim, High-Temperature Sheet: 50mil thick minimum, consisting of slip-resisting top surface laminated to SBS-modified asphalt adhesive, with release-paper backing; cold applied.

Thermal Stability: Stable after testing at 250 deg F; ASTM D1970/D1970M.
Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970/D1970M
Seams shall be lapped in accordance with manufacturer's recommendations.
Underlayment shall be approved for 90 days (minimum) of exposure to UV and weather penetrations.
Products: Aqua Block 50 by IMETCO, or equal.

Provide underlayment having a current NOA.

2.4 LABORATORY TESTS FOR PANEL FINISH

Previously manufactured panels of the same type and finish as proposed for the project shall have been tested by an approved testing laboratory to ensure conformance to specifications. The term "appearance of base metal" refers to the aluminum base metal. Panels shall meet the following test requirements.

2.4.1 Salt Spray Test

Panels shall withstand a salt spray test for a minimum of 2000 hours in accordance with ASTM B117, including the scribe requirement in the test. Immediately upon removal of the panel from the test, coating shall receive a rating of 10, no blistering, as determined by ASTM D714; and a rating of 7, 1/16 inch failure at scribe, as determined by ASTM D1654, Rating Schedule No. 1.

2.4.2 Formability Test

For formability test, when subjected to a 180 degree bend over a 1/8 inch diameter mandrel in accordance with ASTM D522, exterior coating film shall show only microchecking of the exterior film and there shall be no loss of adhesion.

2.4.3 Accelerated Weathering Test

Panels shall withstand an accelerated weathering test for a minimum of 2000 hours in accordance with ASTM G152, ASTM G153 or ASTM D2565 without

cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with a penknife blade or similar instrument shall be considered to indicate loss of adhesion.

2.4.4 Chalking Resistance

After the 2000-hour weatherometer test, exterior coating shall not chalk greater than No. 8 rating when measured in accordance with ASTM D4214 test procedures.

2.4.5 Abrasion Resistance Test for Color Coating

When subjected to the falling sand test in accordance with ASTM D968, coating system shall withstand a minimum of 100 liters of sand per mil of coating thickness before appearance of base metal.

2.4.6 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage, or corrosion.

2.4.7 Fire Hazard

The finish on factory-fabricated panels shall have a flame spread rating of not more than 75 when tested in accordance with ASTM E84.

2.4.8 Gloss

The gloss of the finish shall be 30 plus or minus 5 at an angle of 60 degrees, when measured in accordance with ASTM D523.

2.4.9 Glare Resistance

Surfaces of panels that will be exposed to the exterior shall have a specular reflectance of not more than 10 when measured in accordance with ASTM D523 at an angle of 85 degrees. Requirements specified under "Formability Test" will be waived if necessary to conform to this requirement.

PART 3 EXECUTION

3.1 EXAMINATION

Examine surfaces to receive standing seam metal roofing and flashing. Provide plumb and true surfaces, clean, even, smooth and as dry as possible. Ensure that surfaces are free from defects and projections which might affect the installation. Report unsuitable conditions to Contracting Officer.

3.2 PROTECTION OF DISSIMILAR METALS

Where an aluminum component is in contact with, fastened to, or contacted by drainage from dissimilar metals other than stainless steel, give such dissimilar metals one of the following treatments:

a. A heavy brush coat of primer followed by two coats of aluminum metal and masonry paint.

b. A heavy coat of alkali-resistant bituminous paint.

c. Separate contact surfaces with non-absorptive tape or gasket.

3.2.1 Contact with Masonry

Where aluminum is in contact with masonry, concrete, or plaster, apply a heavy coat of alkali-resistant bituminous paint.

3.2.2 Contact with Wood

Where aluminum is in contact with wood or other absorptive material subject to wetting, or with wood treated with a preservative not compatible with aluminum, seal joints with sealing compound and apply one heavy brushcoat of aluminum pigmented bituminous paint.

3.3 INSTALLATION

Install in accordance with approved manufacturer's erection instructions shop drawings, and diagrams, except as specified otherwise herein. Provide panels in full and firm contact with clips. Obtain approval prior to installation on prefinished panels cut in the field, and factory applied coverings or coatings that were repaired after being abraded or damaged during handling or installation. Make repairs with material of same color as weather coating. Completely seal openings through panels. Correct defects or errors in materials in an approved manner. Replace materials which cannot be corrected in an approved manner with new materials. Provide molded closure strips where indicated and where necessary for weathertight construction. Use shims as required to ensure clip line is true. Use a spacing gage at each row of panels to ensure that panel width is not stretched or shortened.

3.3.1 Roof Panels

Apply roofing panels with standing seams parallel to slope of roof. Provide roofing panels in full lengths from ridge to eaves (top to eaves on shed roofs), with no transverse joints except at the junction of ventilators, curbs, skylights, chimneys, and similar openings. Form interlocking rib type panel seams in the field with an automatic mechanical seamer approved by the manufacturer. Attach panels to structure with concealed clips which are incorporated into the panel seams. Clip attachment shall allow roof to move freely and independently of the structure, except at fixed points as indicated.

3.3.2 Flashings

Provide flashing and related closures and accessories as necessary to provide a weathertight installation. Install flashing to ensure positive water drainage away from roof penetrations. Flash and seal roof at ridge, eaves and rakes, at projections through roof, and elsewhere as necessary. Accomplish placement of closure strips, flashing, and sealing material in an approved manner that will ensure complete weathertightness. Details of installation which are not indicated shall be in accordance with the NRCA Details, SMACNA 1793, AA ASM-35, panel manufacturer's printed instructions and details of the approved shop drawings. Installation shall allow for expansion and contraction of flashing.

3.3.3 Flashing Fasteners

Fastener spacings shall be in accordance with the panel manufacturer's recommendations and as necessary to withstand the indicated design loads. Install fasteners in roof valleys as recommended by the manufacturer of the panels. Install fasteners in straight lines within a tolerance of 1/2 inch in the length of a bay. Drive exposed penetrating type fasteners normal to the surface and to a uniform depth to seat gasketed washers properly and drive so as not to damage factory applied coating. Exercise extreme care in drilling pilot holes for fastenings to keep drills perpendicular and centered. Do not drill through sealant tapes. After drilling, remove metal filings and burrs from holes prior to installing fasteners and washers. Torque used in applying fasteners shall not exceed that recommended by the manufacturer. Remove panels deformed or otherwise damaged by over-torqued fastenings, and provide new panels.

3.3.4 Closure/Closure Strips

Set closure/closure strips in joint sealant material.

3.4 CLEANING

Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs on completion to prevent discoloration and harm to the panels and flashing. Remove grease and oil films, excess sealants handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces shall be free of dents, creases, waves, scratch marks, and solder or weld marks.

3.5 MANUFACTURER'S FIELD INSPECTION

Quality Assurance Inspections: Roof panel manufacturer shall provide at no additional cost to the owner, a minimum of three scheduled field nspections which shall include a written report from the panel manufacturer upon pre-installation to inspect materials from the factory, upon 50% completion, and upon final completion. Inspections shall be conducted by a salaried employee of the roof panel manufacturer. Inspector shall be registered with the project architect prior to project commencement. Inspections conducted by roofing system distributors / dealers, or third parties will not be acceptable. The field inspector reserves the right to review and report to the Contracting Officer's Representative the level of acceptability of work completed and to subsequently issue a report of items not acceptable.

> The manufacturer must take action to ensure the installing contractor follows the project specific shop drawings and all manufacturer requirements and recommendations.

Manufacturer's technical representative shall visit the site as necessary during the installation process to assure panels, flashings, and other components are being installed in a satisfactory manner. Manufacturer's technical representative shall perform a field inspection during the first 20 squares of roof panel installation and at substantial completion prior to issuance of warranty, as a minimum, and as otherwise requested by the Contracting Officer. Additional inspections shall not exceed one for each 100 squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors shall be performed as requested by the Contracting Officer. Each inspection

visit shall include a review of the entire installation to date. After each inspection, a report, signed by the manufacturer's technical representative, shall be submitted to the Contracting Officer noting the overall quality of work, deficiencies and any other concerns, and recommended corrective actions in detail. Notify Contracting Officer a minimum of 2 working days prior to site visit by manufacturer's technical representative.

3.6 COMPLETED WORK

Completed work shall be plumb and true without oil canning, dents, ripples, abrasion, rust, staining, or other damage detrimental to the performance or aesthetics of the completed roof assembly.

3.7 INFORMATION CARD

For each roof, provide a typewritten card, laminated in plastic and framed for interior display or a photoengraved 0.032 inch thick aluminum card for exterior display. Card to be 8 1/2 by 11 inches minimum and contain the information listed on Form 1 at end of this section. Install card near point of access to roof, or where indicated. Send a photostatic paper copy to the Contracting Officer's Representative.

3.8 FORM ONE

FORM 1 - PREFORMED STEEL STANDING SEAM ROOFING SYSTEM COMPONENTS

1. Contract Number:

2. Building Number & Location:

3. NAVFAC Specification Number:

4. Deck/Substrate Type:

5. Slopes of Deck/Roof Structure:

6. Insulation Type & Thickness: Field install thermal insulation per 07 22 00 to correspond with required R value.

7. Insulation Manufacturer:

8. Vapor Retarder: ( )Yes ( )No

9. Vapor Retarder Type:

10. Preformed Steel Standing Seam Roofing Description:

a. Manufacturer (Name, Address, & Phone No.):
b. Product Name:
c. Width:
d. Gage:
e. Base Metal:
f. Method of Attachment:

11. Repair of Color Coating:

a. Coating Manufacturer (Name, Address & Phone No.):
b. Product Name:
c. Surface Preparation:
d. Recoating Formula:
e. Application Method:

12. Statement of Compliance or Exception:_____
_____
_____

13. Date Roof Completed:

14. Warranty Period: From_____ To_____

15. Roofing Contractor (Name & Address):

16. Prime Contractor (Name & Address):

Contractor's Signature _____ Date:

Inspector's Signature _____ Date:

-- End of Section --

SECTION 07 81 00

SPRAY-APPLIED FIREPROOFING
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATION OF THE WALL AND CEILING INDUSTRIES - INTERNATIONAL (AWCI)

AWCI TM 12-A	(1997; 3rd Ed) Standard Practice for the Testing and Inspection of Field Applied Sprayed Fire-Resistive Materials; An Annotated Guide

ASTM INTERNATIONAL (ASTM)

ASTM E1042	(2002; R 2008e1) Acoustically Absorptive Materials Applied by Trowel or Spray
ASTM E119-12a	(2012) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E605	(1993; R 2011) Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM E736	(2000; R 2011) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E759	(1992; R 2011) Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E760	(1992; R 2011) Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E761	(1992; R 2011) Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E859	(1993; R 2011) Air Erosion of Sprayed Fire-Resistive Materials (SFRMS) Applied to Structural Members

ASTM E937	(1993; R 2011) Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM G21	(2009) Determining Resistance of Synthetic Polymeric Materials to Fungi

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC23	(2004; R 2008; R 2011) Acceptance Criteria for Spray-Applied and Intumescent Mastic Coating Fire-Protection Materials

UNDERWRITERS LABORATORIES (UL)

UL 263	(2011) Fire Tests of Building Construction and Materials
UL Fire Resistance	(2012) Fire Resistance Directory

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SYSTEM DESCRIPTION

1.3.1 General Requirements

Protect all structural steel, undersides of steel floors (if required) and steel roof decks (if required) with spray-applied fireproofing to a fire resistance hour-rating as indicated below, unless otherwise indicated.

1.3.2 Fire Resistance Rating

Fire resistance ratings shall be in accordance with the fire rated assemblies listed in UL Fire Resistance. Proposed materials not listed in UL Fire Resistance shall have fire resistance ratings at least equal to the UL Fire Resistance ratings as determined by an approved independent testing laboratory, based on tests specified in UL 263 or ASTM E119-12a. Submit reports and test records, attesting that the fireproofing material conforms to the specified requirements. Each test report shall conform to the report requirements specified by the test method. For the underside of the decking use metal lath installed prior to the fireproofing material or Rigid Board Fireproofing Material as outlined in the UL Fire Resistance Directory Volume 1. Apply fireproofing to structural steel members, with the following hourly fire resistance rating and in accordance with the following UL design or approved equivalent. Use unrestrained fire resistance ratings, unless the architect/engineer has specified that the degree of thermal restraint of the construction meets or exceeds the degree of thermal restraint of the tested assembly. Performance tests shall be in accordance with ASTM E119-12a.

Fire Rating Schedule: As indicated on the Drawings.

1.3.3 Evaluation Reports - ICC-ES Reports

Materials shall be evaluated in accordance with ICC-ES AC23. ICC-ES Reports shall be included as part of the Submittals below. The reports will identify the product as code compliant and having met the physical performance requirements outlined in paragraphs "Dry Density and Cohesion/Adhesion" through "Air Erosion".

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fireproofing Material; G; (LEED NC)

SD-04 Samples

Spray-Applied Fireproofing; G

SD-06 Test Reports

Fire Resistance Rating; G
Field Tests; G
Evaluation Reports; G
Compressive strength

SD-07 Certificates

Installer Qualifications; G
Surface Preparation Report; G

SD-11 Closeout Submittals

Low Emitting Materials - Adhesives and Sealants
Low Emitting Materials - Paints and Coatings

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualifications

Engage an experienced installer that is certified, licensed, or otherwise qualified by the spray-on fireproofing manufacturer as having the necessary experience, staff, and training to install the manufacturer's products in accordance with specified requirements. Submit manufacturer's certification that each listed installer is qualified and trained to install the specified fireproofing. Show evidence that each fireproofing installer has had a minimum of 3 years experience in installing the specified type of fireproofing. Each installer of fireproofing material shall be trained, have a minimum of 3 years experience and a minimum of three installations using fireproofing of the type specified. A manufacturer's willingness to sell its products to the Contractor or installer does not infer qualification of the buyer.

1.5.2 Pre-Installation Meeting

Hold a meeting with the installer, field testing agency, the manufacturer, subcontractors (whose employees come into contact with the fireproofing), and the Contracting Officer prior to the installation of any fireproofing material to review the substrates for acceptability, method of application, applied thickness, patching, repair, inspection and testing procedures.

1.6 DELIVERY, STORAGE, AND HANDLING

Packaged material shall be delivered in the original unopened containers, marked to show the brand name, the manufacturer, and the UL markings. Fireproofing material shall be kept dry until ready to be used, and shall be stored off the ground, under cover and away from damp surfaces. Damaged or opened containers will be rejected. Material with shelf-life shall be applied prior to expiration of the shelf-life.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Temperature

Maintain substrate and ambient air temperatures above 40 degrees F during application and for 24 hours after application. Relative humidity shall be maintained within the limits recommended by the fireproofing manufacturer.

1.7.2 Ventilation

Provide adequate ventilation to properly dry the fireproofing after application. In enclosed areas, provide a minimum of 4 air exchanges per hour by forced air circulation.

PART 2 PRODUCTS

2.1 SPRAY-APPLIED FIREPROOFING

Provide spray-applied fireproofing material, including sealer, conforming to ASTM E1042, Class (a), Category A, Type I, except that the dust removed shall not exceed 0.0025 gram per square foot of fireproofing material applied as specified in the project. Only products that have been evaluated at UL and bear and "investigated for exterior use" approval are allowed in waterfront areas where the fireproofing may be directly exposed to a natural body of water. Material shall be asbestos free, and shall resist fungus for a period of 28 days when tested in accordance with ASTM G21. Material shall have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84. Submit one sample panel, 18 inches square, for each specified type of fireproofing. Also, a designated sample area of not less than 100 square feet shall be prepared. Sample area shall be representative of typical installation of fireproofing including metal decks, beams, columns and attachments. Equipment, materials and procedures used in the sample area shall be the same as, or representative of, that to be used in the work. The sample area shall be approved prior to proceeding with fireproofing work in any other area. The approved sample area shall be used as a reference standard for applied fireproofing material. Sample area shall remain in place and open to observation until all spray-applied fireproofing is completed and accepted, at which time it may become part of the work.

2.1.1 Fireproofing Assemblies

Provide fire-rated assembly ratings to UL Design Nos. as follows:

Exterior and Interior Steel Tube and Pipe Columns: 1 hour; UL No. Y710 (at at one story west wing, and penthouse interior columns, and exterior cafeteria columns)
Interior Columns: 1 hour; UL No. Y715
Roof Deck and Beams at Metal Deck with Insulation: 1 hour; P732 (at cafeteria and penthouse)
Roof Deck at Composite Deck with 3 1/2" Concrete Thickness: 1 hour; D925 (at one story west wing)
Steel Beams Supporting Composite Deck with Insulation: 1 1/2 hours; D925 or N782 (at one story west wing)

Steel Framing Supporting Interstitial Floor: Non-fire rated except as noted below:

2.1.2 Properties

Sprayed Fire-Resistive Material for Interior Concealed Applications: Manufacturer's standard factory-mixed material, free of mineral fibers, which when combined with water to form a slurry or mortar before conveyance and application is capable of providing the indicated fire resistance, and conforming to the following requirements:

Bond Strength: 200 -lbf/sq. ft. minimum, when tested in accordance with ASTM E736 when set and dry.

Dry Density: 15 lb/cu. ft. and as required by fire resistance design.

Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Flame-Spread Index: 0.
Smoke-Developed Index: 0.

Compressive Strength: Minimum 10 lbf/sq. in. according to ASTM E761.

Corrosion Resistance: No evidence of corrosion according to ASTM E937.

Sprayed Fire-Resistive Material Interior Locations, Exposed to View: Manufacturer's standard factory-mixed material, free of mineral fibers, which when combined with water to form a slurry or mortar before conveyance and application is capable of providing the indicated fire resistance, and conforming to the following requirements:

Bond Strength: Minimum 600-lbf/sq. ft. when tested in accordance with ASTM E736 when set and dry.

Dry Density: Not less than 15 lb/cu. ft. and as and as required by fire resistance design.

Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Flame-Spread Index: 0.
Smoke-Developed Index: 0.

Compressive Strength: Minimum 30 lbf/sq. in. according to ASTM E761.

Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760.

Corrosion Resistance: No evidence of corrosion according to ASTM E937.

Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G21.

Sprayed Fire-Resistive Material for Interior Locations, Exposed to Abrasion/Moisture: Manufacturer's standard factory-mixed material, free of mineral fibers, which when combined with water to form a slurry or mortar before conveyance and application is capable of providing the indicated fire resistance, and conforming to the following requirements:

Bond Strength: Minimum 2000-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E736.

Dry Density: Not less than 22 lb/cu. ft. and as and as required by fire resistance design.

Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Flame-Spread Index: 0.
Smoke-Developed Index: 0.

Compressive Strength: Minimum 100 lbf/sq. in. according to ASTM E761.

Corrosion Resistance: No evidence of corrosion according to ASTM E937.

Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G21.

2.1.3 Deflection

Spray-applied fireproofing shall not crack, spall, or delaminate when backing to which it is applied is subject to downward deflection 1/120 of 10 foot clear span, when tested in accordance with ASTM E759.

2.1.4 Bond-Impact

Spray-applied fireproofing material shall not crack, spall or delaminate when tested in accordance with ASTM E760.

2.1.5 Corrosion

Spray-applied fireproofing material shall not contribute to corrosion of test panels when tested as specified in ASTM E937.

2.1.6 Air Erosion

Dust removal shall not exceed 0.025 gram per square foot when tested in accordance with ASTM E859.

2.2 WATER

Water used for material mixing and surface preparation shall be potable.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Thoroughly clean surfaces to be fireproofed of dirt, grease, oil, paint, primers, loose rust, rolling lubricant, mill scale or other contaminants that will interfere with the proper bonding of the sprayed fireproofing to the substrate. Test painted/primed steel substrates in accordance with ASTM E736, with specified sprayed fireproofing material, to provide the required fire-resistance rating; painted or primed steel surfaces may require a fireproofing bond test to determine if the paint formulation will impair proper adhesion. Certify the acceptability of surfaces to receive sprayed-applied fireproofing by inspection and submit a Surface Preparation Report accordingly. The statement shall list the structural members and the areas that have been inspected and certified. Overhead areas to be fireproofed shall be cleared of all obstructions interfering with the uniform application of the spray-applied fireproofing. Hardware such as support sleeves, inserts, clips, hanger attachment devices and the like shall be installed prior to the application of the fireproofing. Condition of the surfaces shall be acceptable to the manufacturer prior to application of spray-applied fireproofing. Applications listed for use on primed surfaces shall be in accordance with the manufacturer's recommendations and standards, and detailed in submittal item SD-03 Product Data.

3.2 PROTECTION

Surfaces not to receive spray-applied fireproofing shall be covered to prevent contamination by splatter, rebound and overspray. Exterior openings in areas to receive spray-applied fireproofing shall be covered prior to and during application of fireproofing with tarpaulins or other approved material. Surfaces not to receive fireproofing shall be cleaned of fireproofing and sealer.

3.3 FIREPROOFING MATERIAL

Mix fireproofing material in accordance with the manufacturer's recommendations. Submit data identifying performance characteristics of fireproofing material. Data shall include recommended application requirements and indicate thickness of fireproofing that should be applied to achieve each required fire rating.

3.4 APPLICATION

3.4.1 Sequence

Prior to application of fireproofing on each floor, the manufacturer shall inspect and approve application equipment, water supply and pressure, and the application procedures. If fireproofing is required to be applied to underside of steel roof deck and steel floor assemblies, it shall be done

only after respective roof or floor construction is complete. No roof or floor traffic shall be allowed during application. Fireproofing material shall be applied prior to the installation of ductwork, piping and conduits which would interfere with uniform application of the fireproofing.

3.4.2 Application Technique

Water pressure and volume shall be maintained to manufacturer's recommendations throughout the fireproofing application. Fireproofing material shall be applied to the thickness and density established for the specified fire resistance rating, in accordance with the procedure recommended by the manufacturer, and to a uniform density and texture. Fireproofing material shall not be tamped to achieve the desired density.

3.4.3 Applied Thickness

The minimum average thickness shall be no less than 0.375 inches. Thicknesses shall not be less than required to achieve designated fire resistance ratings. If the specified thickness is greater than or equal to 1 inch, any individual measurement shall not be less than the specified thickness minus 0.25 inches. If the specified thickness is less than 1 inch, any individual measurement shall not be less than the specified thickness minus 25 percent.

3.5 FIELD TESTS

The applied fireproofing shall be tested by an approved independent testing laboratory to be selected by the A/E and paid for by the Contractor. Submit test reports documenting results of tests on the applied material in the project. Report shall include defects identified, repair procedures, and results of the retests when required. Perform the tests in approved locations: for density in accordance with ASTM E736, cohesion/adhesion in accordance with ASTM E736, and for thickness in accordance with ASTM E605. Determine densities in accordance with ASTM E605 or Appendix A, "Alternate Method for Density Determination" of AWCI TM 12-A. Take density determinations at the flat portion of deck, beam bottom flange, beam web, column, and an equivalent area from the top of the lower beam flange. Areas showing a density less than specified will be rejected. A test sample shall be located every 10,000 square feet of floor area or two for each floor, whichever produces the greatest number of test areas. Any area showing less than minimum requirements shall be corrected. Proposed corrective measures, in writing, shall be approved before starting the corrective action. Corrected work shall be retested.

3.5.1 Structural Components

Each structural component type shall be tested at floor and roof decks, beams, columns, joists, and trusses. Minimum average thickness shall be as required by UL Fire Resistance. Density and cohesion/adhesion shall be as specified.

3.5.2 Repair

Additional fireproofing material may be added to provide proper thickness. Rejected areas of fireproofing shall be corrected to meet specified requirements by adding fireproofing material to provide the proper thickness, or by removing defects and respraying with new

fireproofing material. Repairs shall use same type of fireproofing material as originally applied or patching materials recommended by the manufacturer. Repaired areas shall be retested and reinspected. Fireproofing material shall be applied to voids or damaged areas by hand-trowel, or by respraying.

3.5.3 Visual Inspections

Inspections shall be made by the certified independent laboratory prior to closure of concealed areas. These inspections may be phased, but shall not occur less than 5 working days prior to the enclosure of the fireproofing. Sprayed areas shall receive a final inspection. Fireproofed surfaces shall be inspected after mechanical, electrical, and other work in contact with fireproofing material has been completed and before sprayed material is covered. Any locations missing fireproofing shall be patched in accordance with the manufacturer's requirements.

3.5.4 Patching

Patch and repair damaged fireproofing. The patching material shall be the same as that specified for that area.

3.6 CLEANUP

Surfaces not indicated to receive fireproofing shall be thoroughly cleaned of sprayed material within a 24 hour period after application.

-- End of Section --

SECTION 07 84 00

FIRESTOPPING
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E119	(2012a) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E1399	(1997; R 2009) Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
ASTM E1966	(2007; R 2011) Fire-Resistive Joint Systems
ASTM E2174	(2010a; E 2011) Standard Practice for On-Site Inspection of Installed Fire Stops
ASTM E2307	(2010) Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus
ASTM E2393	(2010a) Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers
ASTM E814	(2011a) Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/
FM AS 4991	(2001) Approval of Firestop Contractors

UNDERWRITERS LABORATORIES (UL)

UL 1479	(2003; Reprint Oct 2012) Fire Tests of Through-Penetration Firestops

UL 2079	(2004; Reprint Dec 2012) Tests for Fire Resistance of Building Joint Systems
UL 723	(2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials
UL Fire Resistance	(2012) Fire Resistance Directory

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SYSTEM DESCRIPTION

1.3.1 General

Furnish and install tested and listed firestopping systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps.

a. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents.

b. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint.

c. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof or floor deck above and at the intersection of shaft assemblies and adjoining fire resistance rated assemblies.

1.3.2 Sequencing

Coordinate the specified work with other trades. Apply firestopping materials, at penetrations of pipes and ducts, prior to insulating, unless insulation meets requirements specified for firestopping. Apply firestopping materials. at building joints and construction gaps, prior to completion of enclosing walls or assemblies. Cast-in-place firestop devices shall be located and installed in place before concrete placement. Pipe, conduit or cable bundles shall be installed through cast-in-place device after concrete placement but before area is concealed or made inaccessible. Firestop material shall be inspected and approved prior to final completion and enclosing of any assemblies that may conceal installed firestop.

1.3.3 Submittals Requirements

a. Submit detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resistance or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a

manufacturer, a manufacturer's engineering judgment, derived from similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal shall indicate the firestopping material to be provided for each type of application. When more than a total of 5 penetrations and/or construction joints are to receive firestopping, provide drawings that indicate location, "F" "T" and "L" ratings, and type of application.

b. Submit certificates attesting that firestopping material complies with the specified requirements. For all intumescent firestop materials used in through penetration systems, manufacturer shall provide certification from UL of passing the "Aging and Environmental Exposure Testing " portion of UL 1479.

c. Submit documentation of training and experience for Installer.

d. Submit manufacturer's representative certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping Materials.

SD-03 Product Data

Firestopping Materials; LEED NC

SD-07 Certificates

Manufacturer's Technical Representative
Firestopping Materials.
Installer Qualifications.
Inspection.

SD-11 Closeout Submittals

Low Emitting Materials - Adhesives and Sealants
Low Emitting Materials - Paints and Coatings

1.5 QUALITY ASSURANCE

1.5.1 Installer

Engage an experienced Installer who is:

a. FM Research approved in accordance with FM AS 4991, operating as a UL Certified Firestop Contractor, or

b. Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products in accordance with specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer installer qualifications on the buyer. The Installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures. The installer shall obtain from the manufacturer written certification of training, and retain proof of certification for duration of firestop installation.

1.5.2 Manufacturer's Technical Representative

The manufacturer's technical representative shall be a direct representative of the manufacturer (not a distributor or an agent). Provide current documentation from the manufacturer that he or she is a direct representative of the manufacturer and is qualified to perform the specified inspections and certify the firestopping installation.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the original unopened packages or containers showing name of the manufacturer and the brand name. Store materials off the ground, protected from damage and exposure to elements. Remove damaged or deteriorated materials from the site.

PART 2 PRODUCTS

2.1 FIRE RATED ASSEMBLIES

Fire-Stopping Systems:

UL System No. HW-D-0044	Rated wall to	concrete slab (1 and 2-hour)
UL System No. HW-D-0194	Rated shaft wall to	concrete slab (2-hour)
UL System No. HW-D-0039	Concrete wall or CMU, perpendicular to	composite deck (1-hour)
UL System No. HW-D-0055	Concrete wall or CMU, parallel to	composite deck (1-hour)
UL System No. HW-D-0043	Rated wall, perpendicular to	composite deck (1 and 2-hour)
UL System No. HW-D-0054	Rated wall, parallel to	composite deck (1 and 2-hour)
UL System No. HW-D-0088	Rated wall, perpendicular to	spray-applied deck (1 and 2-hour)
UL System No. HW-D-0099	Rated wall, parallel to	spray-applied deck (1 and 2-hour)
UL System No. HW-D-0548	Rated shaft wall, perpendicular to	spray-applied deck (2-hour)
UL System No. HW-D-0643	Rated shaft wall, parallel to	spray-applied deck (2-hour)

UL System No. HW-D-0139	Concrete wall, perpendicular to	spray-applied deck (2-hour)
UL System No. HW-D-0140	Concrete wall, parallel to	spray-applied deck (2-hour)
UL System No. CW-D-2042	Curtain wall glazing system to	concrete slab (2-hour)
UL System No. CW-D-2004	Precast wall to	concrete slab (2-hour)
UL System No. HW-D-1037	Precast wall to	c.i.p. column (2-hour

2.2 FIRESTOPPING MATERIALS

Provide firestopping materials, supplied from a single domestic manufacturer, consisting of commercially manufactured, asbestos-free, nontoxic, water-based, noncombustible products FM APP GUIDE approved, or UL listed, for use with applicable construction and penetrating items, complying with the following minimum requirements:

2.2.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E84 or UL 723. Material shall be an approved firestopping material as listed in UL Fire Resistance or by a nationally recognized testing laboratory.

2.2.2 Toxicity

Material shall be nontoxic and carcinogen free to humans at all stages of application or during fire conditions and shall not contain hazardous chemicals or require harmful chemicals to clean material or equipment. Firestop material must be free from Ethylene Glycol, PCB, MEK, or other types of hazardous chemicals.

2.2.3 Fire Resistance Rating

Firestop systems shall be UL Fire Resistance listed or FM APP GUIDE approved with "F" rating at least equal to fire-rating of fire wall or floor in which penetrated openings are to be protected. Where required, firestop systems shall also have "T" rating at least equal to the fire-rated floor in which the openings are to be protected.

2.2.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph SYSTEM DESCRIPTION, shall provide "F", "T" and "L" fire resistance ratings in accordance with ASTM E814 or UL 1479. Fire resistance ratings shall be as follows:

a. Penetrations of Fire Resistance Rated Walls and Partitions: Rating of wall or partition being penetrated.

b. Penetrations of Fire Resistance Rated Floors, Floor-Ceiling Assemblies. Where the penetrating item is outside of a wall cavity the F rating and T rating must be equal to the fire resistance rating of the floor penetrated.

c. Penetrations of Fire and Smoke Resistance Rated Walls, Floors, Floor-Ceiling Assemblies, and the ceiling membrane of Roof-Ceiling Assemblies: Where L rating is required.

2.2.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph SYSTEM DESCRIPTION, and gaps such as those between floor slabs or roof decks and curtain walls shall be the same as the construction in which they occur. Construction joints and gaps shall be provided with firestopping materials and systems that have been tested in accordance with ASTM E119, ASTM E1966 or UL 2079 to meet the required fire resistance rating. Curtain wall joints shall be provided with firestopping materials and systems that have been tested in accordance with ASTM E2307 to meet the required fire resistance rating. Systems installed at construction joints shall meet the cycling requirements of ASTM E1399 or UL 2079. All joints at the intersection of the top of a fire resistance rated wall and the underside of a fire-rated floor, floor ceiling, or roof ceiling assembly shall provide a minimum class II movement capability.

2.2.4 Material Performance

All firestop materials are subject to these minimum standards of performance.

a. Firestop material shall be capable of installation at temperatures of 35 to 120 degrees F.

b. Material must be able to be frozen, thawed and still maintain manufacturer approval for installation.

c. Firestop material must convey a manufacturer's written warranty guaranteeing the performance of the material for the sustainable lifetime of the structure.

d. Material must maintain a shelf life of no less than two years from date of manufacturing.

e. Acceptable firestop cast-in-place devices are factory assembled intumescent lined round or oval plastic cylinders capable of protecting plastic, metallic, cable, and blank openings through the cast-in-place device equal to the fire-resistance rating of the floor.

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement shall be sound and capable of supporting device. Prepare surfaces as recommended by the manufacturer.

3.2 INSTALLATION

Completely fill void spaces with firestopping material regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 4 inches or

more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Install firestopping in accordance with manufacturer's written instructions. Provide tested and listed firestop systems in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.

b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.

c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.

e. Construction joints in floors and fire rated walls and partitions.

f. Other locations where required to maintain fire resistance rating of the construction.

3.2.1 Insulated Pipes and Ducts

Thermal insulation shall be cut and removed where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Replace thermal insulation with a material having equal thermal insulating and firestopping characteristics.

3.2.2 Fire Dampers

Install and firestop fire dampers in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM. Firestop installed with fire damper must be tested and approved for use in fire damper system. Firestop installed with fire damper must be tested and approved for use in fire damper system.

3.2.3 Data and Communication Cabling

Cabling for data and communication applications shall be sealed with re-enterable firestopping products. Firestopping devices shall be pre-manufactured modular devices, containing built-in self-sealing intumescent inserts. Firestopping devices shall allow for cable moves, additions or changes without the need to remove or replace any firestop materials. Devices must be capable of maintaining the fire resistance rating of the penetrated membrane at 0% to 100% visual fill of penetrants; while maintaining "L" rating of <5 cfm/sf measured at ambient temperature and 400* F at 0% to 100% visual fill. Each device must be capable of retrofit applications and be available in square and round configurations, with single, double, triple and six-plex bracket systems provided. Firestop devices must also allow for plastic pipe, metallic pipe, and mixed multiple penetrations plastic, metallic, insulated metallic, and cable through a single device.

3.3 INSPECTION

3.3.1 General Requirements

For all projects, the firestopped areas shall not be covered or enclosed until inspection is complete and approved by the manufacturer's technical representative. The manufacturer's representative shall inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements. Submit written reports indicating locations of and types of penetrations and types of firestopping used at each location; type shall be recorded by UL listed printed numbers.

3.3.2 Inspection Standards

Inspect all firestopping in accordance to ASTM standards for firestop inspection, and document inspection results to be submitted to GC, Architect and Owner.

a. ASTM E2393

b. ASTM E2174

-- End of Section --

SECTION 07 92 00

JOINT SEALANTS
01/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C734	(2006; R 2012) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C834	(2010) Latex Sealants
ASTM C919	(2012) Use of Sealants in Acoustical Applications
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM C1330	(2002; R 2013) Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants
ASTM C1193	Standard Guide for Use of Joint Sealants
ASTM C1521	Standard Practice for Evaluating Adhesion of Installed Waterprofing Sealant Joints
ASTM D217	(2010) Cone Penetration of Lubricating Grease
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants; (LEED NC)

Primers; (LEED NC)

Bond breakers

Backer rod

Perforated weep hole cover

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). Provide a copy of the Material Safety Data Sheet for each solvent, primer or sealant material.

SD-07 Certificates

Sealant

Certificates of compliance stating that the materials conform to the specified requirements.

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content
Low Emitting Materials - Adhesives and Sealants
Low Emitting Materials - Paints and Coatings

1.4 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 40 and 90 degrees F.

1.5 DELIVERY AND STORAGE

Deliver materials to the job site in unopened manufacturers' external shipping containers, with brand names, date of manufacture, color, and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Carefully handle and store materials to prevent inclusion of foreign materials or subjection to sustained temperatures exceeding 90 degrees F or less than 0 degrees F.

1.6 QUALITY ASSURANCE

1.6.1 Compatibility with Substrate

Verify that each of the sealants are compatible for use with joint substrates.

1.6.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.6.3 Mock-Up

Project personnel is responsible for installing sealants in mock-up, using materials and techniques approved for use on the project.

Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6.4 Preconstruction Field-Adhesion Testing

Before installing sealants, field test their adhesion to Project joint substrates as follows:

Locate test joints where indicated Contracting Officer's Representative.
Conduct field tests for each kind of exterior sealant and joint substrate.
Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
Notify Contracting Officer's Representative seven days in advance of dates and times when test joints will be erected.

Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193or Method A, Tail Procedure, in ASTM C1521.

For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.

Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.7 SPECIAL WARRANTY

Guarantee sealant joint against failure of sealant and against water penetration through each sealed joint for five years.

PART 2 PRODUCTS

2.1 SEALANTS

Provide sealant that has been tested and found suitable for the substrates to which it will be applied.

2.1.1 Interior Sealant

Provide ASTM C834 ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT. Sealants and sealant primers used inside the weatherproofing system shall comply with low emitting materials referenced in Section 01 33 29 LEED (TM) Documentation. Location(s) and color(s) of sealant for the following:

LOCATION	COLOR
Small voids between walls or partitions and adjacent lockers, casework, shelving, door frames, built-in or surface-mounted equipment and fixtures, and similar items.	White
Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces.	Match adjacent surface color
Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed.	Match adjacent surface color
Joints between edge members for acoustical tile and adjoining vertical surfaces.	Match adjacent surface color
Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted.	Match adjacent surface color
Joints between bathtubs and ceramic tile; joints between shower receptors and ceramic tile; joints formed where nonplaner tile surfaces meet.	Match adjacent surface color
Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.	Match adjacent surface color
Behind escutcheon plates at valve pipe penetrations and showerheads in showers.	Match adjacent surface color

Provide typical 1/2" sealant for interior application around glazing system frame.

2.1.2 Exterior Sealant

For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

LOCATION	COLOR
Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations.	Match adjacent surface color
Joints between new and existing exterior masonry walls.	Match adjacent surface color
Masonry joints where shelf angles occur.	Match adjacent surface color
Joints in wash surfaces of stonework.	Match adjacent surface color
Expansion and control joints.	Match adjacent surface color
Interior face of expansion joints in exterior concrete or where metal expansion joint covers are not required.	Match adjacent surface color
Voids where items pass through exterior walls.	Match adjacent surface color
Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.	Match adjacent surface color
Metal-to-metal joints where sealant is indicated or specified.	Match adjacent surface color
Joints between ends of gravel stops, fascias, copings, and adjacent walls.	Match adjacent surface color

2.1.3 Floor Joint Sealant

ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

LOCATION	COLOR
Seats of metal thresholds for exterior doors.	Gray

LOCATION	COLOR
Control and expansion joints in floors, slabs, ceramic tile, and walkways.	Match adjacent surface color

2.1.4 Acoustic Sealant

Rubber or polymer-based acoustic sealant conforming to ASTM C919 must have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84. Acoustic sealant must have a consistency of 250 to 310 when tested in accordance with ASTM D217, and must remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C734, and must be non-staining.

2.2 PRIMERS

Provide a nonstaining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application.

2.3 BOND BREAKERS

Provide the type and consistency recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

2.4 BACKER ROD

Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.5 PERFORATED WEEP HOLE COVER

Product and Manufacture: Weep Hole Cover; Pest Control Solutions, Memphis, TN

Color: To be selected by the Contracting Officer's Representative from manufacturer's standard color selections to match adjacent surfact color.

2.6 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer .

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Clean surfaces from dirt frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would tend to destroy or impair adhesion. Remove oil and grease with solvent. Surfaces must be wiped dry with clean cloths. When resealing an existing joint, remove existing caulk or sealant prior to applying new sealant. For surface types not listed below, contact sealant manufacturer for specific recommendations.

3.1.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finish work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue-free solvent.

3.1.2 Aluminum or Bronze Surfaces

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and any residual adhesive just prior to sealant application. For removing protective coatings and final cleaning, use nonstaining solvents recommended by the manufacturer of the item(s) containing aluminum or bronze surfaces.

3.1.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Remove laitance, efflorescence and loose mortar from the joint cavity.

3.1.4 Wood Surfaces

Keep wood surfaces to be in contact with sealants free of splinters and sawdust or other loose particles.

3.2 SEALANT PREPARATION

Do not add liquids, solvents, or powders to the sealant. Mix multicomponent elastomeric sealants in accordance with manufacturer's instructions.

3.3 APPLICATION

3.3.1 Joint Width-To-Depth Ratios

a. Acceptable Ratios:

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
For metal, glass, or other nonporous surfaces:		
1/4 inch (minimum)	1/4 inch	1/4 inch

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
over 1/4 inch	1/2 of width	Equal to width
For wood and concrete,		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
over 1/2 inch to 2 inch	1/2 inch	5/8 inch
Over 2 inch	As recommended by sealant manufacturer	

b. Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is not required on metal surfaces.

3.3.2 Masking Tape

Place masking tape on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Remove masking tape within 10 minutes after joint has been filled and tooled.

3.3.3 Backer Rod

Install backer rod dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide a joint of the depth specified. Install backstops in the following locations:

a. Where indicated.

b. Where backer rod is not indicated but joint cavities exceed the acceptable maximum depths specified in paragraph entitled, "Joint Width-to-Depth Ratios".

3.3.4 Primer

Immediately prior to application of the sealant, clean out loose particles from joints. Where recommended by sealant manufacturer, apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's instructions. Do not apply primer to exposed finish surfaces.

3.3.5 Bond Breaker

Provide bond breakers to the back or bottom of joint cavities, as recommended by the sealant manufacturer for each type of joint and sealant used, to prevent sealant from adhering to these surfaces. Carefully apply the bond breaker to avoid contamination of adjoining surfaces or breaking bond with surfaces other than those covered by the bond breaker.

3.3.6 Sealants

Provide a sealant compatible with the material(s) to which it is applied. Do not use a sealant that has exceeded shelf life or has jelled and can not be discharged in a continuous flow from the gun. Apply the sealant in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Force sealant into joints to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Make sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled joints, apply sealant, and tool smooth as specified. Apply sealer over the sealant when and as specified by the sealant manufacturer.

3.4 Perforated Weep Hole Covers

Install in accordance with manufacturer's instructions and recommendations.

3.5 PROTECTION AND CLEANING

3.5.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled.

3.5.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

a. Masonry and Other Porous Surfaces: Immediately scrape off fresh sealant that has been smeared on masonry and rub clean with a solvent as recommended by the sealant manufacturer. Allow excess sealant to cure for 24 hour then remove by wire brushing or sanding.

b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent-moistened cloth.

-- End of Section --

SECTION 08 11 13

STEEL DOORS AND FRAMES
02/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM C578	(2012b) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C591	(2012a) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C612	(2010) Mineral Fiber Block and Board Thermal Insulation
ASTM D2863	(2012) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM E283	(2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.115	(2006) Hardware Preparation in Steel Doors and Steel Frames

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 105	(2013) Standard for Installation of Smoke Door Assemblies and Other Opening Protectives

NFPA 252	(2012) Standard Methods of Fire Tests of Door Assemblies
NFPA 80	(2013) Standard for Fire Doors and Other Opening Protectives

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR 111	(2009) Recommended Selection and Usage Guide for Standard Steel Doors, Frames and Accessories
SDI/DOOR 113	(2001; R2006) Standard Practice for Determining the Steady State Thermal Transmittance of Steel Door and Frame Assemblies
SDI/DOOR A250.11	(2001) Recommended Erection Instructions for Steel Frames
SDI/DOOR A250.4	(2011) Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcing
SDI/DOOR A250.6	(2003; R2009) Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
SDI/DOOR A250.8	(2003; R2008) Recommended Specifications for Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL 10C	(2009) Standard for Positive Pressure Fire Tests of Door Assemblies

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval.When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G

Frames; G

Accessories

Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

Door and Frame Schedule; G

; Submit door and frame locations.

SD-03 Product Data

Doors; G; (LEED NC)

Frames; G; (LEED NC)

Accessories

Weatherstripping

Submit manufacturer's descriptive literature for doors, frames, and accessories. Include data and details on door construction, panel (internal) reinforcement, insulation, and door edge construction. When "custom hollow metal doors" are provided in lieu of "standard steel doors," provide additional details and data sufficient for comparison to SDI/DOOR A250.8 requirements.

SD-06 Test Reports

Notice of Acceptance Number

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Provide temporary steel spreaders securely fastened to the bottom of each welded frame. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

1.5 DOOR AND FRAME SCHEDULE

Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

PART 2 PRODUCTS

2.1 STANDARD STEEL DOORS

SDI/DOOR A250.8, except as specified otherwise. Prepare doors to receive door hardware as specified in Section 08 71 00. Undercut where indicated. Exterior doors shall have top edge closed flush and sealed to prevent water intrusion. Doors shall be 1-3/4 inch thick, unless

otherwise indicated.

2.1.1 Classification - Level, Performance, Model

2.1.1.1 Exterior Doors

Product and Manufacturer: IR Steelcraft Double Flush Outswing Commercial Steel Doors with Panic Exit Devices; Ingersoll-Rand

Notice of Acceptance Number: 12-0305.13

Expiration Date: May 05, 2015

2.1.1.2 Heavy Duty Doors - Interior Doors

SDI/DOOR A250.8, Level 2, physical performance Level B, Model 2, with core construction as required by the manufacturer for interior doors , of size(s) and design(s) indicated.

2.2 INSULATED STEEL DOOR SYSTEMS

Insulated steel doors shall have a core of polyurethane foam and an R factor of 10.0 or more (based on a k value of 0.16); face sheets, edges, and frames of galvanized steel not lighter than 23 gage, 16 gage, and 16 gage respectively; magnetic weatherstripping; nonremovable-pin hinges; thermal-break aluminum threshold; and vinyl door bottom. Doors and frames shall receive phosphate treatment, rust-inhibitive primer, and baked acrylic enamel finish. Doors shall have been tested in accordance with SDI/DOOR A250.4 and shall have met the requirements for Level C. Prepare doors to receive specified hardware.Doors shall be 1-3/4 inch thick. Provide insulated steel doors and frames at all exterior openings.

2.3 ACCESSORIES

2.3.1 Astragals

Refer to Section 08 71 00 Door Hardware.

For pairs of exterior steel doors which will not have aluminum astragals or removable mullions, as specified in Section 08 71 00 DOOR HARDWARE provide overlapping steel astragals with the doors. For interior pairs of fire rated and smoke control doors, provide stainless steel astragals complying with NFPA 80 for fire rated assemblies and NFPA 105 for smoke control assemblies.

2.4 INSULATION CORES

Insulated cores shall be of type specified, and provide an apparent U-factor of .48 in accordance with SDI/DOOR 113 and shall conform to:

a. Rigid Cellular Polyisocyanurate Foam: ASTM C591, Type I or II, foamed-in-place or in board form, with oxygen index of not less than 22 percent when tested in accordance with ASTM D2863; or

b. Rigid Polystyrene Foam Board: ASTM C578, Type I or II; or

c. Mineral board: ASTM C612, Type I.

2.5 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level 2 , except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners . Provide steel frames for doors, transoms, sidelights, mullions, cased openings, and interior glazed panels, unless otherwise indicated.

2.5.1 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded.

2.5.2 Mullions and Transom Bars

Mullions and transom bars shall be closed or tubular construction and be a member with heads and jambs butt-welded thereto . Bottom of door mullions shall have adjustable floor anchors and spreader connections.

2.5.3 Stops and Beads

Form stops and beads from 20 gage steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 12 to 16 inch on center. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

2.5.4 Cased Openings

Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

2.5.5 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated or painted with rust-inhibitive paint, not lighter than 18 gage.

2.5.5.1 Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 7.5 feet in height, provide one additional anchor for each jamb for each additional 2.5 feet or fraction thereof.

a. Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding;

b. Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111; and

c. Masonry: provide anchors of corrugated or perforated steel straps

or 3/16" inch diameter steel wire, adjustable or T shaped.

2.5.5.2 Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member.

2.6 FIRE AND SMOKE DOORS AND FRAMES

NFPA 80 and NFPA 105 and this specification. The requirements of NFPA 80 and NFPA 105 shall take precedence over details indicated or specified.

2.6.1 Labels

Fire doors and frames shall bear the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing shall be in accordance with NFPA 252 or UL 10C. Labels shall be metal with raised letters, and shall bear the name or file number of the door and frame manufacturer. Labels shall be permanently affixed at the factory to frames and to the hinge edge of the door. Door labels shall not be painted.

2.6.2 Astragal on Fire and Smoke Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements. On smoke control doors, conform to NFPA 105.

2.7 WEATHERSTRIPPING

As specified in Section 08 71 00 DOOR HARDWARE.

2.7.1 Integral Gasket

Black synthetic rubber gasket with tabs for factory fitting into factory slotted frames, or extruded neoprene foam gasket made to fit into a continuous groove formed in the frame, may be provided in lieu of head and jamb seals specified in Section 08 71 00 DOOR HARDWARE. Insert gasket in groove after frame is finish painted. Air leakage of weatherstripped doors shall not exceed 0.5 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283.

2.8 HARDWARE PREPARATION

Provide minimum hardware reinforcing gages as specified in SDI/DOOR A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to ANSI/BHMA A156.115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of SDI/DOOR A250.8, as applicable. Punch door frames to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.9 FINISHES

2.9.1 Factory-Primed Finish

All surfaces of interior doors and frames shall be thoroughly cleaned, chemically treated and factory primed with a rust inhibiting coating as specified in SDI/DOOR A250.8. , or paintable A25 galvannealed steel without primer. Where coating is removed by welding, apply touchup of factory primer.

2.9.2 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate exterior doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A924/A924Mand ASTM A653/A653M. The coating weight shall meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., A40. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in SDI/DOOR A250.8.

2.10 FABRICATION AND WORKMANSHIP

Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable.

2.10.1 Grouted Frames

For frames to be installed in exterior walls and to be filled with mortar or grout, fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of stop-applied head and jamb seals.

2.11 PROVISIONS FOR GLAZING

Materials are specified in Section 08 81 00, GLAZING.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Frames

Set frames in accordance with SDI/DOOR A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction. Where frames require ceiling struts or overhead bracing, anchor frames to the struts or bracing. Backfill frames with mortar. Coat inside of frames with corrosion-inhibiting bituminous material. For frames in exterior walls, ensure that stops are filled with rigid insulation before grout is placed.

3.1.2 Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8.

After erection and glazing, clean and adjust hardware.

3.1.3 Fire and Smoke Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80. Install fire rated smoke doors and frames in accordance with NFPA 80 and NFPA 105.

3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

-- End of Section --

SECTION 08 11 16

ALUMINUM DOORS AND FRAMES
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM E1300	(2012a; E 2012) Determining Load Resistance of Glass in Buildings
ASTM E283	(2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2009) Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM F1642	(2012) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Structural

Exterior doors, frames and hardware shall be designed to resist equivalent static design loads in accordance with ASTM F1642. Frame deflections shall not exceed L/160 of the unsupported member lengths. Equivalent static design loads for connections of window or door frame to the surrounding walls or hardware and associated connections, and glazing stop connections shall be in accordance with ASTM F2248 and ASTM E1300. Design supporting elements and their connections based on their ultimate capacities. Provide calculations of a Professional Engineer that substantiates compliance with these requirements. Use frames that provide an equivalent level of performance. Shapes and thicknesses of framing members shall be sufficient to withstand a design wind load as indicated on the drawings.

1.3.2 Air Infiltration

When tested in accordance with ASTM E283, air infiltration shall not exceed 0.06 cubic feet per minute per square footof fixed area at a test pressure of 6.24 pounds per square foot (50 mile per hour wind).

1.3.3 Water Penetration

When tested in accordance with ASTM E331, there shall be no water penetration at a pressure of 8 pounds per square foot of fixed area.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors and frames; G

Show elevations of each door type, size of doors and frames, metal gages, details of door and frame construction, methods of anchorage, glazing details, weatherstripping, provisions for and location of hardware, and details of installation.

SD-03 Product Data

Exterior Aluminum and Glass Door; (LEED NC); G
Interior Aluminum and Glass Door; (LEED NC); G
Extruded Aluminum Door Frame; (LEED NC); G

SD-04 Samples

Finish sample

SD-05 Design Data

Structural calculations for deflection

SD-08 Manufacturer's Instructions

Doors and frames

Submit detail specifications and instructions for installation, adjustments, cleaning, and maintenance.

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage. Unload and store with minimum handling. Provide storage space in dry location with adequate ventilation, free from dust or water, and easily accessible for inspection and handling. Stack materials on nonabsorptive strips or wood platforms. Do not cover doors and frames with tarps, polyethylene film, or similar coverings. Protect finished surfaces during shipping and handling using manufacturer's standard method, except that no coatings or lacquers shall be applied to surfaces to which caulking and glazing compounds must adhere.

1.6 QUALITY CONTROL

1.6.1 Shop Drawing Requirements

Drawings shall indicate elevations of doors and frames, full-size sections, thickness and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, mullion details, method and materials for weatherstripping, material and method of attaching subframes, trim, installation details, and other related items.

1.6.2 Sample Requirements

1.6.2.1 Finish Sample Requirements

Submit color chart of standard factory-finish color coatings.

PART 2 PRODUCTS

2.1 DOORS AND FRAMES

Exterior Aluminum and Glass Door and Extruded Aluminum Door Frame

Model and Manufacturer - Basis of Design: 350 IR Aluminum Storefront Door; Kawneer an Alcoa Company, or equal.

Notice of Acceptance Number: 11-1013.03
Expiration Date: February 08, 2017

Refer to Section 08 71 00 Door Hardware for required hardware.

Refer to Section 08 81 00 Glazing for glass requirements.

Refer to Section 08 71 00 Door Hardware for automatic opening devices.

Interior Aluminum and Glass Door and Extruded Aluminum Door Frame

Model and Manufacturer - Basis of Design: 350 Medium Stile Aluminum Entrance Door; Kawneer an Alcoa Company, or equal.

2.2 MATERIALS

2.2.1 Anchors

Stainless steel.

2.2.2 Weatherstripping

Continuous wool pile, silicone treated, or type recommended by door manufacturer.

2.2.3 Aluminum Alloy for Doors and Frames

ASTM B221, Alloy 6063-T5 for extrusions. ASTM B209, alloy and temper best suited for aluminum sheets and strips.

2.2.4 Fasteners

Hard aluminum or stainless steel.

2.2.5 Structural Steel

ASTM A36/A36M.

2.2.6 Aluminum Paint

Aluminum door manufacturer's standard aluminum paint.

2.3 FABRICATION

2.3.1 Aluminum Frames

Extruded aluminum shapes with contours approximately as indicated. Provide removable glass stops and glazing beads for frames accommodating fixed glass. Use countersunk stainless steel Phillips screws for exposed fastenings, and space not more than 12 inches on center. Mill joints in frame members to a hairline fit, reinforce, and secure mechanically.

Door Frames: Reinforce as required to support loads imposed by door operation and for installing door hardware.

At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

Accurately fit and secure joints and corners. Make joints hairline in appearance. Prepare components with internal reinforcement for door hardware. Arrange fasteners and attachments to conceal from view.

2.3.2 Aluminum Doors

Of type, size, and design indicated and not less than 1-3/4 inch thick. Minimum wall thickness, 0.125 inch, except beads and trim, 0.050 inch. Door sizes shown are nominal and shall include standard clearances as

follows: 0.093 inch at hinge and lock stiles, 0.125 inch between meeting stiles, 0.125 inch at top rails, 0.187 inch between bottom and threshold, and 0.687 inch between bottom and floor. Bevel single-acting doors 0.063 or 0.125 inch at lock, hinge, and meeting stile edges. Double-acting doors shall have rounded edges at hinge stile, lock stile, and meeting stile edges.

2.3.2.1 Full Glazed Stile and Rail Doors

Doors shall have medium stiles and rails as indicated. Fabricate from extruded aluminum hollow seamless tubes or from a combination of open-shaped members interlocked or welded together. Fasten top and bottom rail together by means of welding or by 3/8 or 1/2 inch diameter cadmium-plated tensioned steel tie rods. Provide an adjustable mechanism of jack screws or other methods in the top rail to allow for minor clearance adjustments after installation.

2.3.3 Welding and Fastening

Where possible, locate welds on unexposed surfaces. Dress welds on exposed surfaces smoothly. Select welding rods, filler wire, and flux to produce a uniform texture and color in finished work. Remove flux and spatter from surfaces immediately after welding. Exposed screws or bolts will be permitted only in inconspicuous locations, and shall have countersunk heads. Weld concealed reinforcements for hardware in place.

2.3.4 Weatherstripping

Provide on stiles and rails of exterior doors. Fit into slots which are integral with doors or frames. Weatherstripping shall be replaceable without special tools, and adjustable at meeting rails of pairs of doors. Installation shall allow doors to swing freely and close positively. Air leakage of a single leaf weatherstripped door shall not exceed 0.5 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283.

2.3.5 Anchors

On the backs of subframes, provide anchors of the sizes and shapes indicated for securing subframes to adjacent construction. Anchor transom bars at ends and mullions at head and sill. Where indicated, reinforce vertical mullions with structural steel members of sufficient length to extend up to the overhead structural slab or framing and secure thereto. Reinforce and anchor freestanding door frames to floor construction as indicated on approved shop drawings and in accordance with manufacturer's recommendation. Place anchors near top and bottom of each jamb and at intermediate points not more than 25 inches apart.

2.3.6 Provisions for Hardware

Coordinate with Section 08 71 00 DOOR HARDWARE. Deliver hardware templates and hardware (except field-applied hardware) to the door manufacturer for use in fabrication of aluminum doors and frames. Cut, reinforce, drill, and tap doors and frames at the factory to receive template hardware. Provide doors to receive surface-applied hardware, except push plates, kick plates, and mop plates, with reinforcing only; drill and tap in the field. Provide hardware reinforcements of stainless steel or steel with hot-dipped galvanized finish, and secure with stainless steel screws. Provide reinforcement in core of flush doors as

required to receive locks, door closers, and other hardware.

2.3.7 Provisions for Glazing

Provide extruded aluminum snap-in glazing beads on interior side of doors. Provide extruded aluminum, theft-proof, snap-in glazing beads or fixed glazing beads on exterior or security side of doors. Glazing beads shall have vinyl insert glazing gaskets. Design glazing beads to receive glass of thickness indicated or specified.

2.3.8 Finishes

Provide aluminum surfaces with factory finish of anodic coating.

2.3.8.1 Anodic Coating

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45. Finish shall be clear (natural), designation AA-M10-C22-A41, Architectural Class I 0.7 mil or thicker).

PART 3 EXECUTION

3.1 INSTALLATION

Plumb, square, level, and align frames and framing members to receive doors, adjoining sidelights, and adjoining window walls. Anchor frames to adjacent construction as indicated and in accordance with manufacturer's printed instructions. Anchor bottom of each frame to rough floor construction with 3/32 inch thick stainless steel angle clips secured to back of each jamb and to floor construction; use stainless steel bolts and expansion rivets for fastening clip anchors. Hang doors to produce clearances specified in paragraph entitled "Aluminum Doors," of this section. After erection and glazing, adjust doors and hardware to operate properly.

3.2 PROTECTION FROM DISSIMILAR MATERIALS

3.2.1 Dissimilar Metals

Where aluminum surfaces come in contact with metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact to dissimilar metals.

3.2.1.1 Protection

Provide one of the following systems to protect surfaces in contact with dissimilar metals:

a. Paint the dissimilar metal with one coat of heavy-bodied bituminous paint.

b. Apply a good quality elastomeric sealant between the aluminum and the dissimilar metal.

c. Paint the dissimilar metal with one coat of primer and one coat of aluminum paint.

d. Use a nonabsorptive tape or gasket in permanently dry locations.

3.2.2 Drainage from Dissimilar Metals

In locations where drainage from dissimilar metals has direct contact with aluminum, provide protective paint to prevent aluminum discoloration.

3.2.3 Masonry and Concrete

Provide aluminum surfaces in contact with mortar, concrete, or other masonry materials with one coat of heavy-bodied bituminous paint.

3.2.4 Wood or Other Absorptive Materials

Provide aluminum surfaces in contact with absorptive materials subject to frequent moisture, and aluminum surfaces in contact with treated wood, with two coats of aluminum paint or one coat of heavy-bodied bituminous paint. In lieu of painting the aluminum, the Contractor shall have the option of painting the wood or other absorptive surface with two coats of aluminum paint and sealing the joints with elastomeric sealant.

3.3 CLEANING

Upon completion of installation, clean door and frame surfaces in accordance with door manufacturer's written recommended procedure. Do not use abrasive, caustic, or acid cleaning agents.

3.4 PROTECTION

Protect doors and frames from damage and from contamination by other materials such as cement mortar. Prior to completion and acceptance of the work, restore damaged doors and frames to original condition, or replace with new ones.

-- End of Section --

SECTION 08 14 00

WOOD DOORS
08/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI AWS	(2009) Architectural Woodwork Standards

ASTM INTERNATIONAL (ASTM)

ASTM E2226	(2012) Standard Practice for Application of Hose Stream

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 105	(2013) Standard for Installation of Smoke Door Assemblies and Other Opening Protectives
NFPA 252	(2012) Standard Methods of Fire Tests of Door Assemblies
NFPA 80	(2013) Standard for Fire Doors and Other Opening Protectives

UNDERWRITERS LABORATORIES (UL)

UL 10B	(2008; Reprint Apr 2009) Fire Tests of Door Assemblies

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

WDMA I.S. 1-A	(2007) Architectural Wood Flush Doors
WDMA TM-7	(2008) Cycle Slam Test Method
WDMA TM-8	(2008) Hinge Loading Test Method

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control

approval. When used, a designation following the "G" designation identifies the office that will the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

Wood Doors; G

Submit drawings or catalog data showing each type of door unit. Drawings and data shall indicate door type and construction, sizes, thickness, methods of assembly, door louvers, and glazing,.

SD-03 Product Data

Wood Doors; G; (LEED NC)
Accessories
Sample warranty
Fire resistance rating; G

SD-04 Samples

Wood Doors

Prior to the delivery of wood doors, submit a sample section of each type of door which shows the stile, rail, veneer, finish, and core construction.

Factory finish; G

Submit a minimum of three color selection samples , minimum 3 by 5 inches in size representing wood stain.

SD-06 Test Reports

Cycle-slam
Hinge loading resistance

Submit cycle-slam test report for doors tested in accordance with WDMA TM-7, and hinge loading resistance test report for doors tested in accordance with WDMA TM-8.

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content
Certified Wood

1.4 LOCAL/REGIONAL MATERIALS

Use products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources. Refer to Section 01 33 29 LEED DOCUMENTATION for cumulative total local material requirements. Wood doors may be locally available.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against

damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 4 inch thick, located at each end and at the midpoint of the door. Store doors in a well-ventilated building so that they will not be exposed to excessive moisture, heat, dryness, direct sunlight, or extreme changes of temperature and humidity. Do not store in a building under construction until concrete, masonry work, and plaster are dry. Replace defective or damaged doors with new ones.

1.6 WARRANTY

Warrant doors free of defects as set forth in the door manufacturer's standard door warranty.

PART 2 PRODUCTS

2.1 WOOD DOORS

Provide doors of the types, sizes, and designs indicated free of urea-formaldehyde resins.

2.1.1 Wood Doors

Conform to WDMA I.S. 1-A for flush doors. Provide hollow core doors with lock blocks and 1 inch minimum thickness hinge stile. Hardwood stile edge bands of doors receives a natural finish, compatible with face veneer. Provide mill option for stile edge of doors scheduled to be painted. No visible finger joints will be accepted in stile edge bands. When used, locate finger-joints under hardware.

2.1.1.1 Interior Flush Doors

Provide particleboard core, Type II flush doors conforming to WDMA I.S. 1-A with faces of select premium grade white oak. Hardwood veneers shall be rift cut slip matched.

2.1.2 Composite-Type Fire Doors

Provide doors specified or indicated to have a fire resistance rating conforming to the requirements of UL 10B, ASTM E2226, or NFPA 252 for the class of door indicated. Affix a permanent metal label with raised or incised markings indicating testing agency's name and approved hourly fire rating to hinge edge of each door.

2.2 ACCESSORIES

2.2.1 Door Light Openings

Provide glazed openings with the manufacturer's standard wood moldings. Provide moldings for doors to receive natural finish of the same wood species and color as the wood face veneers. Lip type moldings for flush doors.

2.2.2 Fixed Wood Door Panel

Description: Match Interior Flush Doors.

2.2.3 Additional Hardware Reinforcement

Provide the minimum lock blocks to secure the specified hardware. The

measurement of top, bottom, and intermediate rail blocks are a minimum 125 mm 5 inch by full core width. Comply with the manufacturer's labeling requirements for reinforcement blocking, but not mineral material similar to the core.

2.3 FABRICATION

2.3.1 Marking

Stamp each door with a brand, stamp, or other identifying mark indicating quality and construction of the door.

2.3.2 Quality and Construction

Identify the standard on which the construction of the door was based and identify doors having a Type I glue bond.

2.3.3 Adhesives and Bonds

WDMA I.S. 1-A. Use Type II bond for interior doors. Provide a nonstaining adhesive on doors with a natural finish.

2.3.4 Prefitting

Provide factory prefinished factory prefitted doors for the specified hardware, door frame and door-swing indicated. Machine and size doors at the factory by the door manufacturer in accordance with the standards under which the doors are produced and manufactured. The work includes sizing, beveling edges, mortising, and drilling for hardware and providing necessary beaded openings for glass and louvers. Provide the door manufacturer with the necessary hardware samples, and frame and hardware schedules to coordinate the work.

2.3.5 Finishes

2.3.5.1 Field Painting

Factory prime or seal doors, and field paint.

2.3.5.2 Factory Finish

Provide doors finished at the factory by the door manufacturer as follows: AWI AWS Section 1500, specification for System No. 4 Conversion varnish alkyd urea or System No. 5 Vinyl catalyzed. The coating is AWI AWS premium, medium rubbed sheen, closed grain effect. Use stain when required to produce the finish specified for color. Seal edges, cutouts, trim, and wood accessories, and apply two coats of finish compatible with the door face finish. Touch-up finishes that are scratched or marred, or where exposed fastener holes are filled, in accordance with the door manufacturer's instructions. Match color and sheen of factory finish using materials compatible for field application.

2.4 SOURCE QUALITY CONTROL

Meet or exceed the following minimum performance criteria of stiles of "B" and "C" label fire doors utilizing standard mortise leaf hinges:

a. Cycle-slam: 200,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the

requirements of WDMA TM-7.

b. Hinge loading resistance: Averages of ten test samples not less than 700 pounds load when tested for direct screw withdrawal in accordance with WDMA TM-8 using a No. 12, 1-1/4 inch long, steel, fully threaded wood screw. Drill 5/32 inch pilot hole, use 1-1/2 inch opening around screw for bearing surface, and engage screw full, except for last 1/8 inch. Do not use a steel plate to reinforce screw area.

PART 3 EXECUTION

3.1 INSTALLATION

Before installation, seal top and bottom edges of doors with the approved water-resistant sealer. Seal cuts made on the job immediately after cutting using approved water-resistant sealer. Fit, trim, and hang doors with a 1/16 inch minimum, 1/8 inch maximum clearance at sides and top, and a 3/16 inch minimum, 1/4 inch maximum clearance over thresholds. Provide 3/8 inch minimum, 7/16 inch maximum clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 1/8 inch in 2 inch. Door warp shall not exceed1/4 inch when measured in accordance with WDMA I.S. 1-A.

3.1.1 Fire and Smoke Doors

Install fire doors in accordance with NFPA 80. Install smoke doors in accordance with NFPA 105. Do not paint over labels.

-- End of Section --

SECTION 08 33 23

OVERHEAD COILING DOORS
07/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-10	(2010; Change 2010; Change 2011; Errata 2011; Change 2011) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A27/A27M	(2010) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A307	(2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications
ASTM E330	(2002; R 2010) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

ASTM F568M	(2007) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA MG 1	(2011; Errata 2012) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 DESCRIPTION

Overhead coiling doors and grilles to be counterbalanced doors by methods of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members. Doors to be coiling type, with interlocking slats, complete with anchoring and door hardware, metal guides, hood, and operating mechanisms, and designed for use on openings as indicated.

1.4 PERFORMANCE REQUIREMENTS

1.4.1 Wind Loading for Exterior Coiling Doors

Design and fabricate door assembly to withstand the wind loading pressure indicated on the Drawings with a maximum deflection of 1/120 of the opening width. Provide test data showing compliance with ASTM E330. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested Complete assembly must meet or exceed the requirements of ASCE 7-10.

1.4.2 Operational Cycle Life

All portions of the doors and grilles, hardware and operating mechanism that are subject to movement, wear, or stress fatigue must be designed to operate through a minimum number of 10 cycles per day . One complete cycle of door operation is defined as when the door is in the closed position, moves to the fully open position, and returns to the closed position.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Provide fabrication drawings that show complete assembly with hardware and framing details for the following items:

Overhead Coiling Doors
Overhead Coiling Counter Doors
Overhead Coiling Grilles
Counterbalancing Mechanism
Electric Door Operators
Bottom Bar
Guides
Mounting Brackets
Overhead Drum
Hood
Painting

Submit Installation Drawings in accordance with paragraph entitled, "Overhead Coiling Door Assemblies," of this section.

SD-03 Product Data

Submit manufacturer's catalog data for the following items listing all accessories including supports, locks and latches, and weather stripping.

Overhead Coiling Doors; (LEED NC); G
Overhead Coiling Counter Doors; (LEED NC); G
Overhead Coiling Grilles; (LEED NC); G
Hardware; G
Counterbalancing Mechanism; G
Electric Door Operators; G

SD-05 Design Data

Submit equipment and performance data for the following items in accordance with the paragraph entitled, "Performance Requirements" of this section.

Overhead Coiling Doors
Overhead Coiling Counter Doors
Overhead Coiling Grills
Hardware
Counterbalancing Mechanism
Electric Door Operators

SD-06 Test Reports

Notice of Acceptance Number

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies , including the following items:

Materials
Devices
Procedures
Manufacture's Brochures
Parts Lists
Cleaning

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.6 OVERHEAD COILING DOORS AND GRILLES DETAIL SHOP DRAWINGS

Provide installation drawings for overhead coiling doors and grilles assemblies which show elevations of each door type, shape and thickness of materials, finishes, details of joints and connections, and details of guides and fittings, rough opening dimensions, location and description of hardware, anchorage locations, and counterbalancing mechanism and door operator details. Show locations of replaceable fusible links wiring diagrams for power, signal and controls. Include a schedule showing the location of each door with the drawings.

Contractor must submit 6 copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the Overhead Coiling Door and Grille Assemblies. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

Provide operation and maintenance manuals which are consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Provide test data that is legible and of good quality.

1.7 WARRANTY, OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies, Overhead Coiling Counter Door Assemblies and Overhead Coiling Grille Assemblies, including the following items:

Materials

Devices

Electric Door Operators
Hood

Counterbalancing Mechanism

Painting

Procedures

Manufacture's Brochures

Parts Lists

Contractor must furnish a written guarantee that the helical spring and counterbalance mechanism are free from defects in material and workmanship and that they will remain so for not less than two years after completion

and acceptance of the project.

Contractor must warrant that upon notification by the Government, he will immediately make good any defects in material, workmanship, and door operation within the same time period covered by the guarantee, at no cost to the Government.

1.8 DELIVERY AND STORAGE

Delivered doors to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Store doors in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling.

PART 2 PRODUCTS

2.1 OVERHEAD COILING DOORS

2.1.1 Overhead Coiling Door Insulated

Model and Manufacturer - Basis of Design: Stormtite 625 Insulated Heavy-Duty Rolling Service Door; Overhead Door Corporation, Lewisville, TX, or equal.

Notice of Acceptance Number: 10-0831.10
Expiration Date: October 14, 2014

Curtain: Galvanized steel front and back.
Slat Profile: Flat, insulated.
Insulation: Foamed-in-place, CFC-free polyurethane; R-Value 7.7.
Finish: PowderGuard Finish; color to be selected by the Contracting Officer from Premium Color selections.
Hood: Galvanized steel.
Operation: Motor operated.
Sensing Edge Protection: Bottom sensing edge and photo eyes.
Mounting: Anchored to precast wall.
High Wind Load Option: Provide high-wind load option.
Weatherseal: Weatherseal for interior side guide and lintel seal; seal jambs and bottom to minimize outside air.
Bottom Bar Angle Metal Guides: Galvanized steel.
Locking: Cylinder lock; key to building system.

2.1.2 Curtain Materials and Construction

Provide curtain slats which are fabricated from steel sheets conforming to ASTM A653/A653M, Grade A, with the additional requirement of a minimum yield point of 33,000 psi. Provide sheets which are galvanized in accordance with ASTM A653/A653M and ASTM A924/A924M.

Fabricate doors from interlocking cold-rolled slats, with section profiles as specified, designed to withstand the specified wind loading. Provide slats which are continuous without splices for the width of the door.

2.1.3 Locks

Provide end and/or wind locks of cast steel conforming to ASTM A27/A27M, Grade B; galvanized in accordance with ASTM A653/A653M, ASTM A153/A153M and ASTM A924/A924M and secured at every other curtain slat.

2.1.4 Weather Stripping

Weather-stripping at the door-head and jamb must be 1/8-inch thick sheet of natural or neoprene rubber with air baffles, secured to the insides of hoods with galvanized-steel fasteners through continuous galvanized-steel pressure bars at least 5/8-inch wide and 1/8-inch thick.

Threshold weather-stripping must be 1/8-inch thick sheet natural or neoprene rubber secured to the bottom bars.

Provide weather-stripping of natural or neoprene rubber conforming to ASTM D2000.

Seal jambs and bottom to minimize outside air.

2.1.5 Safety Interlock

Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.1.6 OVERHEAD COILING COUNTER DOORS

Overhead Coiling Counter Doors - Motor Operated: Post Office

Model and Manufacturer - Basis of Design: Model 651 Series Rolling Counter Door; Overhead Door Corporation, Lewisville, TX, or equal.

Curtain: Stainless Steel Slat Profile, Interlocking flat, type F-158
Construction: Stainless Steel
Mounting: Between jambs.
Bottom Bar: Stainless Steel.
Hood: Stainless Steel.
Operation: Electric motor operator.
Operator Controls: Key operation with open, close, and stop controls; interior location; flush mounted.
Locking: Two point dead locks with mortise cylinders; key to building system.
Sensing Edge Protection: Electric sensing edge.
Stainless Steel Finish: Clear #4.

Overhead Coiling Counter Doors - Manually Operated: Mail Room (Interior)

Model and Manufacturer - Basis of Design: Model 657 Series Integral Frame Rolling Counter Door; Overhead Door Corporation, Lewisville, TX, or equal.

Curtain: Interlocking 22 gauge stainless steel slats.
Integral Frame: 16 gauge stainless steel.
Counter Door Sill: 14 gauge stainless steel.
Hood: Stainless steel.
Mounting: Between jambs.
Operation: Manual, push-up.
Locking: Cylinder lock; key to building system.

2.2 OVERHEAD COILING GRILLES

Overhead Coiling Grille - Motor Operated: Food Court

Model and Manufacturer - Basis of Design: Model 670 Series Upward Coiling Grille; Overhead Door Corporation, Lewisville, TX, or equal.

Material: Aluminum
Finish: Clear anodized.
Pattern: Straight lattice; 5/16" rods at 2" on center and links at 9" link spacing on center.
Mounting: Between jambs.
Operation: Electric motor operator.
Sensing Edge Protection: Monitored electronic safety edge.
Operation: Electric Motor Operator
Locking: Keylock control station, both sides of opening.
Motor: Model RSX; front-of-hood mounted.

2.3 HARDWARE

All hardware must conform to ASTM A153/A153M, ASTM A307, ASTM F568M, and ASTM A27/A27M.

2.3.1 Metal Guides

Fabricate curtain jamb guides from the manufacturer's standard angles or channels of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for track adjustment.

2.3.2 Equipment Supports

Fabricate door-operating equipment supports from the manufacturer's standard steel shapes and plates conforming to ASTM A36/A36M, galvanized in accordance with ASTM A653/A653M and ASTM A924/A924M. Size the shapes and plates in accordance with the industry standards for the size, weight, and type of door installation..

2.4 COUNTERBALANCING MECHANISM

Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members.

2.4.1 Brackets

Provide the manufacturer's standard mounting brackets of either cast iron or cold-rolled steel with one located at each end of the counterbalance barrel conforming to ASTM A48/A48M.

2.4.2 Counterbalance Barrels

Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, conforming to ASTM A53/A53M, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 inch per foot of span under full load.

2.4.3 Spring Balance

One or more oil-tempered, heat-treated steel helical torsion springs installed within the barrel capable of producing sufficient torque to assure easy operation of the door curtain. Provide and size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

2.4.4 Torsion Rod for Counter Balance

Fabricate rod from the manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

2.5 ELECTRIC OPERATORS FOR INTERIOR OVERHEAD DOORS AND GRILLES

Model: RSX medium duty motor; size as required by the manufacturer for door and grille type and size indicated.

Provide electrical wiring and door operating controls conforming to the applicable requirements of NFPA 70.

Electric door-operator assemblies must be the sizes and capacities recommended and provided by the door manufacturer for specified doors. Assemblies must be complete with electric motors and factory-prewired motor controls, starter, gear reduction units, solenoid-operated brakes, clutch, remote-control stations, manual or automatic control devices, and accessories as required for proper operation of the doors.

Design the operators so that motors may be removed without disturbing the limit-switch adjustment and affecting the emergency auxiliary operators.

Provide a manual operator of crank-gear or chain-gear mechanisms with a release clutch to permit manual operation of doors in case of power failure. Arrange the emergency manual operator so that it may be put into and out of operation from floor level, and its use will not affect the adjustment of the limit switches. Provide an electrical or mechanical device which will automatically disconnect the motor from the operating mechanism when the emergency manual operating mechanism is engaged.

2.5.1 Electric Motors

Provide motors which are the high-starting-torque, reversible, constant-duty electrical type with overload protection of sufficient torque and horsepower to move the door in either direction from any position and produce a door-travel speed of not less than 8 nor more than 12 inches per second without exceeding the horsepower rating.

Provide motors which conform to NEMA MG 1 designation, temperature rating, service factor, enclosure type, and efficiency to the requirements specified.

2.5.2 Motor Starters, Controls, and Enclosures

Each door motor must have a factory-wired, unfused, disconnect switch; a reversing, across-the-line magnetic starter with thermal overload protection; 120-volt operating coils with a control transformer limit switch; and a safety interlock assembled in a NEMA ICS 6 type enclosure as specified herein. Control equipment must conform to NEMA ICS 2.

Provide adjustable switches, electrically interlocked with the motor controls and set to stop the door automatically at the fully open and fully closed position.

2.5.3 Control Enclosures

Provide control enclosures that conform to NEMA ICS 6 for general purpose NEMA Type 1.

2.5.4 Remote-Control Stations

Provide interior remote control stations which are full-guarded, momentary-contact three-button, heavy-duty, surface-mounted NEMA ICS 6 type enclosures as specified. Mark buttons "OPEN," "CLOSE," and "STOP." The "CLOSE" button must be the type requiring a constant pressure to maintain the closing motion of the door. When the door is in motion and the "STOP" button is pressed, the door must stop instantly and remain in the stopped position; from the stopped position, the door may then be operated in either direction.

PART 3 EXECUTION

3.1 GENERAL

Install overhead coiling door assembly, anchors and inserts for guides, brackets, motors, switches, hardware, and other accessories in accordance with approved detail drawings and manufacturer's written instructions. Upon completion of installation, doors must be free from all distortion.

Install overhead coiling doors, motors, hoods, and operators at the mounting locations as indicated for each door in the contract documents and as required by the manufacturer.

Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility and as required by the manufacturer.

3.2 ACCEPTANCE PROVISIONS

After installation, adjust hardware and moving parts. Lubricate bearings and sliding parts as recommended by manufacturer to provide smooth operating functions for ease movement, free of warping, twisting, or distortion of the door assembly.

Adjust seals to provide weather-tight fit around entire perimeter.

Engage a factory-authorized service representative to perform startup service and checks according to manufacturer's written instructions.

Test the door opening and closing operation when activated by controls or alarm-connected fire-release system. Adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Reset door-closing mechanism after successful test.

Test and make final adjustment of new doors at no additional cost to the Government.

3.2.1 Maintenance and Adjustment

Not more than 90 calendar days after completion and acceptance of the project, the Contractor shall schedule a site visit and must examine, lubricate, test, and re-adjust doors as required for proper operation.

3.2.2 CLEANING

Clean doors in accordance with manufacturer's approved instructions.

-- End of Section --

SECTION 08 41 13

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS
02/11

PART 1 GENERAL

1.1 SUMMARY

This Specification includes interior aluminum storefronts, glass and glazing, and components.

Aluminum Doors: Refer to Section 08 11 16 ALUMINUM DOORS AND FRAMES

Interior Entrances; medium stile, 3-1/2 inch vertical face dimension, 1-3/4 inch depth.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(1998; R 2004) Voluntary Specification for Anodized Architectural Aluminum
AAMA 800	(2010) Voluntary Specifications and Test Methods for Sealants

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2009; Errata 2010) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2004) Glazing Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

1.3 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.4 ADMINISTRATIVE REQUIREMENTS

Within 30 days of the Contract Award, submit the following for review and approval by the Contracting Officer's Representative:

Listing of product installations

Sample warranty

Finish and color samples

Manufacturer's catalog data

Installation drawings

Fabrication drawings for custom fabrications

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sample Warranty
Listing of Product Installations

SD-02 Shop Drawings

Installation Drawings; G
Fabrication Drawings; G

SD-03 Product Data

Manufacturer's Catalog Data
Aluminum Framed Storefront System; (LEED NC)
Sealants; (LEED NC)

SD-04 Samples

Finish and Color Samples; G

SD-07 Certificates

Manufacturer's Product Warranty; G

SD-11 Closeout Submittals

Local/Regional Materials

Recycled Content
Low Emitting Materials - Adhesives and Sealants

1.6 QUALITY ASSURANCE

1.6.1 Qualifications

1.6.1.1 Installer Qualifications

Provide documentation of Installer experience as determined by Contractor to perform work of this section, who has specialized in the installation of work similar to that required for this project, and who is acceptable to product manufacturer.

1.6.1.2 Manufacturer Qualifications

Ensure manufacturer is capable of providing field service representation during construction, approving acceptable installer and approving application method.

1.6.2 Pre-Installation Meetings

Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

1.6.3 Single Source Responsibility

Provide design, structural engineering, and custom fabrication for storefront system and supply of all components, materials, and products based on a single manufacturer of sole responsibility. Provision of products from numerous sources for site assembly without complete single source design and supply responsibility is not acceptable. Work items and components to be fabricated or supplied by single source are:

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Ordering

Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

1.7.2 Packing, Shipping, Handling and Unloading

Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

1.7.3 Storage and Protection

Store materials protected from exposure to harmful weather conditions. Handle storefront material and components to avoid damage. Protect storefront material against damage from elements, construction activities, and other hazards before, during and after storefront installation.

1.8 PROJECT CONDITIONS/ SITE CONDITIONS

1.8.1 Field Measurements

Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication scheduled with construction progress to avoid construction delays.

PART 2 PRODUCTS

2.1 ALUMINUM FRAMED STOREFRONT SYSTEM

Model and Manufacturer - Basis of Design: Trifab 450; Kawneer an Alcoa Company, or equal.

Refer to Section 08 81 00 GLAZING for glass requirements.

2.2 MATERIALS

2.2.1 Aluminum Components

2.2.1.1 Material Standard

ASTM B221 ASTM B221M; 6063-T5 alloy and tempered

2.2.1.2 Tolerances

Reference to tolerances for wall thickness and other cross-sectional dimensions of members are nominal and in compliance with Aluminum Standards and Data, published by The Aluminum Association.

2.3 MANUFACTURERS

Manufacturers are acceptable providing they meet the requirements specified in this section.

2.4 ACCESSORIES

2.4.1 Fasteners

Provide stainless steel where exposed.

2.5 RELATED MATERIALS

2.5.1 Sealants

Refer to Section 07 92 00 JOINT SEALANTS. Ensure all sealants conform to AAMA 800.

2.5.2 Glass

Refer to Section 08 81 00 GLAZING.

2.6 FABRICATION

2.6.1 Fabrication

2.6.2 Finishes

Provide exposed aluminum surfaces with factory finish of anodic coating.

2.6.2.1 Anodic Coating

Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.6.3 Shop Assembly

Fabricate and assemble units with joints only at intersection of aluminum members with hairline joints; rigidly secure, and sealed in accordance with manufacturer's recommendations.

2.6.3.1 Welding

Conceal welds on aluminum members in accordance with AWS recommendations or methods recommended by manufacturer. Members showing welding bloom or discoloration on finish or material distortion will be rejected.

2.6.4 Fabrication Tolerance

Fabricate and assemble units with joints only at intersection of aluminum members with hairline joints; rigidly secure, and sealed in accordance with manufacturer's recommendations.

Fabricate aluminum storefront in accordance with storefront manufacturer's prescribed tolerances.

2.6.4.1 Material Cuts

Square to 1/32 inch off square, over largest dimension; proportionate amount of 1/32 inch on the two dimensions.

2.6.4.2 Joints

Between adjacent members in same assembly: Hairline and square to adjacent member.

2.6.4.3 Variation

In squaring diagonals for storefront and fabricated assemblies: 1/16 inch.

2.6.4.4 Flatness

For storefront and fabricated assemblies: plus/minus 1/16 inch of neutral plane.

2.7 SOURCE QUALITY CONTROL

2.7.1 Source Quality

Provide aluminum storefront specified herein from a single source.

2.7.2 Fabrication Tolerances

Fabricate aluminum storefront in accordance with storefront manufacturer's prescribed tolerances.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Site Verification of Conditions

Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions.

Verify openings are sized to receive storefront system and sill plate is level in accordance with manufacturer's acceptable tolerances.

3.1.2 Field Measurements

Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.

3.2 INSTALLATION

Install storefront system in accordance with manufacturer's instructions and AAMA storefront guide specifications manual. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities. Provide alignment attachments and shims to permanently fasten system to building structure. Align assembly plumb and level, free of warp and twist. Maintain assembly dimensional tolerances aligning with adjacent work.

Protect aluminum members in contact with masonry, steel, concrete, or dissimilar materials using nylatron pads. Shim and brace aluminum storefront system before anchoring to structure. Seal metal to metal joints using sealant recommended by system manufacturer.

3.2.1 Preparation

Field verify dimensions prior to fabricating storefront assembly components.

3.2.1.1 Adjacent Surfaces Protection

Protect adjacent work areas and finish surfaces from damage during product installation.

3.2.1.2 Aluminum Surface Protection

Protect aluminum surfaces from contact with lime, mortar, cement, acids, and other harmful contaminants.

3.2.2 Related Products Installation Requirements

3.2.2.1 Sealants (Perimeter)

Refer to Section 07 92 00 JOINT SEALANTS.

3.2.2.2 Glass

Refer to Section 08 81 00 GLAZING.

3.2.2.3 Reference

ANSI Z97.1, 16 CFR 1201 and GANA Glazing Manual.

3.3 PROTECTION AND CLEANING

3.3.1 Protection

Protect installed product's finish surfaces from damage during construction. Protect aluminum storefront system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.

3.3.2 Cleaning

Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.

3.4 WARRANTY

Submit three signed copies of manufacturer's product warranty for storefront system as follows:

Warranty Period: Two years from Date of Substantial Completion of the project, provided that the Limited Warranty begins in no event later than six months from date of shipment by manufacturer.

Ensure Warranty language is identical to "As Approved" version of the sample warranty submitted and returned from the Contracting Officer's Representative.

-- End of Section --

SECTION 08 44 00

CURTAIN WALL AND GLAZED ASSEMBLIES
08/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM-105	(2005; Errata 2005) Aluminum Design Manual
AA ASD1	(2009) Aluminum Standards and Data

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501	(2005) Methods of Test for Exterior Walls
AAMA 501.1	(2005) Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
AAMA 609 & 610	(2009) Cleaning and Maintenance Guide for Architecturally Finished Aluminum
AAMA 611	(1998; R 2004) Voluntary Specification for Anodized Architectural Aluminum
AAMA 800	(2010) Voluntary Specifications and Test Methods for Sealants
AAMA CW-10	(2004) Care and Handling of Architectural Aluminum from Shop to Site
AAMA/NWWDA 101/I.S.2	(2011) Standard/Specification for Windows, Doors, and Skylights

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121	(2004) Standard Definitions for Use in the Design of Steel Structures
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS A5.10/A5.10M	(2012) Welding Consumables - Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys -

	Classification
AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2012a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A1011/A1011M	(2012b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability and Ultra-High Strength
ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A27/A27M	(2010) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A283/A283M	(2012a) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A424/A424M	(2009a) Standard Specification for Steel Sheet for Porcelain Enameling
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A501	(2007) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B108/B108M	(2012; E 2012) Standard Specification for Aluminum-Alloy Permanent Mold Castings

ASTM B136	(1984; R 2013) Standard Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum
ASTM B137	(1995; R 2009) Standard Test Method for Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminum
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B211	(2012) Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B244	(2009) Standard Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments
ASTM B26/B26M	(2012) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B316/B316M	(2010) Standard Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods
ASTM B85/B85M	(2010) Standard Specification for Aluminum-Alloy Die Castings
ASTM C542	(2005; R 2011) Lock-Strip Gaskets
ASTM C864	(2005; R 2011) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM E283	(2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330	(2002; R 2010) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2009) Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

ASTM E34	(2011) Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM E546	(2008) Frost Point of Sealed Insulating Glass Units
ASTM E576	(2008) Frost Point of Sealed Insulating Glass Units in the Vertical Position

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 1	(1982; E 2004) Solvent Cleaning
SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 7/NACE No.4	(2007) Brush-Off Blast Cleaning

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Glazed curtain wall system; G

Submit for curtain wall system, accessories, and mock-up. Drawings shall indicate in detail all system parts including elevations, full-size sections, framing, jointing, panels, types and thickness of metal, flashing and coping details, field connections, weep and drainage system, finishes, sealing methods, glazing, glass sizes and details, firestopping insulation materials, and erection details.

Installation Drawings; G

SD-03 Product Data

Glazed curtain wall system; (LEED NC); G

Include descriptive literature, detailed specifications, and available performance test data.

Preventive Maintenance and Inspection; G
Metals For Fabrication; G
Metal Accessories; G

Curtain-wall Framing Members
Aluminum Doors and Frames
Curtain Wall Frame; G
Curtain-Wall Installation Materials; G

Sample warranties

SD-05 Design Data

Calculations
Finish
Exposed-to-View Aluminum Finish

SD-08 Manufacturer's Instructions

Glazed curtain wall system

SD-11 Closeout Submittals

WARRANTY
Local/Regional Materials
Recycled Content
Low Emitting Materials - Adhesives and Sealants

1.4 REQUIREMENT FOR DESIGN DATA

Submit structural and thermal calculations for complete wall assembly.

1.5 QUALITY ASSURANCE

1.5.1 Testing Requirements

The components listed below shall be tested in accordance with the requirements below, and meet performance requirements specified.

Insulating Glass: ASTM E546 or ASTM E576 at minus 20 degrees F, no frost or dew point.

1.5.2 Mockup

1.5.2.1 Construction

Construct at manufacturer's plant full size typical wall unit which incorporates horizontal and vertical joints, framing, window units, panels, glazing, and other accessories as detailed and specified. Mock-up wall unit size and design shall be as indicated.

1.5.2.2 Performance Test

Conduct after approval of visual aspects has been obtained. Finished work shall match approved mock-up.

1.5.2.3 Approved Mock-Up

After completion and approval of test results transport mock-up to job site and install, where directed, for reference during construction. Approved mock-up shall remain property of the Contractor.

1.5.3 Factory Tests

1.5.3.1 Deflection and Structural Tests

A static air design load of 40 psf (1915 Pa) shall be applied in the positive and negative direction in accordance with ASTM E330. There shall be no deflection in excess of L/175 of the span of any framing member at design load. At structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.

1.5.3.2 Water Penetration Test

Water Resistance, (static): The test specimen shall be tested in accordance with ASTM E331. There shall be no leakage at a static air pressure differential of 12 psf (575 Pa) as defined in AAMA 501.

Water Resistance, (dynamic): The test specimen shall be tested in accordance with AAMA 501.1. There shall be no leakage at an air pressure differential of 12 psf (575 Pa) as defined in AAMA 501.

1.5.3.3 Air Infiltration Test

Air Infiltration: The test specimen shall be tested in accordance with ASTM E283. Air infiltration rate shall not exceed 0.06 cfm/ft2 (0.3 l/s ⊠ m2) at a static air pressure differential of 6.24 psf (300 Pa).

1.6 GLAZED CURTAIN WALL SYSTEM REQUIREMENTS

Provide system complete with framing, mullions, trim, glass, glazing, sealants, fasteners, anchors, accessories, concealed auxiliary members, and attachment devices for securing the wall to the structure as specified or indicated.

1.6.1 Source

Furnish curtain wall system components by one manufacturer or fabricator; however, all components need not be products of the same manufacturer.

1.6.2 Design

Stick system with mullions, horizontal rails, and panels. Fully coordinate system accessories directly incorporated, and adjacent to contiguous related work and insure materials compatibility, deflection limitations, thermal movements, and clearances and tolerances as indicated or specified.

1.6.3 Thermal Movement

Fabricate, assemble, and erect system with adequate allowances for expansion and contraction of components and fastenings to prevent buckling damage, joint seal failure, glass breakage, undue stress on fastenings or other detrimental effects. For design purposes, base provisions for thermal movement on assumed ambient temperature range local ambient conditions.

1.6.4 Tolerances

Design and erect wall system to accommodate tolerances in building frame

and other contiguous work as indicated or specified. Provide with the following tolerances:

a. Maximum variation from plane or location shown on approved shop drawings: 1/8 inch per 12 feet of length up to not more than 1/2 inch in any total length.

b. Maximum offset from true alignment between two identical members abutting end to end in line: 1/16 inch.

1.6.5 Structural Requirements

No member shall deflect in a direction parallel to the plane of the wall, when carrying its full design load, more than an amount which will reduce the edge cover or glass bite below 75 percent of the design dimension. No member after deflection under full design load, shall have a clearance between itself and the top of the panel, glass, sash, or other part immediately below it less than 1/8 inch; the clearance between the member and an operable window or door shall be minimum 1/16 inch. Design entire system to withstand the indicated wind and concentrated loads, and the following wind loads acting normal to the plane of the wall:

a. Wind Loads: As indicated on the Drawings.

1.7 QUALIFICATION OF WELDERS

Welding shall be performed by certified welders qualified in accordance with AWS D1.1/D1.1M using procedures, materials, and equipment of the type required for the work.

1.8 DELIVERY AND STORAGE

Inspect materials delivered to the site for damage; unload and store with a minimum of handling in accordance with recommendations contained in AAMA CW-10. Storage spaces shall be dry locations with adequate ventilation, free from heavy dust, not subject to combustion products or sources of water, and shall permit easy access for inspection and handling. Deliver caulking and sealing compounds to the job site in sealed containers labeled to show the designated name, formula or specifications number; lot number; color; date of manufacturer; shelf life; and curing time when applicable.

1.8.1 Protective Covering

Prior to shipment from the factory provide protective covering for components. Covering shall not chip, peel, or flake due to temperature or weather, shall protect against discoloration and surface damage from transportation, and storage, and shall be resistant to alkaline mortar and plaster. Do not cover aluminum surfaces that will be in contact with sealants after installation.

1.8.2 Identification

Prior to delivery, mark wall components to correspond with shop and erection drawings placement location and erection.

1.9 WARRANTY

Guarantee insulating glass units not to develop material obstruction of

vision as a result of dust or film formation on the inner glass surface caused by failure of the seal, other than through glass breakage, within a period of 5 years from date of acceptance of work by the Government. Replace units failing to comply with the terms of this guarantee with new units without additional cost to the Government. The Contractor shall require the manufacturer to execute their warranties in writing directly to the Government.

1.9.1 Sample Warranties

Provide curtain wall and glazing assemblies material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard membrane manufacturer warranty to comply with the specified requirements.

a. Project Warranty: Refer to Section 01 11 00 SUMMARY OF WORK and Section 01 33 00 SUBMITTAL PROCEDURES for project warranty provisions.

b. Manufacturer's Warranty: Submit, for Owner's acceptance, Manufacturer's standard warranty document executed by authorized company official manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.

c. Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of steel fire-rated glazed curtain-wall systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.

d. Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering. Determine warranty on finish by type of finish selected.

    Warranty Period: 5 years commencing on Date of Substantial Completion.

e. Beneficiary: Issue warranty in the legal name of the project Owner.

f. Warranty Period: 5 years commencing on Date of Substantial Completion, covering complete curtain wall system for failure to meet specified requirements.

g. Warranty Acceptance: Owner is sole authority who will determine acceptability of manufacturer's warranty documents.

1.10 INTERPRETATION OF AWS CODE

Section 05 05 23 WELDING, STRUCTURAL applies to work specified in this section.

AWS code, when referred to herein, shall mean AWS D1.1/D1.1M, "Structural Welding Code - Steel" with the following modification:

Revise AWS code Section 1, "General Provisions," Paragraph 1.1 as follows: References to the need for approval shall mean "Approval by the Contracting Officer" and references to the "Building Commissioner" shall mean the "Contracting Officer."

1.11 QUALIFICATIONS FOR THE CURTAIN-WALL INSTALLER

Submit a written description of the proposed curtain-wall system installer giving the name of the curtain-wall manufacturer, qualifications of personnel, years of concurrent contracting experience, lists of projects similar in scope to the specified work, and other information as may be required by the Contracting Officer.

1.12 PERFORMANCE REQUIREMENTS

1.12.1 Allowable Design Stresses

Aluminum-alloy framing member allowable design stresses shall be in accordance with the requirements of AA ADM-105 pertaining to building type structures made of the specified aluminum alloy.

Hot-rolled structural-steel member allowable design stresses and design rules shall be in accordance with the requirements of AISC/AISI 121 pertaining to the specified structural steel.

Cold-formed light-gage steel structural member allowable design stresses and design rules shall be in accordance with the requirements of AISI SG03-3SG570 pertaining to structural members formed from the specified structural-steel sheet or strip.

1.12.2 Design Wind Load

Design windload as indicated on the Drawings.

1.12.3 Structural Capacity

Design curtain-wall system, including framing members, windows, doors and frames, metal accessories, panels, and glazing to withstand the specified design windload acting normal to the plane of the curtain wall and acting either inward or outward.

Deflection of any metal framing member in a direction normal to the plane of the curtain wall, when subjected to the test of structural performance, using the specified windload in accordance with AAMA/NWWDA 101/I.S.2, shall not exceed 1/175 of the clear span of the member or 3/4 inch, whichever value is less.

Deflection of any metal member in a direction parallel to the plane of the curtain wall, when the metal member is carrying its full design load, shall not exceed 75 percent of the design clearance dimension between that member and the glass, sash, panels, or other part immediately below it.

1.12.4 Provisions for Thermal Movement

Design curtain-wall systems, including framing members, windows, doors and frames, metal accessories, and other components incorporated into the curtain wall, to allow for expansion and contraction of the component parts at an ambient temperature of 100 degrees F without causing buckling, opening of joints, overstressing of fasteners, or other harmful effects.

1.13 DRAWINGS

Installation Drawings shall include the following information for curtain

wall assemblies.

Curtain-wall locations in building, layout and elevations, dimensions, shapes and sizes of members, thickness of metals, types and locations of shop and field connections, details of anchorage to building construction, glazing provisions, and other pertinent construction and erection details.

Panel dimensions, thicknesses and kinds of materials, edge details, details of installation in curtain-wall framing, and other pertinent construction and erection details.

1.14 MANUFACTURER'S INFORMATION

Preventive Maintenance and Inspection shall consist of the aluminum manufacturer's recommended cleaning materials and application methods, including detrimental effects to the aluminum finish when improperly applied.

PART 2 PRODUCTS

2.1 GLAZED ALUMINUM CURTAIN WALL SYSTEM

Rational Analysis Engineering: Rational analysis may be used to allow deviations from NOA tables for mullion locations and spacing indicated on the Drawings.

Products and Manufacturers:

Type 1 - up to 60ft, unless otherwise noted on the Drawings: 7 13/16" Deep System: 1600 System 1 Dry Glazed Aluminum Curtain Wall; Kawneer Company, Inc. or approved equal.

NOA Large Missile - applicable between 0ft-30ft in height; NOA 12-0622.07; expiration date June 22, 2016
NOA Small Missile - applicable between 30ft-60ft in height; NOA 12-0622.08; expiraton date June 9, 2015.

Type 2: 7 13/16" Deep System: 1600 System 1 Dry Glazed Aluminum Curtain Wall; Kawneer Company, Inc. or approved equal.

NOA Large Missile - applicable between 0ft-30ft in height; NOA 12-0622.07; expiration date June 22, 2016
NOA Small Missile - applicable between 30ft-60ft in height; NOA 12-0622.08; expiraton date June 9, 2015.

Above 60ft installation without laminated glass not subject to NOA.

Type 3, applicable at Cafeteria glazing only, see Drawings: 10 13/16" Deep System: 1600 System 1 Aluminum Glazed Curtain Wall L.M.I.; Kawneer Company, Inc. or approved equal.

Notice of Acceptance Number: 12-0622.10
Expiration Date: January 08, 2014

2.2 MATERIALS

2.2.1 Aluminum

Shall be free from defects impairing strength or durability of surface

finish. Provide standard alloys shall conform to standards and designations of AA ASD1. Special alloys, not covered by the following ASTM specifications, shall conform to standards and designations recommended by the manufacturer for the purpose intended.

2.2.1.1 Wrought Aluminum Alloys

Shall be those which include aluminum alloying elements not exceeding the following maximum limits when tested and additional in accordance with ASTM E34. These limits apply to both bare products and the core of clad products. The cladding of clad products shall be within the same limits except that the maximum zinc limit may be 2.5 percent in order to assure that the cladding is anodic to the core. Special wrought alloys with a silicon content not more than 7.0 percent will be acceptable for limited structural uses where special appearance is required:

ALLOY	PERCENT
Silicon	1.5
Magnesium, Manganese, and Chromium combined	6.0
Iron	1.0
Copper	0.4
Zinc	1.0

Within the chemical composition limits set forth above, wrought aluminum alloys shall conform to the following:

a. Extruded bars, rods, shapes and tubes: ASTM B221.

b. Sheet and Plate: ASTM B209.

2.2.1.2 Cast Aluminum Alloys

Provide those in which the alloying elements are silicon, magnesium, manganese, or a combination of these. Other elements shall not exceed the following limits:

ALLOY	PERCENT
Iron	1.2
Copper	0.4
Nickel	0.4
Titanium	0.2

ALLOY	PERCENT
Others (total)	0.5

Within the chemical composition limits set forth above, cast aluminum alloys shall conform to the following:

a. Sand castings: ASTM B26/B26M.

b. Die casting: ASTM B85/B85M.

c. Permanent mold castings: ASTM B108/B108M.

2.2.1.3 Welding Rods and Electrodes

Provide welding rods and bare electrodes shall conform to AWS A5.10/A5.10M as recommended by the manufacturer of the aluminum base metal alloy being used.

2.2.1.4 Strength

Aluminum extrusions for framing members used in curtain walls and main frame shall have a minimum ultimate tensile strength of 22,000 psi and a minimum yield strength of 16,000 psi.

2.2.2 Carbon Steel

Conform to the following specifications:

a. Rolled shapes, plates, and bars: ASTM A36/A36M.

b. Galvanized sheets: ASTM A653/A653M.

c. Sheets for porcelain enameling: ASTM A424/A424M.

d. Other sheets: ASTM A1011/A1011M or ASTM A1008/A1008M.

2.2.3 Stainless Steel

Conform to ASTM A167, Type 302 or 304, and finish in accordance with the NAAMM AMP 500 conform to Metal Finishes Manual as follows:

a. Concealed flashings: Dead soft fully annealed, 2 D finish .

2.2.4 Metal Fasteners

300 Series stainless steel.

2.2.5 Joint Sealants and Accessories

Sealants: Refer to Section 07 92 00; provide manufacturer's standard colors as closely matching the adjacent surfaces as possible.

Foam Tape: Provide double-sided adhesive foam tape at formed aluminum channel closures.

2.2.5.1 Elastomeric, Single or Multiple Component

ASTM C920, Type S, single componen or Type M, multiple component. Use Grade NS, nonsag type in joints on vertical surfaces and use Grade P, self-leveling or flow type, in joints on horizontal surfaces.

2.2.5.2 Single Component Silicone Rubber Base

ASTM C920, Type S, Grade NS (Silicone).

2.2.5.3 Solvents and Primers

Provide material which is quick drying, colorless, nonstaining, compatible with compound used, as recommended by sealant manufacturer. Where primer is specified or recommended by sealant manufacturer, tests related to that material shall include primer.

2.2.5.4 Backing Material

Provide material which is nonstaining, nonabsorbent, and compatible with sealing compound. Closed cell resilient urethane, polyvinylchloride or polyethylene foam; closed-cell sponge of vinyl or rubber; closed cell neoprene or butyl rod; or polychloroprene tubes or beads.

2.2.5.5 Bond Preventive Materials

Provide polyethylene tape with pressure-sensitive adhesive; aluminum foil or waxed paper.

2.2.5.6 Preformed Sealing Compound

Provide nonskinning type conforming to AAMA 800. Tapes, beads, ribbons or other shapes as required.

2.2.6 Glass and Glazing

Materials are specified under Section 08 81 00 GLAZING.

2.2.6.1 Glass Sizes and Clearances

Sizes indicated are nominal. Verify actual sizes required by measuring frames. Coordinate dimensions for glass and glass holding members to meet applicable minimum clearances as recommended by glass manufacturer. Do not nip to remove flares or to reduce oversized dimensions. Refer to Section 08 81 00 for glass types.

2.2.6.2 Glass Setting Materials

a. Sealants and preformed sealing compounds: Shall be as specified under paragraph entitled "Joint Sealant and Accessories."

b. Preformed compression gaskets and seals: ASTM C864, color black . Gaskets used shall have durable compatible, and colorfast coating.

c. Preformed lock-strip type gaskets: ASTM C542, factory formed, color black. Provide separate filler or locking strips, approximately 10 Shore "A" Durometer points harder than gasket body, and insure permanent and continuous pressure of sealing lips.Butt or miter grooves 45 degrees.

d. Setting blocks, edge blocks, and spacer shims: Fabricate from neoprene or other materials recommended by glass manufacturer compatible with compounds, sealants, or gaskets used. Unless otherwise recommended by the glass manufacturer, shore "A" Durometer hardness for setting and edge blocks shall be 90 plus or minus 5; for spacer shims, 50 plus or minus 5.

2.2.7 Firestopping Material

Refer to Section 07 84 00 Firestopping for firestopping materials.

2.3 METALS FOR FABRICATION

2.3.1 Aluminum-Alloy Extrusions

Extrusions shall conform to ASTM B221.

Extrusions to receive an integral-color anodic coating shall be the alloy and temper recommended by the aluminum producer for the specified finish with integral-color anodic coating and have mechanical properties equal to or exceeding those of 6063-T5.

2.3.2 Aluminum-Alloy Sheets and Plates

Unless otherwise specified, sheets and plates shall conform to ASTM B209, Alloy 3003-H16.

Sheets and plates to receive a clear anodic coating shall conform to ASTM B209, Alloy 5005-H16.

Sheets and plates to receive an integral-color anodic coating shall be the alloy and temper recommended by the aluminum producer for the specified coating and have mechanical properties equal to or exceeding those of 5005-H16.

2.3.3 Structural Steel

Hot-rolled shapes, plates, and bars shall conform to ASTM A36/A36M.

Hot-formed tubing shall conform to ASTM A501.

Sheet and strip for cold-formed, light-gage, structural members shall conform to ASTM A1011/A1011M.

2.3.4 Metals for Fasteners

Provide aluminum-alloy bolts and screws made from rod conforming to ASTM B211, Alloy 2024-T351.

Provide aluminum-alloy nuts made from rod conforming to ASTM B211, Alloy 6061-T6.

Provide aluminum-alloy washers made from sheet conforming to ASTM B209, Alloy 2024-T4.

Provide aluminum-alloy rivets made from rod or wire conforming to ASTM B316/B316M, Alloy 6053-T61.

Provide steel fasteners made from corrosion-resistant chromium-nickel Type 302, 303, 304, 305, or 316 with the form and condition best suited for the work.

2.4 NONSKINNING SEALING COMPOUND

Sealing compound shall be nonskinning, gun-grade type conforming to AAMA 800.

2.5 FABRICATION

2.5.1 Workmanship

Metal Accessories shall be accurately formed; joints, except those designed to accommodate movement, accurately fitted and rigidly assembled.

Insofar as practical, fitting and assembly of the work shall be done in the manufacturer's plant. Mark work that cannot be permanently factory-assembled before shipment to ensure proper assembly at the site.

2.5.2 Shop-Painting Steel

Shop prime surfaces of concealed steel.

Remove scale, rust, and other deleterious materials. Remove heavy rust and loose mill scale in accordance with SSPC SP 3 or SSPC SP 7/NACE No.4. Remove oil, grease, and similar contaminants in accordance with SSPC SP 1.

Give steel surfaces two coats of paint; the second coat shall have a color different from the first coat. Apply paint to dry, clean, surfaces to provide a continuous minimum dry-film thickness of 1.5 mils for the first coat and 1 mil for the second coat.

2.5.3 Depth of Glazing Rabbets

Depth of glazing rabbets for openings to receive glass materials or panels shall be as follows:

MATERIAL	NOMINAL THICKNESS	MAXIMUM SIZE	MINIMUM RABBET DEPTH
Single-glass lights	Double strength	Up to 5 square feet	3/8 inch
	Double strength	Over 5 square feet	1/2 inch
	1/8 inch	Up to 5 square feet	3/8 inch
	1/8 inch	5 to 25 square feet	1/2 inch
	1/8 inch	25 to 70 square feet	5/8 inch
	3/16 inch	Up to 25 square feet	1/2 inch
	3/16 inch	Over 25 square feet	5/8 inch
	7/32 inch	All sizes	5/8 inch
	1/4 inch	Up to 100 square feet	5/8 inch
	1/4 inch	Over 100 square feet	3/4 inch
	5/16 inch	All sizes	3/4 inch
	3/8 inch	All sizes	7/8 inch
	1/2 inch	All sizes	7/8 inch
	3/4 inch	All sizes	7/8 inch
Double-glazing units	All thicknesses	Up to 25 square feet	5/8 inch
	All thicknesses	25 to 70 square feet	3/4 inch
Panels	Up to 1 inch	All sizes	5/8 inch
	1 to 1-1/2 inches	All sizes	3/4 inch

2.5.4 Finish

Exposed-to-View Aluminum Finish of surfaces must be:

Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker..

Test the anodic coating on aluminum for thickness in accordance with ASTM B244.

Test anodically coated aluminum for the weight of the coating in accordance with ASTM B137.

Test the resistance of anodically coated aluminum to staining by dyes in accordance with ASTM B136.

2.6 CURTAIN-WALL FRAMING MEMBERS

2.6.1 General

Framing members shall be the section dimensions and arrangement indicated and designed to accommodate windows, panels, and other materials to be incorporated into the curtain-wall system.

Curtain-wall framing shall be the grid type with both the vertical and horizontal mullions extending the indicated distance beyond the exterior face of the curtain wall.

2.6.2 Construction

Framing members shall be aluminum-alloy extrusions with a wall thickness not less than 0.125 inch. Glazing rabbet legs shall be an integral part of the frame with the leg depth not less than the minimum depth specified for the thickness and size of the glass material or panel to be installed in the curtain-wall frame. Design and construct frames to receive window sash and louvers of the type specified when required.

Prepare vertical mullions for anchorage to the building construction at the bottom, at each intermediate floor elevation, and at the top.

2.7 ALUMINUM DOORS AND FRAMES

Aluminum doors and frames are specified in Section 08 41 13 ALUMINUM DOORS AND FRAMES.

2.8 METAL ACCESSORIES

2.8.1 Sills

Sills shall be the shapes and dimensions indicated and fabricated of aluminum-alloy extrusions having a wall thickness not less than 0.125 inch.

Sills shall run continuously under the curtain wall and permit the lower curtain wall frame member to interlock without fastenings.

Provide two-piece sill component; refer to drawings for sizes (5"high).

2.8.2 Inserts

Brake Metal Aluminum: Break metal aluminum inserts, 1/8" minimum thickness.

2.8.3 Mullions

Extruded Aluminum Mullions: SSG mullion profile for ionterior vertical mullions; see Drawings for locations.

2.8.4 Steel Roof Pedestals

Steel roof pedestals for window wash maintenance, refer to structural roof anchor supports details.

2.9 SEALANTS

Sealants are specified in Section 07 92 00 JOINT SEALANTS.

2.10 CURTAIN-WALL INSTALLATION MATERIALS

2.10.1 Threaded Concrete Inserts

Galvanized ferrous castings with enlarged bases with not less than two nailing lugs, length as indicated, internally threaded 3/4-inch diameter machine bolt shall conform to ASTM A47/A47M, Grade or ASTM A27/A27M, Grade U-60-30, and hot-dip galvanized in accordance with ASTM A153/A153M.

2.10.2 Wedge Concrete Inserts

Galvanized, box-type, ferrous castings with an integral loop at the back of the box and designed for 3/4-inch diameter bolts with wedge-shaped heads shall conform to ASTM A47/A47M, Grade or ASTM A27/A27M, Grade U-60-30, and hot-dip galvanized in accordance with ASTM A153/A153M.

Carbon steel bolts with wedge-shaped heads, nuts, washers, and shims shall be hot-dip galvanized in accordance with ASTM A153/A153M.

2.10.3 Slotted Concrete Inserts

Galvanized pressed-steel plate, welded construction, box type with a slot designed for 3/4-inch diameter square-head bolts to provide lateral adjustment shall be 1/8-inch minimum thickness, conforming to ASTM A283/A283M, Grade C, hot-dip galvanized in accordance with ASTM A123/A123M. Length of the insert body less anchorage lugs shall be 6 inches minimum and provided with a knockout cover.

2.10.4 Toggle Bolts

Toggle bolts shall be the tumble-wing type.

2.10.5 Steel Bolts, Nuts, and Washers

Bolts shall be regular hexagon head, low-carbon steel.

Nuts shall be hexagon, regular style, carbon steel.

Plain washers shall be round, general-assembly purpose, carbon steel.

Lockwashers shall be helical spring, carbon steel.

2.10.6 Machine Screws

Provide screws for concealed work that are corrosion-resistant steel, slotted or cross-recessed type, roundhead.

Provide screws for exposed-to-view work that are corrosion-resistant steel, cross-recessed, flathead.

2.10.7 Electrodes for Welding Steel

Electrodes for welding steel by the manual shielded metal arc welding process shall meet the requirements of AWS D1.1/D1.1M and be covered mild-steel electrodes conforming to AWS A5.1/A5.1M, E60 series.

PART 3 EXECUTION

3.1 GENERAL

Install curtain walls and accessories in accordance with the approved drawings and as specified.

3.2 FABRICATION

Provide curtain wall components of the materials and thickness indicated or specified. The details indicated are representative of the required design and profiles. Acceptable designs may differ from that shown if the proposed system components conform to the limiting dimensions indicated and the requirements specified herein. Unless specifically indicated or specified otherwise, the methods of fabrication and assembly shall be at the discretion of the curtain wall manufacturer. Perform fitting and assembling of components in the shop to the maximum extent practicable. Provide anchorage devices shall permit adjustment in three directions. Exposed fastenings used on finished surfaces shall be truss head, flat head, or oval head screws or bolts.

3.2.1 Joints

Provide welded or mechanical fasteners as indicated or specified. Match joints in exposed work to produce continuity of line and design. Bed-joints or rabbets receiving caulking or sealing material shall be minimum 3/4 inch deep and 3/8 inch wide at mid ambient temperature range.

3.2.2 Welding

Conform to AWS D1.1/D1.1M. Use methods and electrodes recommended by manufacturers of base metal alloys. Provide welding rods of an alloy that matches the color of the metal being welded. Protect glass and other finish from exposure to welding spatter. Ground and finish weld beads on exposed metal surfaces to minimize mismatch and to blend with finish on adjacent parent metal. If flux is used in welding aluminum, completely remove it immediately upon completion of welding operations. Do not use exposed welds on aluminum surfaces.

3.2.3 Soldering and Brazing

Provide as recommended by suppliers. Solder only for filling or sealing joints.

3.2.4 Ventilation and Drainage

Provide internal ventilation drainage system of weeps or based on principles of pressure equalization to ventilate the wall internally and to discharge condensation and water leakage to exterior as inconspicuously as possible. Flashings and other materials used internally shall be nonstaining, noncorrosive, and nonbleeding.

3.2.5 Protection and Treatment of Metals

3.2.5.1 General

Remove from metal surfaces lubricants used in fabrication and clean off other extraneous material before leaving the shop.

3.2.5.2 Galvanic Action

Provide protection against galvanic action wherever dissimilar metals are in contact, except in the case of aluminum in permanent contact with galvanized steel, zinc, stainless steel, or relatively small areas of white bronze. Paint contact surfaces with one coat bituminous paint or apply appropriate caulking material or nonabsorptive, noncorrosive, and nonstaining tape or gasket between contact surfaces.

3.2.5.3 Protection for Aluminum

Protect aluminum which is placed in contact with, built into, or which will receive drainage from masonry, lime mortar, concrete, or plaster with one coat of alkali-resistant bituminous paint. Where aluminum is contacted by absorptive materials subject to repeated wetting or treated with preservative noncompatible with aluminum, apply two coats of aluminum paint, to such materials and seal joints with approved caulking compound.

3.3 INSTALLATION

Installation and erection of glazed wall system and all components shall be performed under direct supervision of and in accordance with approved recommendations and instructions of wall system manufacturer or fabricator.

3.3.1 Bench Marks and Reference Points

Establish and permanently mark bench marks for elevations and building line offsets for alignment at convenient points on each floor level. Should any error or discrepancy be discovered in location of the marks, stop erection work in that area until discrepancies have been corrected.

3.3.2 Verifying Conditions and Adjacent Surfaces

After establishment of lines and grades and prior to system installation examine supporting structural elements. Verify governing dimensions, including floor elevations, floor to floor heights, minimum clearances between curtain wall and structural frames, and other permissible dimensional tolerances in the building frame.

3.3.3 Windows

Install windows in accordance with details indicated and approved detail drawings.

3.3.3.1 Sealing

Seal exterior metal to metal joints between members of windows, frames, mullions, and mullion covers. Remove excess sealant.

3.3.4 Joint Sealants

3.3.4.1 Surface Preparation

Surfaces to be primed and sealed shall be clean, dry to the touch, free from frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter. Enclose joints on three sides. Clean out grooves to proper depth. Joint dimensions shall conform to approved detail drawings with a tolerance of plus 1/8 inch. Do not apply compound unless ambient temperature is between 40 and 90 degrees F. Clean out loose particles and

mortar just before sealing. Remove protective coatings or coverings from surfaces in contact with sealants before applying sealants or tapes.

3.3.4.2 Applications

Match approved sample. Force compound into grooves with sufficient pressure to fill grooves solidly. Sealing compound shall be uniformly smooth and free of wrinkles and, unless indicated otherwise, tooled and left sufficiently convex to result in a flush joint when dry. Do not trim edges of sealing material after joints are tooled. Mix only amount of multi-component sealant which can be installed within four hours, but at no time shall this amount exceed 5 gallons.

3.3.4.3 Primer

Apply to concrete, wood, and other surfaces as recommended by sealant manufacturer. Do not apply primer to surfaces which will be exposed after caulking is completed.

3.3.4.4 Backing

Tightly pack in bottom of joints which are over 1/2 inch in depth with specified backing material to depth indicated or specified. Roll backing material of hose or rod stock into joints to prevent lengthwise stretching.

3.3.4.5 Bond Prevention

Install bond preventive material at back or bottom of joint cavities in which no backstop material is required, covering full width and length of joint cavities.

3.3.4.6 Protection and Cleaning

Remove compound smears from surfaces of materials adjacent to sealed joints as the work progresses. Use masking tape on each side of joint where texture of adjacent material will be difficult to clean. Remove masking tape immediately after filling joint. Scrape off fresh compound from adjacent surfaces immediately and rub clean using materials and methods recommended by the manufacturer. Upon completion of caulking and sealing, remove remaining smears, stains, and other soiling, and leave the work in clean neat condition.

3.3.5 Glass

Install in accordance with manufacturer's recommendations as required for NOA compliance.

3.3.5.1 Inspection of Sash and Frames

Before installing glass, inspect sash and frames to receive glass for defects such as dimensional variations, glass clearances, open joints, or other conditions that will prevent satisfactory glass installation. Do not proceed with installation until defects have been corrected.

3.3.5.2 Preparation of Glass and Rabbets

Clean sealing surfaces at perimeter of glass and sealing surfaces of rabbets and stop beads before applying glazing compound, sealing compound, glazing tape, or gaskets. Use only approved cleaning agents recommended

by compound or gasket manufacturer.

3.3.5.3 Positioning Glass

Set glass from inside the building unless otherwise indicated or specified. Maintain specified edge clearances and glass bite at perimeter. Maintain position of glass in rabbet and provide required sealant thickness on both sides of glass. For glass dimensions larger than 50 united inches, provide setting blocks at sill and spacer shims on all four sides; locate setting blocks one quarter way in from each jamb edge of glass. Where setting blocks and spacer shims are set into glazing compound or sealant, butter with compound or sealant, place in position, and allow to firmly set prior to installation of glass.

3.3.5.4 Void Space

Heat absorbing, insulating, spandrel, and tempered glass, and glass of other types that exceed 100 united inches in size: Provide void space at head and jamb to allow glass to expand or move without exuding the sealant.

3.3.5.5 Insulating Glass

Provide adequate means to weep incidental water and condensation away from the sealed edges of insulated glass units and out of the wall system. The weeping of lock-strip gaskets should be in accordance with the recommendation of the glass manufacturer.

3.3.6 Firestopping

Provide firestopping, where indicated and where required by fire assembly. Refer to Section 07 84 00 Firestopping.

3.4 FINISHES

3.4.1 Shop Cleaning and Painting

3.4.1.1 Cleaning

Clean steel and iron work by power wire brushing or other approved manual or mechanical means, for removal of rust, loose paint, scale, and deleterious substances. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other foreign matter, in accordance with manufacturer's instructions and recommendations until thoroughly clean. Cleaning steel embedded in concrete is not required.

3.4.1.2 Painting Steel or Iron Surfaces

Apply one coat of primer. Apply additional shop coat of specified paint, to which a small amount of tinting material has been added, on surfaces that will be concealed in the finished construction or that will not be accessible for finish painting. Accomplish painting in dry weather or under cover, and on steel or iron surfaces that are free from moisture and frost. Do not paint surfaces of items to be embedded in concrete. Recoat damaged surfaces upon completion of work. Prime coat steel immediately after cleaning. Do not apply bituminous protective coatings to items to be finish painted.

3.5 FIELD TESTS

Conduct field check test for water leakage on designated wall areas after erection. Conduct test on two wall areas, two bays wide by two stories high where directed. Conduct test and take necessary remedial action as described in AAMA 501.1.

3.6 CLEANING AND PROTECTION

3.6.1 General

At the completion of the installation, clean the work to remove mastic smears and other foreign materials.

3.6.2 Glass

Upon completion of wall system installation, thoroughly wash glass surfaces on both sides and remove labels, paint spots, putty, compounds, and other defacements. Replace cracked, broken, and defective glass with new glass at no additional cost to the Government.

3.6.3 Aluminum Surfaces

Protection methods, cleaning, and maintenance shall be in accordance with AAMA 609 & 610.

3.6.4 Other Metal Surfaces

After installation, protect windows, panels, and other exposed surfaces from disfiguration, contamination, contact with harmful materials, and from other construction hazards that will interfere with their operation, or damage their appearance or finish. Protection methods must be in accordance with recommendations of product manufacturers or of the respective trade association. Remove paper or tape factory applied protection immediately after installation. Clean surfaces of mortar, plaster, paint, smears of sealants, and other foreign matter to present neat appearance and prevent fouling of operation. In addition, wash with a stiff fiber brush, soap and water, and thoroughly rinse. Where surfaces become stained or discolored, clean or restore finish in accordance with recommendations of product manufacturer or the respective trade association.

3.6.5 Porcelain-Enamel Surfaces

Wash surfaces with clean water and soap and rinsed with clean water. Do not use acid solutions, steel wool, or other harsh abrasives.

3.7 MATERIALS EMBEDDED IN OTHER CONSTRUCTION

Install materials to be embedded in cast-in-place concrete and masonry prior to the installation of the curtain wall. Provide setting drawings, templates, and instructions for installation.

3.8 FASTENING TO CONSTRUCTION-IN-PLACE

Provide anchorage devices and fasteners for fastening work to construction-in-place. Provide fasteners as specified.

3.9 SETTING MASONRY ANCHORAGE DEVICES

Set devices in masonry or concrete-in-place construction in accordance with the manufacturer's printed instructions. Leave drilled holes rough and free of drill dust.

3.10 FIELD-WELDING STEEL AND TOUCHUP PAINTING

Procedures of manual shielded metal arc welding, the appearance and quality of the welds made, and the methods used in correcting welding work shall conform to AWS D1.1/D1.1M.

After completion of welding, clean and paint field welds and scarred surfaces on steel work and on adjacent ferrous-metal surfaces. Paint shall be the same as that used for shop painting.

3.11 INSTALLATION TOLERANCES

Install curtain walls within the following tolerances:

Deviation in location from that indicated on the drawings	Plus or minus 1/4 inch
Deviation from the plumb or horizontal	
n 12 feet of length	Not more than 1/8 inch
In any total length	Not more than 1/2 inch
Offset from true alignment at joints between abutting members in line	Not more than 1/16 inch

3.12 PLACING CURTAIN-WALL FRAMING MEMBERS

Install members plumb, level, and within the limits of the installation tolerances specified.

Connect members to building framing. Provide supporting brackets adjustments for the accurate location of curtain-wall components. Adjustable connections shall be rigidly fixed after members have been positioned.

3.13 PANEL INSTALLATION

Panels shall be set with a glazing-tape back bed, two-component elastomeric sealing-compound heel bead, glazing-tape bedding of the stop, and two-component elastomeric sealing-compound topping bead on both sides of the panel. Face and edge clearances shall not be less than 1/8 inch. Remove excess sealing compound on both sides of the curtain wall opening with a glazing knife at a slight angle over the rabbet leg or applied stop. Install applied stops on the exterior side of the curtain wall and secured with screws.

3.14 INSPECTION AND ACCEPTANCE PROVISIONS

3.14.1 Finished Curtain-Wall System Requirements

Curtain-wall work shall be rejected for any of the following deficiencies:

Finish of exposed-to-view aluminum having color and appearance that are outside the color and appearance range of the approved samples.

Installed curtain-wall components having stained, discolored, abraded, or otherwise damaged exposed-to-view surfaces that cannot be cleaned or repaired.

Aluminum surfaces in contact with dissimilar materials that are not protected as specified.

3.14.2 Repair of Defective Work

Remove and replace defective work with curtain-wall materials that meet the specifications at no expense to the Government.

-- End of Section --

SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. The work in this section shall include furnishing of all items of finish hardware as hereinafter specified or obviously necessary to complete the building, except those items that are specifically excluded from this section of the specification.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. Hollow Metal Frames
B. Wood Doors
C. Aluminum Doors and Frames
D. Overhead Doors
E. Card/Badge Readers Power Supplies (Except as noted), Accessories

1.03 DESCRIPTION OF WORK:

A. Furnish labor and material to complete hardware work indicated, as specified herein, or as may be required by actual conditions at building.

B. Include all necessary screws, bolts, expansion shields, other devices, if necessary, as required for proper hardware application. The hardware supplier shall assume all responsibility for correct quantities.

C. All hardware shall meet the requirements of Federal, State and Local codes having jurisdiction over this project, notwithstanding any real or apparent conflict herewith in these specifications.

D. Fire-Rated Openings:

1. Provide hardware for fire-rated openings in compliance with ANSI/NFPA Pamphlet No. 80 and NFPA Standards No. 101. This requirement takes precedence over other requirements for such hardware. Provide only hardware that has been tested and listed by UL for the type and sizes of doors required, and complies with the requirements of the door and door frame labels.

2. Where panic exit devices are required on fire rated doors, provide supplementary marking on door UL label indicating Fire Door to be equipped with fire exit

hardware and provide UL label on exit device indicating "Fire Exit Hardware".

E. Wind Resistance-Florida Building Code

1. Furnish finish hardware for all exterior doors that has been tested and certified by an engineer registered in the State of Florida in an approved testing lab as defined by the Test Protocols for High Velocity Hurricane Zones. Hollow metal doors and frames shall also share the same testing and approval criteria. Hardware and door products are required to be passed for the missile impact criteria of the test, as well be tested and approved for the static and cyclic loading as defined by positive and negative PSF factors shown in the contract documents. As this is a Health Care project with I-2 classification it must comply the same as a Wind Born Debris region and must also be furnished with products tested and certified for the missile impact criteria.

F. Fasteners:

1. Hardware as furnished shall conform to published templates generally prepared for machine screw installation.

2. Furnish each item complete with all screws required for installation. Insofar as practical, furnish concealed type fasteners for hardware units. Screws that are exposed, shall be furnished with Phillips flat heads, finished to match adjacent hardware.

3. Door closers and exit devices to be installed on mineral core wood fire doors shall be attached with closed head through bolts (sex bolts).

1.04 QUALITY ASSURANCE:

A. Material herein specified shall establish the standard for the material used and shall be considered the minimum quality acceptable.

1.05 SUBMITTALS:

SD-02 Shop Drawings

Hardware schedule; G

The finish hardware supplier shall prepare and submit to the architect five (5) copies of a complete hardware schedule identifying each door and each set number, following the numbering system and not creating any separate system himself. He shall submit the schedule for review, make

corrections as directed and resubmit the corrected schedule for final approval. Approval of schedule will not relieve Contractor of the responsibility for furnishing all necessary hardware, including the responsibility for furnishing correct quantities.

No manufacturing orders shall be placed until detailed schedule has been submitted to the architect and written approval received.

After hardware schedule has been approved, furnish templates required by manufacturing contractors for making proper provisions in their work for accurate fitting and finish hardware setting. Furnish templates in ample time to facilitate progress of work.

Keying system

SD-03 Product Data

Hardware items; G

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance data

Hardware Schedule; G

Submit data package in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA

SD-11 Closeout Submittals

Key Bitting

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Wrap and protect finish hardware items for shipment. Deliver to manufacturing contractors hardware items required by them for their application; deliver balance of hardware to job; store in designated location. Each item shall be clearly marked with its intended location.

1.07 WARRANTY:

A. The materials furnished shall be warranted for one year after installation or longer as the individual manufacturer's warranty permits.

PART 2 - PRODUCTS:

2.01 ACCEPTABLE MANUFACTURERS:

A. To the greatest extent possible, obtain each kind of hardware from one manufacturer only.

B. If material manufactured by other than that specified or listed herewith as an equal, is to be bid upon, permission must be requested from the architect seven (7) days prior to bidding. If a substitution is allowed, it will be so noted by addendum.

C. All numbers and symbols used herein have been taken from the current catalogues of the following manufacturers.

	PRODUCTS	SPECIFIED MFGR.	ACCEPTABLE SUBSTITUTE
1.	Butt Hinges,	Hager	McKinney
2.	Electrified Hinges	ACSI	Hager, McKinney
3.	Locksets, Latch-Sets, Privacy Sets, Cylinders, Keys, and Keying	Best Lock Company	None-To Match Existing Cormax MX8 High Security Keying
4.	Exit Devices	Sargent	Von Duprin, Corbin/Russwin Yale, Precision
5.	Door Closers	Sargent	LCN, Yale, Stanley
6.	Protections Plates, Pull Plates, Wall Bumpers, Floor Stops, Flush Bolts, Dust Proof Strikes	Rockwood Mfg.	Trimco, H. B. Ives, G-J
7.	Automatic Flush Bolts, Coordinators	H B Ives	Rockwood, Door Controls
8.	Overhead Stops and Holders	Rixson	Glunn-Johnson, Sargent
9.	Door Seals, Thresholds, Weatherstrip	Pemko Manufacturing	National Guard, Zero
10.	Magnetic Locks, Power Supplies For Magnetic Locks	Schlage Electronics	None
11.	Key Cabinet	Lund	Telkee, Key Controls

12.	Header/Auto Door Operator	Assa Abloy	None

2.02 FINISH OF HARDWARE:

A. The basic finish of hardware shall be US26D satin chrome. Door pulls, pull plates, wall bumpers, and other hardware as listed in the hardware schedule shall be US32D satin stainless steel. Protection plates shall be manufactured from .050 Stainless Steel in US32D finish. Door closers shall be sprayed aluminum lacquer or enamel to match.

2.03 HARDWARE ITEMS

A. Clearly and permanently mark with the manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts and closers where the identifying mark will be visible after the item is installed.

2.04 HINGES AND PIVOTS:

A. Exterior butts shall be five-knuckle solid stainless steel with stainless steel pins. Butts on all out swinging exterior doors shall be furnished with non-removable pins (NRP)

B. Interior butts shall be five-knuckle as listed.

C. Doors 5' or less in height shall have two (2) butts. Furnish one (1) additional butt for each 2'6" in height or fraction thereof. Dutch doors shall have two (2) butts per leaf.

2.05 KEYING SYSTEM:

A. Submit key bitting charts to the Contracting Officer prior to completion of the work.

B. All locks and cylinders shall be masterkeyed to a Best 7-pin Patented MX8 High Security system as directed by the owner and architect. Provide all cylinders with construction cores for use during construction.

C. Furnish three (3) change keys per lock, six (6) master keys per set, six (6) grandmaster keys and six (12) construction master keys. All keys shall be stamped "U.S. Property-Do Not Duplicate".

2.06 LOCKSETS:

A. Locksets shall be heavy-duty mortise type, unless specified otherwise, in 45H series X 14H design as manufactured by Best Lock Division of Stanley of ASSA/Abloy.

1. Acceptable substitutions:

a. None-To match existing keying

2.07 EXIT DEVICES:

A. All devices shall be Sargent 80 series in types and functions specified. All devices must be listed under "Panic Hardware" in the accident equipment list of Underwriters Laboratories. All labeled doors with "Fire Exit Hardware" must have labels attached and be in strict accordance with Underwriters Laboratories. Levers, pulls and dummy trim shall be as listed in the hardware sets.

1. Acceptable Substitutions:

a. Von Duprin 99 Series
b. Corbin/Russwin ED5000 series
c. Yale 7000 series
d. Precision Apex 2000 series

2.08 DOOR CLOSERS:

A. All closers shall be Sargent 351 series as shown in the hardware schedule having non-ferrous covers, steel arms, separate valves for adjusting backcheck, closing and latching cycles and adjustable spring power to provide a full range of sizes 2-6. Closers shall be furnished parallel arm mounted on all doors opening into corridors or other public spaces and shall be mounted to permit 180 degrees door swing wherever wall conditions permit. Furnish with non-hold open arms unless otherwise indicated.

1. Acceptable Substitutions:

a. LCN 4041XP series
b. Yale 4400 series
c. Stanley D4550 series

2.09 TRIM AND PLATES:

A. Kickplates, mop plates, and armor plates, shall be .050 gauge with US32D satin stainless steel finish. Kickplates to be ten (10) inches high, mop plates to be four (4) inches high, armor plates to be thirty-six (36) inches high. Kick and armor plates shall be two (2) inches less full width of door. Mop plates shall be one (1) inch less full width of door.

B. Push plates, pull plates, door pulls, and miscellaneous door trim shall be shown in the hardware schedule.

2.10 DOOR STOPS:

A. Door stops shall be furnished for all doors to prevent damage to doors or hardware from striking adjacent walls or fixtures. Wall bumpers equal to Rockwood 409 or 411 series are preferred, but where not practical furnish floor stops equal to Rockwood 440/442 series. Where conditions prohibit the use of either wall or floor type doorstops, furnish surface mounted overhead stops equal to Glynn-Johnson GJ450 series.

2.11 THRESHOLDS AND WEATHERSTRIP:

A. Thresholds and weatherstrip shall be as listed in the hardware schedule.

2.12 DOOR SILENCERS:

A. Furnish rubber door silencers equal to Ives 20 for all new interior hollow metal frames, (2) per pair and (3) per single doorframe.

2.13 HEADER/AUTO DOOR OPERATOR:

A. Besam SW100 by Assa Abloy, low energy surface applied. The Contractor shall provide a device enclosure to extend the full width of double doors, not just limited to the active door. Provide push button actuation device.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. All hardware shall be applied and installed in accordance with best trade practice. Care shall be exercised not to mar or damage adjacent work.

B. Provide secure lock-up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items, which are not immediately replaceable, so that the completion of the work will not be delayed by hardware losses both before and after installation.

3.02 ADJUSTING AND CLEANING:

A. Contractor shall adjust all hardware in strict compliance with manufacturer's instructions. Prior to turning project to owner, contractor shall clean and make any final adjustments to the finish hardware.

3.03 PROTECTION:

A. Contractor shall protect the hardware while it is stored on construction site in a covered and dry place.

B. The contractor shall protect exposed hardware installed on doors during the construction phase.

3.04 HARDWARE SCHEDULE:

A. The following schedule is furnished for whatever assistance it may afford the contractor. Do not consider it as entirely inclusive. Should any particular door or item be omitted in any scheduled hardware group, provide door or item with hardware same as required for similar purposes. Quantities listed are for each pair of doors; or for each single door.

HW SET 1

EACH TO HAVE:

3.0 PR BUTTS 5 X 4 ½-BB1199-32D-NRP
2.0 EA ELECTRIC HINGE 4 ½ X 4 ½-BB1199-32D X 1106 X LC6
1.0 ELECTRIC EXIT DEVICE 53-56-M8410 X 106 AUX OPERATOR
X US32D X LESS 822 PULL X L/C
1.0 ELECTRIC EXIT DEVICE 53-56-M8410 X US32D
1.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 POWER SUPPLY PS902 X 9004RL-FA
(TO POWER EXIT DEVICES AND COORIDNATE RELAY WITH AUTOMATIC OPERATORS)
2.0 DOOR PULLS RM202-32D X TYPE 1 HD
1.0 THRESHOLD 2005AV-LAR
1.0 HEADER / AUTO DOOR OPERATOR - Besam SW100 by Assa Abloy

(WEATHERSTRIP BY ALUMINUM DOOR MFGR)

HW SET 2

EACH TO HAVE:

3.0 PR BUTTS 5 X 4 ½-BB1199-32D-NRP
2.0 EA ELECTRIC HINGE 4 ½ X 4 ½-BB1199-32D X 1106 X LC6
1.0 ELECTRIC EXIT DEVICE 53-16-M8410 X 106 AUX OPERATOR
X US32D X LESS 822 PULL X L/C
1.0 ELECTRIC EXIT DEVICE 53-16-M8410 X US32D
3.0 CYLINDER 1E74-26D X MX8-CORMAX
2.0 MAGNETIC LOCKS M450P X 4504 FILLER PLATES
1.0 REQUEST TO EXIT BUTTON 621GR-NS
1.0 PASSIVE INFRARED DETECTOR SCAN II
1.0 POWER SUPPLY PS902 X 900-FA
(TO POWER MAGNETS)
2.0 DOOR PULLS RM202-32D X TYPE 1 HD
2.0 DOOR CLOSER EN351-P10 X 581-2 X 350D
1.0 THRESHOLD 2005AV-LAR
1.0 HEADER / AUTO DOOR OPERATOR - Besam SW100 by Assa Abloy

(WEATHERSTRIP BY ALUMINUM DOOR MFGR)

HW SET 3

EACH TO HAVE:

4.0 PR BUTTS 5 X 4 ½-BB1199-32D-NRP
1.0 EXIT DEVICE 16-M8410 X 106 AUX OPERATOR
X US32D X LESS 822 PULL X L/C
1.0 EXIT DEVICE 16-M8410 X US32D
3.0 CYLINDER 1E74-26D X MX8-CORMAX
2.0 DOOR PULLS RM202-32D X TYPE 1 HD
2.0 DOOR CLOSER EN351-P10 X 581-2 X 350D
2.0 DOOR STOP 483-26D
1.0 THRESHOLD 2005AV-LAR

(WEATHERSTRIP BY ALUMINUM DOOR MFGR)

HW SET 4

EACH TO HAVE:

1.5 PR BUTTS 5 X 4 ½-BB1199-32D-NRP
1.0 EA ELECTRIC HINGE 4 ½ X 4 ½-BB1199-32D X 1106 X LC6
1.0 ELECTRIC EXIT DEVICE 53-16-M8410 X 106 AUX OPERATOR
X US32D X LESS 822 PULL X L/C
2.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 MAGNETIC LOCK M450P X 4504 FILLER PLATES
1.0 REQUEST TO EXIT BUTTON 621GR-NS
1.0 PASSIVE INFRARED DETECTOR SCAN II
1.0 POWER SUPPLY PS902 X 900-FA
(TO POWER MAGNETS)
1.0 DOOR PULL RM202-32D X TYPE 1 HD
1.0 DOOR CLOSER EN351-P10 X 581-2 X 350D
1.0 DOOR STOP 483-26D
1.0 THRESHOLD 2005AV-LAR

(WEATHERSTRIP BY ALUMINUM DOOR MFGR)

HW SET 5

EACH TO HAVE:

2.0 PR BUTTS 5 X 4 ½-BB1199-32D-NRP
1.0 EXIT DEVICE 16-M8410 X 106 AUX OPERATOR
X US32D X LESS 822 PULL X L/C
2.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 DOOR PULL RM202-32D X TYPE 1 HD
1.0 DOOR CLOSER EN351-P10 X 581-2 X 350D
1.0 DOOR STOP 483-26D
1.0 THRESHOLD 2005AV-LAR

(WEATHERSTRIP BY ALUMINUM DOOR MFGR)

HW SET 6

EACH TO HAVE:

3.0 PR BUTTS 5 X 4 ½-BB1168-26D-NRP
2.0 EA ELECTRIC HINGE 4 ½ X 4 ½-BB1168-26D X 1106 X LC6
1.0 ELECTRIC EXIT DEVICE 53-56-M8410 X 106 AUX OPERATOR
X US32D X LESS 822 PULL X L/C
1.0 ELECTRIC EXIT DEVICE 53-56-M8410 X US32D
1.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 POWER SUPPLY 3520
(TO POWER EXIT DEVICE)
1.0 DOOR CLOSER EN351-P10 X 581-2 X 350D
2.0 DOOR PULLS RM202-32D X TYPE 1 HD
2.0 WALL BUMPERS 406-32D

(WEATHERSTRIP BY ALUMINUM DOOR MFGR)

HW SET 7

EACH TO HAVE:

4.0 PR BUTTS 5 X 4 ½-BB1168-26D-NRP
1.0 DEADLOCK MS1850-628
1.0 CYLINDER 1E74-26D X MX8-CORMAX
2.0 FLUSH BOLTS 555-26D (24" TOP/12" BOTTOM)
1.0 DUST PROOF STRIKE 570-26D
2.0 DOOR PUSH/PULL BAR SETS RM252-32D X TYPE 1 HD X TYPE 5 HD
2.0 DOOR CLOSER/STOP EN351-CPS-X 581-2 X 350D

HW SET 8

EACH TO HAVE:

2.0 PR BUTTS 5 X 4 ½-BB1168-26D-NRP
1.0 DEADLOCK MS1850-628
1.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 DOOR PUSH/PULL BAR SET RM252-32D X TYPE 1 HD X TYPE 5 HD
1.0 DOOR CLOSER/STOP EN351-CPS-X 581-2 X 350D

HW SET 9

EACH TO HAVE:

1.0 PR BUTTS 5 X 4 ½-BB1168-26D-NRP
1.0 EA ELECTRIC HINGE 4 ½ X 4 ½-BB1168-26D X 1106 X LC6
1.0 ELECTRIC EXIT DEVICE 53-56-M8410 X 106 AUX OPERATOR
X US32D X LESS 822 PULL X L/C
1.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 POWER SUPPLY 3520
(TO POWER EXIT DEVICE)
1.0 DOOR CLOSER EN351-CPS X 581-2 X 350D
1.0 DOOR PULL RM202-32D X TYPE 1 HD

(WEATHERSTRIP BY ALUMINUM DOOR MFGR)

HW SET 10

EACH TO HAVE:

1.0 CONTINOUS HINGE 780-224HD-LAR-CLR X EPT PREP
1.0 CONTINOUS HINGE 780-224HD-LAR-CLR
1.0 POWER TRANSFER CEPT10-32D
1.0 ELECTRIC EXIT DEVICES HC8774-ETP-32D X 306
AUX OPERATOR X L/C
2.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 EXIT DEVICE HC8710-32D
2.0 DOOR CLOSER/STOP HOLDER EN351-CPSH
2.0 ARMOR PLATE 34" X 2" LDW-32D
1.0 SET ASTRAGAL 18041CNB X 18041CNB-LAR
1.0 SET WEATHERSTRIP S88D25

HW SET 11

EACH TO HAVE:

1.0 CONTINOUS HINGE 780-224HD-LAR-CLR X EPT PREP
1.0 CONTINOUS HINGE 780-224HD-LAR-CLR
1.0 POWER TRANSFER CEPT10-32D
1.0 ELECTRIC EXIT DEVICES HC8774-ETP-32D X 306
AUX OPERATOR X L/C
2.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 EXIT DEVICE HC8710-32D
2.0 DOOR CLOSER EN351-P10
2.0 KICKPLATE 10" X 2" LDW-32D
2.0 WALL BUMPER 406-32D
1.0 SET ASTRAGAL 18041CNB X 18041CNB-LAR
1.0 SET WEATHERSTRIP S88D25

HW SET 12

EACH TO HAVE:

2.0 CONTINOUS HINGE 780-224HD-LAR-CLR
1.0 LOCKSET 45H-7-T-14H-32D X MX8
2.0 SURFACE BOLTS 988-2C-12"
2.0 DOOR CLOSER/STOP HOLDER EN351-CPSH
1.0 COORDINATOR 600 SERIES X 601AB BCKTS
2.0 ARMOR PLATE 34" X 2" LDW-32D
1.0 THRESHOLD 2005AV-LAR
1.0 SET WEATHERSTRIP S88D25
1.0 SET ASTRAGAL 18041CNB X 18041CNB-LAR

HW SET 13

EACH TO HAVE:

4.0 PR BUTTS 4 ½ X 4 ½-BB1199-32D-NRP
1.0 LOCKSET 45H-7-T-14H-32D X MX8
2.0 SURFACE BOLTS 988-2C-12"
2.0 DOOR CLOSER/STOP HOLDER EN351-CPSH
1.0 COORDINATOR 600 SERIES X 601AB BCKTS
2.0 KICKPLATE 10" X 2" LDW-32D
1.0 THRESHOLD 2005AV-LAR
1.0 SET WEATHERSTRIP S88D25

(ASTRAGAL BY THE HOLLOW METAL DOOR MFGR.)

HW SET 13A

EACH TO HAVE:

2.0 PR HINGES 4 ½ X 4 ½-BB1199-32D-NRP
1.0 EXIT DEVICE HC8804-ETP-32D X L/C
1.0 CYLINDER 12E72-26D X MX8-COREMAX
1.0 DOOR CLOSER/STOPEN351-CPS
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 THRESHOLD 2005AV-LAR
1.0 SET WEATHERSTRIP S88D20
1.0 DRIP CAP 347A X 68AR-DOOR WIDTH PLUS 4"

HW SET 13B

EACH TO HAVE:

1.0 CONTINOUS HINGE 780-224HD-LAR-CLR X EPT PREP
1.0 POWER TRANSFER CEPT10-32D
1.0 ELECTRIC EXIT DEVICE 55-HC8776-ETP-32D X L/C
1.0 CYLINDER 12E72-26D X MX8-COREMAX
1.0 DOOR CLOSER/STOP EN351-CPS
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 THRESHOLD 2005AV-LAR
1.0 DRIP CAP 347A X 68AR-DOOR WIDTH PLUS 4"
1.0 SET WEATHERSTRIP S88D18

HW SET 14

EACH TO HAVE:

1.0 CONTINOUS HINGE 780-224HD-LAR-CLR X EPT PREP
1.0 POWER TRANSFER CEPT10-32D
1.0 ELECTROMECHAINCIAL LOCKSET 45WH-7-DEU-14H-32D X RQE X MX8 (STAIR SIDE IS LOCKED SIDE OF DOOR)
1.0 DOOR CLOSER/STOP EN351-CPS
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 THRESHOLD 2005AV-LAR
1.0 DRIP CAP 347A X 68AR-DOOR WIDTH PLUS 4"
1.0 SET WEATHERSTRIP S88D17
1.0 2ND SET WEATHERSTRIP 336A X 335AR-LAR

HW SET 15

EACH TO HAVE:

2.0 PR HINGES 4 ½ X 4 ½-BB1199-32D-NRP
1.0 LOCKSET 45H-7-T-14H-32D X MX8
1.0 DOOR CLOSER/STOP HOLDER EN351-CPSH
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 THRESHOLD 2005AV-LAR
1.0 SET WEATHERSTRIP S88D25

HW SET 16

EACH TO HAVE:

2.0 CONTINOUS HINGES 780-224HD-LAR-CLR
2.0 EXIT DEVICES 12-NB8713-ETP-32D X TB X L/C
2.0 CYLINDER 1E74-26D X MX8-CORMAX
2.0 DOOR CLOSER EN351-P10 X TB
2.0 KICKPLATE 10" X 2" LDW-32D
2.0 WALL MAGNETS FM998-689
1.0 SET SMOKE ASTRAGAL 18041CNB X 18041CNB-LAR
1.0 SET SMOKE GASKET S88D25

HW SET 17

EACH TO HAVE:

2.0 CONTINOUS HINGES 780-224HD-LAR-CLR
2.0 EXIT DEVICES 12-NB8713-ETP-32D X TB X L/C
2.0 CYLINDER 1E74-26D X MX8-CORMAX
2.0 DOOR CLOSER EN351-P10 X TB
2.0 KICKPLATE 10" X 2" LDW-32D
2.0 WALL BUMPERS 406-32D
1.0 SET SMOKE ASTRAGAL 18041CNB X 18041CNB-LAR
1.0 SET SMOKE GASKET S88D25

HW SET 17A

EACH TO HAVE:

4.0PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 EXIT DEVICE NB8706-ETP-32D X L/C
1.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 EXIT DEVICE NB8710-32D
2.0 DOOR CLOSER EN351-P10
2.0 KICKPLATE 10" X 2" LDW-32D
2.0 WALL BUMPER 406-32D
1.0 SET ASTRAGAL 18041CNB X 18041CNB-LAR
2.0 SILENCERS 608-GRAY

HW SET 18

EACH TO HAVE:

2.0 CONTINOUS HINGES 780-224HD-LAR-CLR
2.0 EXIT DEVICES 12-NB8713-ETP-32D X TB X L/C
2.0 CYLINDER 1E74-26D X MX8-CORMAX
2.0 DOOR CLOSER/STOP EN351-CPS X TB
2.0 KICKPLATE 10" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
1.0 SET SMOKE ASTRAGAL 18041CNB X 18041CNB-LAR
1.0 SET SMOKE GASKET S88D25

HW SET 18A

EACH TO HAVE:

2.0 CONTINOUS HINGES 780-224HD-LAR-CLR
1.0 LOCKSET 45H-7-R-14H-32D X MX8
2.0 FLUSH BOLT 555-26D (24" TOP/12" BOTTOM)
1.0 DUST PROOF STRIKE 570-26D
1.0 DOOR CLOSER/STOP/HOLDER EN351-CPSH X TB
(ACTIVE LEAF ONLY)
2.0 ARMOR PLATE 36" X 2" LDW-32D
2.0 FLOOR STOP 442-26D
2.0 SILENCERS 608-GRAY

HW SET 18B

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 LATCHSET 45H-0-N-14H-32D
1.0 SET TOP AUTOMATIC FLUSH BOLT 2940-32D
2.0 DOOR CLOSER EN351-P10
1.0 COORDINATOR 600 SERIES-PC X 2 601AB BCKT
2.0 WALL MAGNET FM998-689
1.0 SET SMOKE ASTRAGAL 18041CNB X 18041CNB-LAR
1.0 SET SMOKE SEAL S88D25

HW SET 19

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 LOCKSET 45H-7-D-14H-32D X MX8
1.0 SET TOP AUTOMATIC FLUSH BOLT 2940-32D
2.0 DOOR CLOSER EN351-0
1.0 COORDINATOR 600 SERIES-PC
2.0 KICKPLATE 10" X 2" LDW-32D
2.0 FLOOR STOP 442-26D
2.0 SILENCERS 608-GRAY

HW SET 19A

EACH TO HAVE:

2.0 CONTINOUS HINGES 780-224HD-LAR-CLR
2.0 PUSH PLATE 73C-4" X 16"-32D
2.0 PULL PLATE 122 X 70C-4" X 16"-32D
2.0 DOOR CLOSER/STOP/HOLDER EN351-CPSH X TB
X DELAYED ACTION
2.0 ARMOR PLATE 36" X 2" LDW-32D
2.0 SILENCERS 608-GRAY

HW SET 20

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
1.0 LOCKSET 45H-7-TD-14H-32D X MX8
2.0 FLUSH BOLT 555-26D (24" TOP/12" BOTTOM)
1.0 DUST PROOF STRIKE 570-26D
2.0 OVERHEAD STOP 10-32D
2.0 SILENCERS 608-GRAY

HW SET 21

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 EA ELECTRIC HINGE 4 ½ X 4 ½-BB1168-26D X 1106 X LC6
1.0 ELECTRIC EXIT DEVICE 12-8875-ETP-32D X TB X L/C
(FAIL SAFE TO ACCOMMODATE THE HIGH RISE PORTION OF THE BUILDING CODE)
1.0 CYLINDER 12E72-26D X MX8-CORMAX
1.0 DOOR CLOSER/STOP EN351-CPS X TB
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 SET SMOKE SEAL S88D17

HW SET 21A

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 EA ELECTRIC HINGE 4 ½ X 4 ½-BB1168-26D X 1106 X LC6
1.0 ELECTRIC EXIT DEVICE 12-8875-ETP-32D X TB X L/C
(FAIL SAFE TO ACCOMMODATE THE HIGH RISE PORTION OF THE BUILDING CODE)
1.0 CYLINDER 12E72-26D X MX8-CORMAX
1.0 DOOR CLOSER EN351-O X TB
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 SET SMOKE SEAL S88D17

HW SET 22

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 EXIT DEVICE 12-8813-ETP-32D X TB X L/C
1.0 CYLINDER 1E74-26D X MX8-CORMAX
1.0 DOOR CLOSER EN351-P10 X TB
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 SET SMOKE SEAL S88D17

HW SET 23

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 EXIT DEVICE 12-8815-ETP-32D X TB
1.0 DOOR CLOSER EN351-O OR P10 AS REQUIRED X TB
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
1.0 SET SMOKE SEAL S88D18

HW SET 24

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 EXIT DEVICE 12-8810-32D X TB
1.0 DOOR CLOSER/STOP EN351-CPS X TB
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 SET SMOKE SEAL S88D17

HW SET 25

PR BUTTS 4 ½ X 4 ½-BB1279-26D
(BB1168 AT DOORS OVER 3'0" WIDE)
1.0 EA ELECTRIC HINGE 4 ½ X 4 ½-BB1279-26D X 1106 X LC6
1.0 ELECTROMECHANICAL LOCKSET 45WH-7-DEU-14H-32D X RQE X MX8 (FAIL SECURE. FAIL SAFE AT DOORS 8010, 8431, AND 9431 ONLY)
1.0 DOOR CLOSER EN351-0 OR P10 AS REQUIRED (X TB AT MINERAL CORE WOOD DOORS)
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
3.0 SILENCERS 608-GRAY

HW SET 25A

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
(BB1168 AT DOORS OVER 3'0" WIDE)
1.0 LOCKSET 45H-7-R-14H-32D X MX8
1.0 DOOR CLOSER/STOP EN351-CPS X TB
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 SET SMOKE SEAL S88D17

HW SET 26

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
(BB1168 AT DOORS OVER 3'0" WIDE)
1.0 LOCKSET 45H-7-R-14H-32D X MX8
1.0 DOOR CLOSER EN351-0 OR P10 AS REQUIRED
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
3.0 SILENCERS 608-GRAY

HW SET 26A

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 LOCKSET 45H-7-D-14H-32D X MX8
1.0 DOOR CLOSER EN351-0 OR P10 AS REQUIRED X DELAYED ACTION
1.0 ARMOR PLATE 36" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
3.0 SILENCERS 608-GRAY

HW SET 26B

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1168-26D
1.0 LOCKSET 45H-7-D-14H-32D X MX8
1.0 DOOR CLOSER/STOP EN351-CPS X DELAYED ACTION
1.0 ARMOR PLATE 36" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
3.0 SILENCERS 608-GRAY

HW SET 27

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
(BB1168 AT DOORS OVER 3'0" WIDE)
1.0 LOCKSET 45H-7-D-14H-32D X MX8
1.0 DOOR CLOSER EN351-0 OR P10 AS REQUIRED
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
3.0 SILENCERS 608-GRAY

HW SET 27A

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
(BB1168 AT DOORS OVER 3'0" WIDE)
1.0 LATCHSET 45H-0-N-14H-32D
1.0 DOOR CLOSER EN351-0 OR P10 AS REQUIRED
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
1.0 SET SMOKE SEAL S88D18

HW SET 28

EACH TO HAVE:

PR BUTTS 4 X 4 ½-BB1168-26D
1.0 PUSH PLATE 73C-4" X 16"-32D
1.0 PULL PLATE 122 X 70C-4" X 16"-32D
1.0 DOOR CLOSER EN351-P10
1.0 KICKPLATE 10" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
3.0 SILENCERS 608-GRAY

HW SET 28A

EACH TO HAVE:

1.0 CONTINOUS HINGE 780-224HD-LAR-CLR
1.0 PUSH PLATE 73C-4" X 16"-32D
1.0 PULL PLATE 122 X 70C-4" X 16"-32D
1.0 DOOR CLOSER EN351-P10
1.0 ARMOR PLATE 38" X 2" LDW-32D
1.0 WALL BUMPER 406-32D
3.0 SILENCERS 608-GRAY

HW SET 28B

EACH TO HAVE:

1.0 OVERHEAD CONCEALED CLOSER MW806-26D
2.0 PUSH PLATES 73C-4" X 16"-32D
2.0 ARMOR PLATES 38" X 1" LDW-32D X B4E
2.0 WALL BUMPERS 406-32D

HW SET 29

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
1.0 LOCKSET 45H-7-AB-14H-32D X MX8
1.0 WALL BUMPER 406-32D OR FLOOR STOP 442-26D
AS REQURIED
3.0 SILENCERS 608-GRAY

HW SET 30

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
1.0 LOCKSET 45H-7-R-14H-32D X MX8
1.0 WALL BUMPER 406-32D OR FLOOR STOP 442-26D
AS REQURIED
3.0 SILENCERS 608-GRAY

HW SET 30A

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
1.0 LOCKSET 45H-7-R-14H-32D X MX8
1.0 OVERHEAD STOP 10-32D
3.0 SILENCERS 608-GRAY

HW SET 31

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
1.0 LOCKSET 45H-7-D-14H-32D X MX8
1.0 WALL BUMPER 406-32D OR FLOOR STOP 442-26D
AS REQURIED
3.0 SILENCERS 608-GRAY

HW SET 31A

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
1.0 LOCKSET 45H-7-D-14H-32D X MX8
1.0 OVERHEAD STOP 10-32D
3.0 SILENCERS 608-GRAY

HW SET 32

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
1.0 PRIVACY SET 45H-O-LT-14H-32D X VIN
1.0 WALL BUMPER 406-32D OR FLOOR STOP 442-26D
AS REQURIED
3.0 SILENCERS 608-GRAY

HW SET 33

EACH TO HAVE:

PR BUTTS 4 ½ X 4 ½-BB1279-26D
1.0 LATCHSET 45H-O-N-14H-32D
1.0 WALL BUMPER 406-32D OR FLOOR STOP 442-26D
AS REQURIED
3.0 SILENCERS 608-GRAY

HW SET 34

EACH TO HAVE:

ALL HARDWARE BY THE OVERHEAD DOOR MFGR. EXCEPT:
MX8 COREMAX CYLINDER AS REQUIRED
1.0 SET WEATHERSTRIP S88D25

MISCELLANEOUS:

1.0 KEY CABINET 1205

---End Of Section ---

SECTION 08 81 00

GLAZING
08/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2009; Errata 2010) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C1036	(2010; E 2012) Standard Specification for Flat Glass
ASTM C509	(2006; R 2011) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C864	(2005; R 2011) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM D2287	(2012) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D395	(2003; R 2008) Standard Test Methods for Rubber Property - Compression Set
ASTM E1300	(2012a; E 2012) Determining Load Resistance of Glass in Buildings

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2004) Glazing Manual
GANA Sealant Manual	(2008) Sealant Manual

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

IGMA TB-3001	(2001) Guidelines for Sloped Glazing
IGMA TM-3000	(1990; R 2004) North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 255	(2006; Errata 2006) Standard Method of Test of Surface Burning Characteristics of Building Materials
NFPA 257	(2012) Standard on Fire Test for Window and Glass Block Assemblies
NFPA 80	(2013) Standard for Fire Doors and Other Opening Protectives

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

UNDERWRITERS LABORATORIES (UL)

UL 9	(2009) Standard for Fire Tests of Window Assemblies

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval.When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Glass Installation

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

SD-03 Product Data

Insulating Glass; (LEED NC); G
Laminated Glass; (LEED NC); G
Sealants; (LEED NC)
Glazing Accessories; G

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

SD-04 Samples

Insulating Glass; G

Laminated Glass; G

Sealant

Two 8 by 10 inch samples of each of the following:

Heat strengthened clear glass
Tempered clear glass
Laminated translucent glass
Fire-rated safety glass
Hurricane resistant laminated Low-E clear glass
Insulating heat strengthened Low-E tinted glass
Insulating heat strengthened Low-E tinted spandrel glass
Insulating tempered Low-E tinted glass
Insulating hurricane resistant laminated Low-E clear glass
Insulating hurricane resistant laminated Low-E tinted glass
Insulating hurricane resistant laminated Low-E clear with silkscreen pattern glass
Insulating hurricane resistant laminated Low-E tinted spandrel glass

Two 24 by 24 inch samples of the following:

Insulating hurricane resistant laminated Low-E clear glass with slikscreen pattern spandrel glass

SD-07 Certificates

Insulating Glass

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

SD-08 Manufacturer's Instructions

Setting and sealing materials

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.

SD-11 Closeout Submittals

Low Emitting Materials - Adhesives and Sealants
Recycled Content

1.4 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E1300.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not start glazing work until the outdoor temperature is above 40 degrees F and rising, unless procedures recommended by the glass manufacturer and approved by the Contracting Officer's Representative are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

1.7 SUSTAINABLE DESIGN REQUIREMENTS

1.7.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Glazing materials may be locally available.

1.8 WARRANTY

1.8.1 Warranty for Insulating Glass Units

Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Government. For control tower units, the warranty period shall be 10 years; warranty shall be signed by the manufacturer.

PART 2 PRODUCTS

2.1 GLASS

ASTM C1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

2.1.1 Tempered Clear Glass

For interior glazing, 1/4 inch thick fully tempered glass should be used.

ASTM C 1036 Type I, Class 1 (clear), Quality q3; ASTM C 1048 Condition C, Kind FT (fully tempered). Provide for glazing openings not indicated or specified otherwise.

2.1.2 Interior Glass

Glass in Aluminum Storefront, Entrances and Doors: Heat Strengthened and Tempered Clear Glass; Thickness: 1/4 inch

Glass in Aluminum Storefront, Entrances and Doors: Laminated Glass, Translucent: Total Thickness: 3/8 inch

Glass Makeup: Two pieces of heat strengthened glass with 0.030 inch thick translucent PVB interlayer, 65% White, 10.0L, Cardinal Laminated Glass

Glass Display in Lobby:

Tempered Clear Glass:

Thickness: 3/8 inch.

Graphic Film: Furnished by owner installed by contractor.

Stainless Steel Stand Off: SOB2112BS 1 1/2" base with SOB22BS 2" diameter cap as manufactured by C.R.Laurence Co., or equal.

Glass Marker Board in Innovation Room:

Laminated Translucent Glass:

Total Thickness: 3/8 inch.
Glass Makeup: Two pieces of heat strengthened glass with 0.030 inch thick translucent PVB interlayer.

Stainless Steel Stand Off: SOB2112BS 1 1/2" base with SOB22BS 2" diameter cap as manufactured by C.R.Laurence Co., or equal.

2.1.3 Hurricane Resistant Laminated Low-E Clear Glass - at all exterior doors

Product and Manufacturer: 9/16" VLE 1-70; Viracon, or equal.

Glass: Laminated; two pieces of 1/4-inch thick clear heat strengthend glass with two 0.045-inch thick clear PVB interlayer sheets.

2.1.4 Insulating Heat Strengthened Low-E Tinted Glass - 60ft and above

Product and Manufacturer: 1-5/16 inch thick VE3-2M Insulated Glass; Viracon, or equal.

Outboard Glass: 1/4-inch thick, HS, Gray tint, with VE-2M #2 surface

SHGC Criteria: 0.24 (in case of substitutes)

Airspace: 3/16-inch

Inboard Glass: 1/4-inch thick clear heat strengthend glass.

2.1.5 Insulating Heat Strengthened Low-E Tinted Spandrel Glass - 60 ft and above

Product and Manufacturer: 1-5/16 inch thick VE3-2M Insulated Glass; Viracon, or equal

Outboard Glass: 1/4-inch thick, HS, Gray tint, with VE-2M #2 surface

Airspace: 3/16-inch

Inboard Glass: Spandrel glass; 1/4-inch thick clear heat strengthend glass. Spandrel coating V933 - Warm Gray Viraspan on #4 surface.

2.1.6 Insulating Tempered Low E Tinted Glass - 60ft and above

Product and Manufacturer: 1-5/16 inch thick VE3-2M Insulated Glass; Viracon, or equal.

Outboard Glass: 1/4-inch thick, HS, Gray tint, with VE-2M #2 surface

SHGC Criteria: 0.24 (in case of substitutes)

Airspace: 13/16-inch

Inboard Glass: 1/4-inch thick clear HS glass.

2.1.7 Insulating Hurricane Resistant Laminated Low E Clear Glass -Cafeteria up to 8ft in height

Product and Manufacturer: 1-5/16 inch thick VE1-2M Insulated Laminated Glass; Viracon, or equal.

Outboard Glass: 1/4-inch thick, fully tempered, clear, with VE-2M #2 surface

SHGC Criteria: 0.37 (in case of substitutes)

Airspace: 1/2-inch

Inboard Glass: Laminated; two pieces of 1/4-inch thick clear heat strengthend glass with 0.060 inch thick clear PVB interlayer.

2.1.8 Insulating Hurricane Resistant Laminated Low E Tinted Glass

Product and Manufacturer: 1-5/16 inch thick VE3-2M Insulated Laminated Glass; Viracon, or equal.

Outboard Glass: 1/4-inch thick, HS, Gray tint, with VE-2M #2 surface

SHGC Criteria: 0.23 (in case of substitutes)

Airspace: 1/2-inch

Inboard Glass: Laminated; two pieces of 1/4-inch thick clear heat strengthend glass with two 0.045-inch thick clear PVB interlayer sheets.

2.1.9 Insulating Hurricane Resistant Laminated Low E Clear Glass with Silkscreen Pattern Glass

Product and Manufacturer: 1-5/16 inch thick VE1-2M Insulated Laminated Glass with 50% Silkscreen #2; Viracon, or equal.

Outboard Glass: 1/4-inch thick, HS, clear, with VE1-2M #2 surface with V175 High Opacity White Viracon - 50% Coverage on #2 surface

SHGC Criteria: 0.26 (in case of substitutes)

Airspace: 1/2-inch

Inboard Glass: Laminated; two pieces of 1/4-inch thick clear heat strengthend glass with 0.060" clear PVB interlayer.

2.1.10 Insulating Hurricane Resistant Laminated Low E Tinted Spandel Glass

Product and Manufacturer: 1-5/16 inch thick VE3-2M Insulated Laminated Glass; Viracon, or equal.

Outboard Glass: 1/4-inch thick, fully tempered, Gray tint, with VE-2M #2 surface

Airspace: 1/2-inch

Inboard Glass: Laminated; two pieces of 1/4-inch thick clear heat strengthend glass with two 0.045-inch thick clear PVB interlayer sheets. Spandrel coating V933 - Warm Gray Viraspan on surface #6.

2.1.11 Insulating Hurricane Resistant Laminated Low E Clear with Silkscreen Pattern Spandrel Glass - Cafeteria north area

Product and Manufacturer: 1-5/16 inch thick VE1-2M Insulated Laminated Glass with 50% Silkscreen #2; Viracon, or equal.

Outboard Glass: 1/4-inch thick, HS, with VE1-2M screen #2002 #2 surface with V175 High Opacity White Viracon - 50% Coverage on #2 surface

Airspace: 1/2-inch

Inboard Glass: Laminated; two pieces of 1/4-inch thick clear heat strengthend glass with 0.060" silkscreen pattern PVB interlayer sheets. Spandrel coating on surface.

2.1.12 Mirrors

2.1.12.1 Glass Mirrors

Glass for mirrors shall be Type I transparent flat type, Class 1-clear, Glazing Quality q1 1/4 inch thick conforming to ASTM C1036. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint , and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2.1.13 Fire-Rated Safety-Rated Glass

Product and Manufacturer: FireLite Plus; Technical Glass Products (TGP)

Listed and labeled by a testing agency acceptable to authorities

having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 255 NFPA 257, or UL 9 including the hose-stream test, and shall comply with NFPA 80.

2.2 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted shall be gray or neutral color.

2.2.1 Sealants

Provide elastomeric sealants.

Refer to Section 01 33 29 LEED(TM)Documentation.

2.2.1.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing metal sash. Sealant shall be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units . Color of sealant will be selected by the Contracting Officer's Representative.

2.2.2 Preformed Channels

Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the particular condition.

2.2.3 Sealing Tapes

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D2287. Use only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes shall be chemically compatible with the product being set.

2.2.4 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks shall be dense extruded type conforming to ASTM C509 and ASTM D395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (plus or minus 5). Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by glass manufacturer. Block color shall be black.

2.2.5 Glazing Gaskets

Glazing gaskets shall be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at

corners. Glazing gasket profiles shall be as recommended by the manufacturer for the intended application.

2.2.5.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C509, Type 2, Option 1.

2.2.5.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C864, Option 1, Shore A durometer between 65 and 75.

2.2.5.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.2.6 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

PART 3 EXECUTION

3.1 PREPARATION

Preparation, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 GLASS INSTALLATION

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Aluminum windows, wood doors, and wood windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

3.2.1 Sheet Glass

Cut and set with the visible lines or waves horizontal.

3.2.2 Insulating Glass Units

Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation shall conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

3.3 Testing

Commissioning Agent will peform water penetration test using spray method. Testing shall demonstrate that all windows have been sealed watertight. Contractor shall repair any leaks found as a result of testing. Refer also to Section 01 91 13 Commissioning.

3.4 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass shall be clean at the time the work is accepted.

3.5 PROTECTION

Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

3.6 WASTE MANAGEMENT

Disposal and recycling of waste materials, including corrugated cardboard recycling, shall be in accordance with the Waste Management Plan. Close and seal tightly all partly used sealant containers and store protected in well-ventilated, fire-safe area at moderate temperature.

-- End of Section --

SECTION 08 91 00

METAL WALL LOUVERS
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 500-L	(2012) Laboratory Methods of Testing Louvers for Rating
AMCA 511	(2010) Certified Ratings Program for Air Control Devices

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(1998; R 2004) Voluntary Specification for Anodized Architectural Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings; G

Wall louvers

SD-03 Product Data

Metal Wall Louvers; (LEED NC); G

SD-04 Samples

Wall louvers

SD-06 Test Reports

Notice of Acceptance Number

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content

1.4 DELIVERY, STORAGE, AND PROTECTION

Deliver materials to the site in an undamaged condition. Carefully store materials off the ground to provide proper ventilation, drainage, and protection against dampness. Louvers shall be free from nicks, scratches, and blemishes. Replace defective or damaged materials with new.

1.5 DETAIL DRAWINGS

Show all information necessary for fabrication and installation of wall louvers. Indicate materials, sizes, thicknesses, fastenings, and profiles.

1.6 COLOR SAMPLES

Colors of finishes for wall louvers shall closely approximate colors indicated. Where color is not indicated, submit the manufacturer's standard colors to the Contracting Officer's Representative for selection.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aluminum Sheet

ASTM B209, alloy 3003 or 5005 with temper as required for forming.

2.1.2 Extruded Aluminum

ASTM B221, alloy 6063-T5 or -T52.

2.2 METAL WALL LOUVERS

Louvers made to withstand a wind load indicated on the Drawings. Wall louvers shall bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500-L and AMCA 511.

Fixed Impact/Hurricane Louver - Model and Manufacturer: Model DC 7024/A4080; Construction Specialties, Inc., or equal.

Description: Combination louver with A4080 blank panel; DC-7024 fixed impact/hurricane vertical louver back with A4080 horizontal louver front. (at active areas).

Notice of Acceptance Number: 12-0308.28

Expiration Date: May 10, 2016

Material: Heads, sills and jambs to be one piece structural aluminum sections with minimum 0.125 " (3.18mm) thick walls.

Structural Performance: Louvers shall have been tested in accordance with Dade County Protocols PA201, PA202 and PA 203; and shall be Dade County Approved for open structure building envelope protection (including missile) for single unit sizes up to 4 feet wide by 10 feet high; and for allowable design wind loading up to 160 psf (multiple units may be used for larger openings).

Pressure Drop: A 4' X 4' module of the complete system shall have a pressure drop not to exceed .077" in. H2O at an overall system free area velocity of 500 FPM.

Fixed Horizontal Louver - Model and Manufacturer: Model DC4080; Construction Specialties, Inc., or equal.

Description: Fixed horizontal louver attached to aluminum framing designed by specialty louver engineers (decorative louver at inactive areas, in front of metal wall panels subject to NOA, see Section 07 42 13).

Fixed Horizontal Louver Screen - Model and Manufacturer: Model DC4080; Construction Specialties, Inc., or equal.

Description: Fixed horizontal louver screen (screen wall for 1st level roof equipment, only).

2.2.1 Extruded Aluminum Louvers

Fabricated of extruded 6063-T5 or -T52 aluminum with a wall thickness of not less than 0.081 inch.

Aluminum Extrusions: ASTM B211, Alloy 6063-T5, 6063-T6 or 6061-T6.

Aluminum Sheet: ASTM B3209, Alloy 1100, 3003 or 5005.

Louver Blade: Aluminum sheet; manufacturer's standard profile for tested louvers.

Channel Frame: Aluminum; fabricate frames, including sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

Sill Flashing: Aluminum sheet.

2.2.2 Mullions and Mullion Covers

Same material and finish as louvers. Provide mullions where indicated . Provide mullions covers on both faces of joints between louvers.

2.2.3 Screens and Frames

For aluminum louvers, provide 1/2 inch square mesh, 14 or 16 gage aluminum. Mount screens in removable, rewirable frames of same material and finish as the louvers..

2.3 FASTENERS AND ACCESSORIES

Fasteners: Provide stainless steel screws and fasteners for aluminum louvers and zinc-coated or stainless steel screws and fasteners for steel louvers. Provide other accessories as required for complete and proper installation.

Clip Angles: Manufacturer's standard for louver types and applications indicated.

2.4 FINISHES

2.4.1 Aluminum

2.4.1.1 Anodic Coating

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish shall be:

Architectural Class I (0.7 mil or thicker), designation AA-M10-C22-A41, clear (natural) anodized.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Wall Louvers

Install using stops or moldings, flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with manufacturer's recommendations.

3.1.2 Screens and Frames

Attach frames to louvers with screws or bolts.

3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

3.2.1 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

3.2.2 Metal

Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

-- End of Section --

SECTION 09 22 00

SUPPORTS FOR GYPSUM BOARD
02/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A463/A463M	(2010) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A641	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C645	Standard specification for Nonstructural Steel Framing Members
ASTM C754	(2011) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM EMLA 920	(2009) Guide Specifications for Metal Lathing and Furring

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal support systems

Submit for the erection of metal framing, furring, and ceiling suspension systems. Indicate materials, sizes, thicknesses, and fastenings.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the job site and store in ventilated dry locations.

Storage area shall permit easy access for inspection and handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Remove damaged items and provide new items.

PART 2 PRODUCTS

2.1 MATERIALS

Provide steel materials for metal support systems with galvanized coating ASTM A653/A653M, G-60; aluminum coating ASTM A463/A463M, T1-25; or a 55-percent aluminum-zinc coating.

2.1.1 Materials

2.1.1.1 Suspended Ceiling Systems

Hanger Wire: ASTM A641, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

Main Tee: Double-web construction (minimum 0.0179 inch prior to protective coating, ASTM C645), hot dipped galvanized (per ASTM A653).

Cross Tee: Double-web steel construction (minimum 0.0179 inch prior to protective coating, ASTM C645), hot dipped galvanized (minimum G40 or G90 per ASTM A653).

Cross Channel: Hot dipped galvanized (minimum G40)steel; size as required.

Channel Molding: Hot dipped galvanized (minimum G40 steel), unhemmed channel molding, 3/4 inch x 1-9/16 inch x 1-1/4 inch flange.

Angle Molding: 1-1/4 inch x 1-1/4 inch with pre-engineered locking tabs punched 8 inches on center, knurled surface, screw stop hem, pre-punched holes in top flange, 4" O.C., .018 mil., minimum 25 gaugs.

Specialty Edge Trim: Extruded aluminum with acrylic coating; sizes and profiles as indicated.

Control Joints: Minimum #26 gauge, roll-formed zinc alloy, extruded aluminum or plastic with expanded flanges.

Adjustable Rod Suspension Hanger: Hot dipped galvanized steel; size as required for installation indicated.

2.1.1.2 Non-loadbearing Wall Framing

NAAMM EMLA 920; ASTM C645.

Metal Stud and Metal Stud Bracing: Steel.

Depth: As indicated.

Metal CH Stud: Steel;

Fire Rated Assemblies: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.

Metal Stud Track and Metal Stud J Track: Steel.

Depth: As indicated.

Metal Resilient Channel: Steel sheet members designed to reduce sound transmission

Size and Configuration: As indicated.

Metal Hat Channel Furring: Steel rigid furring channels.

Depth: As indicated.

Metal Angles and Clips: Steel; size and profile as indicated.

2.1.2 Materials for Attachment of Gypsum Wallboard

2.1.2.1 Nonload-Bearing Wall Framing and Furring

ASTM C645, but not thinner than 0.0179 inch thickness, with 0.0329 inch minimum thickness supporting wall hung items such as cabinetwork, equipment and fixtures.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Non-loadbearing Wall Framing

NAAMM EMLA 920, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.2 Systems for Attachment of Gypsum Wallboard

3.1.2.1 Suspended and Furred Ceiling Systems

ASTM C754, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.2.2 Non-loadbearing Wall Framing and Furring

ASTM C754, except as indicated otherwise.

3.2 ERECTION TOLERANCES

Provide framing members which will be covered by finish materials such as wallboard or ceramic tile set in a mortar setting bed, within the following limits:

a. Layout of walls and partitions: 1/4 inch from intended position;

b. Plates and runners: 1/4 inch in 8 feet from a straight line;

c. Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and

d. Face of framing members: 1/4 inch in 8 feet from a true plane.

Provide framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive within the following limits:

a. Layout of walls and partitions: 1/4 inch from intended position;

b. Plates and runners: 1/8 inch in 8 feet from a straight line;

c. Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and

d. Face of framing members: 1/8 inch in 8 feet from a true plane.

-- End of Section --

SECTION 09 24 23

STUCCO
05/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM C1063	(2012c) Standard Practice for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C206	(2003; R 2009) Standard Specification for Finishing Hydrated Lime
ASTM C841	(2003; E 2008; R 2008) Installation of Interior Lathing and Furring
ASTM C897	(2005; R 2009) Aggregate for Job-Mixed Portland Cement-Based Plasters
ASTM C926	(2012) Application of Portland Cement-Based Plaster
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lath

SD-03 Product Data

Proportions and Mixing (LEED NC)

Soffit Overflow Screen (LEED NC)

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials to the site in the original packages and containers with labels intact and seals unbroken. Keep cementitious materials dry and stored off the ground, under cover and away from damp surfaces until ready to be used. Aggregate shall be covered to prevent the absorption or loss of moisture.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not apply stucco when the ambient temperature is 40 degrees F or lower, or when a drop in temperature below 40 degrees F is expected within 48 hours after application.

PART 2 PRODUCTS

2.1 PORTLAND CEMENT

Portland cement shall conform to ASTM C150/C150M, gray portland cement Type I.

2.2 LIME

Lime shall conform to ASTM C206, Type S.

2.3 SAND

Sand aggregate for job-mixed base coat and job-mixed finish coat stucco shall conform to ASTM C897.

2.4 ACCESSORIES

Accessories shall bePVC unless otherwise indicated, except that cornerite and striplath shall be formed from steel sheets with manufacturer's standard galvanized coating. Vinyl members shall be in accordance with ASTM D1784. Welded wire corner reinforcements shall be zinc coated, galvanized 17 gauge steel wire conforming to ASTM A185/A185M. Furring shall include hangers, bolts, inserts, clips, fastenings, and attachments of number, size, and design to develop the full strength of the members.

Soffit Overflow Screen: Aluminum flanged insert type vent with stainless steel wire mesh screen.

Model and Manufacturer - Basis of Design: Soffit Vents, Heavy Duty; Bestlouver.com LLC, or equal.

Size: As indicated.
Finish: Manufacturer's standard painted finish, white or silver.
Mesh Screen: Manufacturer's standard heavy mesh screen.

Casing Beads: Fabricated from zinc; square-edged style; with expanded flanges.

Reveals: PVC; size as indicated.

2.5 METAL LATH

Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.

Diamond-Mesh Lath: Self-furring, 3.4 lb/sq. yd. (1.8 kg/sq. m).

Paper Backing: FS UU-B-790, Type I, Grade D, Style 2, 60 minute, vapor-permeable paper. Provide paper-backed lath at all locations.

2.6 WATER

Provide clean, fresh, potable water, free from amounts of oils, acids, alkalis and organic matter that would be injurious to the stucco.

PART 3 EXECUTION

3.1 COLD-FORMED FRAMING

Framing shall be installed as indicated.

3.2 CONTROL JOINTS

Control joints shall be located as indicated on the drawings. Prefabricated control joint members shall be installed prior to the application of the stucco. Control joints shall be cleared of all stucco within the control area after stucco application and prior to final stucco set.

Control Joints: Fabricated from zinc; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.

3.3 LATH

Install lath in accordance with ASTM C841 or ASTM C1063 except as otherwise specified. Metal and wire lath shall be applied straight, without buckles and with joints staggered. End laps of metal lath shall be not less than 1 inch. When paper-backed lath is used, the paper shall be split from the lath at all lap areas to provide a paper to paper and lath to lath lap. Horizontal joints shall be shiplapped. Lath shall be interrupted at all control joints. Submit drawings showing details of construction for reinforcement, furring, and grounds; including manufacturer's installation instructions for stucco materials, and locations where each mix and coating thickness will be used.

3.3.1 Steel Supports

Apply metal lath over vertical open steel backing frame construction. Securely fasten lath every 8 inches vertically and every 16 inches horizontally; and where sheets of lath are lapped.

3.4 PREPARATION OF SURFACES

Preparation of surfaces for application of stucco to solid bases such as stone, masonry or concrete shall conform to the applicable requirements of ASTM C926.

3.5 PROPORTIONS AND MIXING

Proportions and mixing for job-mixed base coat and finish coat shall conform to the applicable requirements of ASTM C926. Mixing of mill-mixed finish coat shall be in accordance with the manufacturer's directions. Submit detailed description of the proposed job-mix proportions for base and finish coats; including identification of thickness of coats.

3.6 STUCCO APPLICATION

Stucco shall be applied in three coats to a thickness of not less than 1 inch as measured from the back plane of metal reinforcement, exclusive of ribs or dimples or from the face of solid backing or support, with or without metal reinforcement, to the finished stucco surface, including moderate texture variations. Stucco application shall conform to the applicable requirements of ASTM C926 and the following:

3.6.1 Workmanship

Items or features of the work in connection with or adjoining the stucco shall be in place, plumb, straight, and true prior to beginning the stucco work. Metal and wire lath, where required, shall be in place and positioned to provide a good key at back of lath. Where lath is applied over copper, the copper shall be given a heavy coat of bituminous paint. Masonry surfaces to receive stucco shall be evenly dampened immediately prior to application of stucco. Each stucco coat shall be applied continuously in one general direction, without allowing mortar to dry at edges. Where it is impossible to work the full dimension of a wall surface in a continuous operation, jointing shall be made at a break, opening, or other natural division of the surface. Edges to be joined shall be dampened slightly to produce a smooth confluence. Exterior corners of stucco shall be slightly rounded. Stucco on soffit surfaces shall be pitched forward to form a drip.

3.6.2 Scratch Coat

Scratch coat shall be applied not less than 3/8 inch thick under sufficient pressure to form good keys and to completely embed the reinforcement. Before the scratch coat has set, it shall be lightly scratched in one direction and vertical surfaces shall be scratched in the horizontal direction only. The scratch coat shall be fog cured for a minimum of 72 hours.

3.6.3 Brown Coat

The scratch coat shall be dampened evenly to obtain uniform suction before the brown coat is applied. There shall be no visible water on the surface when the brown coat is applied. The brown coat shall be applied to the scratch coat with sufficient pressure to force the stucco into the scratches and shall be brought to a plumb, true, even plane with rod or straightedge. When set sufficiently, the brown coat shall be uniformly floated with a dry float to promote densification of the coat and to provide a surface receptive to bonding of the finish coat. Brown coat

shall be fog cured for a minimum of 72 hours.

3.6.4 Finish Coat

Surfaces of the brown coat shall be dampened not more than 1 hour before the finish coat is to be applied to a uniform wetness with no free-standing water on the surface. The finish coat shall have a textured finish and shall conform to the approved sample. The finish coat shall be fog cured for a minimum of 48 hours. Care shall be taken to prevent staining.

3.6.5 Surface Tolerance

When a 10 foot straightedge is placed at any location on the finished surface of the stucco, excluding rough-textured finish, the surface shall not vary more than 1/8 inch from the straightedge.

3.7 CURING AND PROTECTION

Perform fog curing by applying a fine mist of water to the stucco. Care shall be exercised during fog curing to avoid erosion damage of the stucco surfaces. Do not use a solid stream of water. Frequency of fogging shall be not less than three times daily. Protect the stucco from the direct rays of the sun during severe drying conditions using canvas, cloth or other approved sheet material, when directed.

3.8 PATCHING AND POINTING

Loose, cracked, damaged or defective work shall be replaced or patched as directed. Patching shall match existing work in texture and color and shall be finished flush.

-- End of Section --

SECTION 09 29 00

GYPSUM BOARD
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11	(1992; Reaffirmed 2005) Specifications for Interior Installation of Cementitious Backer Units

ASTM INTERNATIONAL (ASTM)

ASTM C1002	(2007) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C1047	(2010a) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C1177/C1177M	(2008) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C1178/C1178M	(2011) Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel
ASTM C1381/C1381M	Standard Specification for Molded Glass Fiber Reinforced Gypsum Parts
ASTM C1396/C1396M	(2013) Standard Specification for Gypsum Board
ASTM C1467/C1467M	Standard Specification for the Installation of Molded Glass Fiber Reinforced Gypsum Parts
ASTM C475/C475M	(2012) Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C840	(2011) Application and Finishing of Gypsum Board
ASTM C954	(2011) Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness

ASTM D1149	(2007; R 2012) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D412	(2006a; R 2013) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D624	(2000; R 2012) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

GYPSUM ASSOCIATION (GA)

GA 214	(2010) Recommended Levels of Gypsum Board Finish
GA 216	(2010) Application and Finishing of Gypsum Panel Products
GA 253	(2007) Application of Gypsum Sheathing

UNDERWRITERS LABORATORIES (UL)

UL Fire Resistance	(2012) Fire Resistance Directory

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Gypsum Board; (LEED NC)

Tile Backer Board; (LEED NC)

Extruded Aluminum Spring Loaded Partition Closure; (LEED NC)

Exterior Gypsum Wall Sheathing; (LEED NC)

Exterior Gypsum Sheathing Sealant; (LEED NC)

Gypsum Roof Sheathing; (LEED NC)

Shaftwall; (LEED NC)

Glass Fiber Reinforced Gypsum Column Cover; (LEED NC)

Accessories; (LEED NC)

Joint Treatment Materials

Adhesives

Submit for each type of gypsum board and for tile backer units.

SD-07 Certificates

Asbestos Free Materials

Certify that gypsum board types, gypsum backing board types, tile backer units, and joint treating materials do not contain asbestos.

SD-10 Operation and Maintenance Data

Waste Management

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content
Low Emitting Materials - Adhesives and Sealants

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

1.4.2 Storage

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board and tile backer units outside, store off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions. Provide adequate ventilation to prevent condensation. Store per manufacturer's recommendations for allowable temperature and humidity range. Do not store panels near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.4.3 Handling

Neatly stack gypsum board and tile backer units flat to prevent sagging or damage to the edges, ends, and surfaces.

1.5 ENVIRONMENTAL CONDITIONS

1.5.1 Temperature

Maintain a uniform temperature of not less than 50 degrees F in the structure for at least 48 hours prior to, during, and following the application of gypsum board, tile backer units, and joint treatment materials, or the bonding of adhesives.

1.5.2 Exposure to Weather

Protect gypsum board and tile backer unit products from direct exposure to rain, snow, sunlight, and other extreme weather conditions.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

1.6.1 Local/Regional Materials

See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Gypsum board materials may be locally available.

1.7 QUALIFICATIONS

Furnish type of gypsum board work specialized by the installer with a minimum of 3 years of documented successful experience.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to specifications, standards and requirements specified. Provide gypsum board types, gypsum backing board types, cementitious backing units, and joint treating materials manufactured from asbestos free materials only.

2.1.1 Gypsum Board

ASTM C1396/C1396M. See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Gypsum board may contain post-consumer or post-industrial recycled content.

2.1.1.1 Regular

48 inch wide, 5/8 inch thick, tapered edges.

2.1.1.2 Fire Rated Gypsum Board

48 inch wide, 5/8 inch thick, tapered edges.

2.1.2 Tile Backer Board

Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M with manufacturer's standard edges.

Core: Regular type and fire rated where indicated.

2.1.2.1 Regular

48 inch wide, 5/8 inch thick, square edges.

2.1.2.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick, square edges.

2.1.3 Exterior Gypsum Wall Sheathing

Exceeds physical properties of ASTM C1396/C1396M and ASTM C1177/C1177M. Provide 5/8 inch, gypsum sheathing. Provide gypsum board of with a

noncombustible water-resistant core, with glass mat surfaces embedded to the gypsum core or reinforcing embedded throughout the gypsum core. Warrant gypsum sheathing board for at least twelve months against delamination due to direct weather exposure. Provide continuous, asphalt impregnated, building felt to cover exterior face of sheathing. Seal all joints, seams, and penetrations with compatible sealant.

2.1.3.1 Exterior Gypsum Sheathing Sealant

Provide sealant compatible with gypsum sheathing, rubber washers for masonry veneer anchors, and other associated cavity wall components such as anchors and through wall flashing. Provide sealants for gypsum sheathing board edge seams and veneer anchor penetrations recommended by the gypsum sheathing manufacturer and have the following performance requirements:

a. ASTM D412: Tensile Strength, 80 psi
b. ASTM D412: Ultimate Tensile Strength (maximum elongation), 170 psi
c. ASTM D624: Tear Strength, dieB, 27 ppi
d. ASTM D1149: Joint Movement Capability after 14 Days cure, plus or minus 50 percent.

2.1.4 Gypsum Roof Sheathing

Roof Sheathing: ASTM C 1177 Type X, fiberglass-mat faced gypsum roof board.
Thickness: 5/8-inch.

2.1.5 Joint Treatment Materials

ASTM C475/C475M. Use all purpose joint and texturing compound containing inert fillers and natural binders, including lime compound. Pre-mixed compounds shall be free of antifreeze, vinyl adhesives, preservatives, biocides and other slow releasing compounds.

Joint Tape: Glass mesh.

Joint Compound: Type recommended by the manufacturer.

2.1.5.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

2.1.5.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

2.1.5.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

2.1.5.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

2.1.5.5 Joint Tape

Use cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape recommended by the manufacturer.

2.1.6 Fasteners

2.1.6.1 Screws

ASTM C1002, Type "G", Type "S" or Type "W" steel drill screws for fastening gypsum board to gypsum board, wood framing members and steel framing members less than 0.033 inch thick. ASTM C954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick. Provide backer unit screws with a polymer coating.

2.1.6.2 Staples

No. 16 USS gageflattened galvanized wire staples with 7/16 inch wide crown outside measurement and divergent point for base ply of two-ply gypsum board application. Use as follows:

Length of Legs	Thickness of Gypsum Board
1-1/8 inches	1/2 inch
1-1/4 inches	5/8 inch

2.1.7 Adhesives

Do not use adhesive containing benzene, carbon tetrachloride, or trichloroethylene. Adhesive must meet the requirements of LEED low emitting materials credit.

2.1.7.1 Adhesive for Fastening Gypsum Board to Metal Framing

Not permitted.

2.1.7.2 Adhesive for Laminating

Not permitted.

2.1.8 Shaftwall Liner Panel

ASTM C1396/C1396M. Conform to the UL Fire Resistance for the Design Numbers(s) indicated for shaftwall liner panels. Manufacture liner panel for cavity shaftwall system, with water-resistant paper faces, bevel edges, single lengths to fit required conditions, 1" or 3/4" thick, by 24" wide.

2.1.9 GLASS FIBER REINFORCED GYPSUM COLUMN COVER

Product and Manufacturer - Basis of Design: Formglas GFRG; Formglas Products Ltd., or equal.

Fabrications: Molded, glass-fiber-reinforced gypsum units complying with ASTM C1381/C1381M.

Embedments: As standard with glass-fiber-reinforced gypsum fabrication

manufacturer and as required for reinforcement and for anchorage to substrates and framing.

Finish: Smooth for paint finish.

Profiles: As indicated.

Adhesives: As recommended in glass-fiber-reinforced gypsum fabrication manufacturer's written instructions.

Steel Drill Screws: Of sufficient length and size to securely fasten glass-fiber-reinforced gypsum fabrications to framing members.

Fire Resistance Characteristics: Flame Spread = 0; Smoke Development Index less than or equal to 25; ATM E84.

Taping and Control Joints (Where Applicable): Follow USG Gypsum Construction Handbook (latest edition) regarding taping methods and control joints.

2.1.10 Accessories

ASTM C1047. Fabricate from corrosion protected steel or plastic designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges shall be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

Shapes: Shapes shall include corner bead, casing bead, J-molding, wall molding end closures, expansion (control) joints, and other shapes required for a complete installation.

Reveal Molding: Extruded aluminum; mill finish; sizes and profiles as indicated.

Extruded Aluminum Spring Loaded Partition Closure:

Product and Manufacturer - Basis of Design: Mullion Mate; Gordon Interior Specialties Division, Gordon, Inc., Bossier City, LA

Desription: Pre-assembled, spring-loaded, extruded aluminum partition closures with acoustical batt insulation; sound tested to a 38 STC rating.

Aluminum Extrusions: 6063-T5 temper.

Finish: Clear anodized.

2.1.11 Water

Provide clean, fresh, and potable water.

2.1.12 FABRICATION OF GLASS FIBER REINFORCED GYPSUM COLUMN COVERS

Fabricate glass-fiber-reinforced gypsum units to comply with ASTM C1381/C1381M, with smooth-finished surfaces; repair hollows, voids, scratches, and other surface imperfections. Fabricate units in lengths and sizes that will minimize number of joints between abutting units.

Embedments: Incorporate embedments into units to develop the full strength of glass-fiber-reinforced gypsum fabrications. Cover embedments with not less than 3/16-inch (5-mm) thickness of glass-fiber-reinforced gypsum composite.

Connection Hardware: Designed and fabricated to support and connect glass-fiber-reinforced gypsum fabrications to hangers, support framing, and substrates.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board and tile backer units. Verify that all blocking, headers and supports are in place to support plumbing fixtures and to receive soap dishes, grab bars, towel racks, and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board and tile backer units.

3.2 APPLICATION OF GYPSUM BOARD

Apply gypsum board to framing and furring members in accordance with ASTM C840 or GA 216 and the requirements specified. Apply gypsum board with separate panels in moderate contact; do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length; select panel sizes to minimize waste. Cut out gypsum board to make neat, close, and tight joints around openings. In vertical application of gypsum board, provide panels in lengths required to reach full height of vertical surfaces in one continuous piece. Lay out panels to minimize waste; reuse cutoffs whenever feasible. Surfaces of gypsum board and substrate members may not be bonded together with an adhesive. Treat edges of cutouts for plumbing pipes, screwheads, and joints with water-resistant compound as recommended by the gypsum board manufacturer. Provide type of gypsum board for use in each system specified herein as indicated.

3.2.1 Solid Gypsum Board Partitions

Provide in accordance with ASTM C840, System V or GA 216.

3.2.2 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C840, System VIII or GA 216.

3.2.3 Arches and Bending Radii

Apply gypsum board in accordance with ASTM C840, System IX or GA 216.

3.2.4 Gypsum Board for Wall Tile or Tile Base Applied with Adhesive

In dry areas (areas other than tubs and shower enclosures), apply tile tile backingbacker board in accordance with ASTM C840, System X or GA 216.

3.2.5 Exterior Application

Apply exterior gypsum board (such as at soffits) in accordance with ASTM C840, System XI or GA 216.

3.2.6 Glass Mat Covered or Fiber Reinforced Gypsum Sheathing

Apply gypsum sheathing in accordance to gypsum association publications GA 253. Follow gypsum sheathing manufacturer's requirements of design details for joints and fasteners and be properly installed to protect the substrate from moisture intrusion. Do not leave exposed surfaces of the gypsum sheathing beyond the manufacturer's recommendation without a weather barrier cladding. Provide continuous asphalt impregnated building felt over sheathing surface in shingle fashion with edges and ends lapped a minimum of 6 inch. Property flash the openings. Seal all joints, seams, and penetrations with a compatible silicone sealant.

3.2.7 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C840, System XIII or GA 216. Fill control joints between studs in fire-rated construction with firesafing insulation to match the fire-rating of construction.

3.3 APPLICATION OF TILE BACKER UNITS

3.3.1 Application

Apply tile backer units in accordance with ANSI A108.11.

3.3.2 Joint Treatment

ANSI A108.11.

3.3.3 APPLYING TILE BACKER BOARD

Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.

3.4 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C840, GA 214 and GA 216. Finish plenum areas above ceilings to Level 1 in accordance with GA 214. Finish water resistant gypsum backing board, ASTM C1396/C1396M, to receive ceramic tile to Level 2 in accordance with GA 214. Finish walls and ceilings to receive a heavy-grade wall covering or heave textured finish before painting to Level 3 in accordance with GA 214. Finish walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings to Level 4 in accordance with GA 214. Unless otherwise specified, finish all gypsum board walls, partitions and ceilings to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Tool joints as smoothly as possible to minimize sanding and dust. Do not use fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only. Provide treatment for water-resistant gypsum board as recommended by the gypsum board manufacturer. Protect workers, building occupants, and HVAC systems from gypsum dust.

3.4.1 Uniform Surface

Wherever gypsum board is to receive eggshell, semigloss or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance to GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum board surface, after the two-coat joint and fastener treatment is complete and dry.

3.4.2 FINISHING TILE BACKER BOARD

Finish according to manufacturer's written instructions.

3.5 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board and cementitious backer units as specified in Section 07 92 00 JOINT SEALANTS Apply material with exposed surface flush with gypsum board or cementitious backer units.

3.5.1 Sealing for Exterior Gypsum Sheathing

Apply silicone sealant in a 3/8 inch bead to all joints and trowel flat. Apply enough of the same sealant to all fasteners penetrating through the glass mat gypsum board surface to completely cover the penetration when troweled flat. Do not place

3.6 FIRE-RESISTANT ASSEMBLIES

Wherever fire-rated construction is indicated, provide materials and application methods, including types and spacing of fasteners, wall and ceiling framing in accordance with the specifications contained in UL Fire Resistance for the Design Number(s) indicated. Joints of fire-rated gypsum board enclosures shall be closed and sealed in accordance with UL test requirements or GA requirements. Seal penetrations through rated partitions and ceilings tight in accordance with tested systems.

3.7 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finishes.

3.8 SHAFTWALL FRAMING

Install the shaftwall system in accordance with the system manufacturer's published instructions. Coordinate bucks, anchors, blocking and other items placed in or behind shaftwall framing with electrical and mechanical work. Patch or replace fireproofing materials which are damaged or removed during shaftwall construction.

3.9 FABRICATION OF GLASS FIBER REINFORCED GYPSUM COLUMN COVERS

Comply with manufacturer's instructions and recommendations and with ASTM C1467/C1467M.

Install glass-fiber-reinforced gypsum fabrications level, plumb, true, and aligned with adjacent materials. Use concealed shims where required for alignment.

Attach glass-fiber-reinforced gypsum fabrications to framing and substrates with steel drill screws unless otherwise indicated. Do not use pneumatic staple guns. Countersink screw heads below adjoining finished surface.

Use joint-treatment materials to finish glass-fiber-reinforced gypsum fabrications to produce surfaces ready to receive primers and paint finishes specified in Section "Painting". Provide Level 5 finish in accordance with ASTM C840.

Finish joints between units and countersunk fastener heads to comply with ASTM C840 for Level 5 and to match surface texture of units.

Repair hollows, voids, scratches, and other surface imperfections on units.

3.10 WASTE MANAGEMENT

As specified in Waste Management Plan.

Institute demolition and construction recycling to take advantage of manufacturer's programs. When such a service is not available, seek local recyclers to reclaim the materials.

-- End of Section --

SECTION 09 30 00

CERAMIC TILE, QUARRY TILE, AND PAVER TILE
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1027	(2009) Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile
ASTM C1028	(2007; E 2010) Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method
ASTM C144	(2011) Standard Specification for Aggregate for Masonry Mortar
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C1378	(2009) Standard Test Method for Determination of Resistance to Staining
ASTM C206	(2003; R 2009) Standard Specification for Finishing Hydrated Lime
ASTM C207	(2006; R 2011) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C241/C241M	(2013) Standard Specification for Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C33/C33M	(2013) Standard Specification for Concrete Aggregates
ASTM C373	(1988; R 2006) Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products
ASTM C650	Standard test method for resistance of Ceramic Tile to Chemical Substances
ASTM C847	(2012) Standard Specification for Metal Lath

MARBLE INSTITUTE OF AMERICA (MIA)

MIA Design Manual	(2003) Dimension Stone Design Manual

TILE COUNCIL OF NORTH AMERICA (TCNA)

TCA Hdbk	(2010) Handbook for Ceramic Tile Installation

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED GBDC	(2009) LEED Reference Guide for Green Building Design and Construction

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SYSTEM DESCRIPTION

1.3.1 General Requirements

For materials like Tile, Accessories, and Marble Thresholds submit samples of specified size, unless explained, to show color range, pattern, type and joints.

1.3.2 Sustainable Design Requiremens

See Section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements. Under product data and closeout submittals, furnish documentation relative to each material credit in accordance with LEED GBDC. Include in LEED Documentation Notebook.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Tile (LEED NC); G
Setting-Bed
Mortar, Grout, and Adhesive
Specialty Metal Trim
Adhesives

SD-04 Samples

Tile; G

Stone Thresholds
Grout

SD-07 Certificates

Tile
Mortar, Grout, and Adhesive

SD-11 Closeout Submittals

Local/Regional Materials
Recycled Content
Low Emitting Materials - Adhesives and Sealants

1.5 QUALITY ASSURANCE

Dimension and draw detail drawings at a minimum scale of 1/4 inch = 1 foot. Include drawings of pattern at inside corners, outside corners, termination points and location of all equipment items such as thermostats, switch plates, mirrors and toilet accessories mounted on surface. Submit drawings showing ceramic tile pattern elevations and floor plans. When ordering material, order in per-floor quantities to avoid different dye lots.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact. Protect materials from weather, and store them under cover in accordance with manufacturer's printed instructions.

1.7 ENVIRONMENTAL REQUIREMENTS

Do not perform ceramic tile work unless the substrate and ambient temperature is at least 50 degrees F and rising. Maintain temperature above 50 degrees F while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used, ventilate the area to the outside to avoid carbon dioxide damage to new tilework.

1.8 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period.

1.9 EXTRA MATERIALS

Supply an extra two percent of each type tile used in clean and marked cartons.

PART 2 PRODUCTS

2.1 TILE

Conform to TCA Hdbk for standard grade tile. Provide grade sealed containers. Mark seals with the marks on the signed master grade certificate. See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Tile may contain post-consumer or post-industrial recycled content. Submit manufacturer's catalog data and

preprinted installation and cleaning instructions plus a master grade certificate for tile.

2.1.1 Porcelain Tile

Porcelain Tile TP-01A, TP-01B, TP-04, TP-05, TP-06:

Water Absorption: Less than or equal to 0.05%; ASTM C373
Abrasion Resistance: Class IV; ASTM C1027
C.O.F. (Wet): Less than or equal to 0.60 COF less than 0.70; ASTM C1028
C.O.F. (Dry): Less than or equal to 0.70 COF less than 0.80; ASTM C1028
Chemical Resistance: Class B; ASTM C650
Stain Resistance: Class A; ASTM C1378

Porcelain Tile TP-02:

Water Absorption: Less than or equal to 0.05%; ASTM C373
Surface Abrasion: IV/STOREM III; ASTM C1027
Chemical Resistance: Class A; ASTM C650
C.O.F. (Wet): Greater than or equal to 0.55; ASTM C1028
C.O.F. (Dry): Greater than or equal to 0.90; ASTM C1028
Stain Resistance: Class A; ASTM C1378
Recycled Content: Minimum 10%

Porcelain Tile TP-03A and TP-03B:

Water Absorption: Less than or equal to 0.05%; ASTM C373
Chemical Resistance: Class A; ASTM C650
Stain Resistance: Class A; ASTM C1378

2.1.2 Quarry Tile

Quarry Tile TQ-01A, TQ-01B, TQ-01C:

Suretread Dynamic C.O.F. (Wet): Greater than or equal to 0.42; ASTM C1028
Suretread C.O.F. (Wet): Greater than or equal to 0.6; ASTM C1028
Suretread C.O.F. (Dry): Greater than or equal to 0.6; ASTM C1028
Paver Dynamic C.O.F.(Wet): Greater than or equal to 0.42; ASTM C1028 0.6;
Paver C.O.F. (Wet): Greater than or equal to 0.6; ASTM C1028
Paver C.O.F. (Dry): Greater than or equal to 0.6; ASTM C1028
Suretread Moisture Absorption: Less than 3.0%
Paver Moisture Absorption: Less than 3.0%

2.2 SETTING-BED

Compose the setting-bed of the following materials:

2.2.1 Aggregate for Concrete Fill

Conform to ASTM C33/C33M for aggregate fill. Do not exceed one-half the thickness of concrete fill for maximum size of coarse aggregate.

2.2.2 Portland Cement

Conform to ASTM C150/C150M for cement, Type I, white for wall mortar and gray for other uses.

2.2.3 Sand

Conform to ASTM C144 for sand.

2.2.4 Hydrated Lime

Conform to ASTM C206 for hydrated lime, Type S or ASTM C207, Type S.

2.2.5 Metal Lath

Conform to ASTM C847 for flat expanded type metal lath, and weighing a minimum 2.5 pound/square yard.

2.3 WATER

Provide potable water.

2.4 MORTAR, GROUT, AND ADHESIVE

Submit certificates indicating conformance with specified requirements. Submit LEED documentation relative to low-emitting materials credit in accordance with LEED GBDC. Include in LEED Documentation Notebook. Interior adhesives, sealants, primers and sealants used as filler must meet the requirements of LEED low emitting materials credit. Conform to the following for mortar, grout, adhesive, and sealant:

2.4.1 Dry-Set Portland Cement Mortar

TCA Hdbk.

2.4.2 Conductive Dry-Set Mortar

TCA Hdbk.

2.4.3 Latex-Portland Cement Mortar

TCA Hdbk.

2.4.4 Ceramic Tile Grout

TCA Hdbk; petroleum-free and plastic-free latex-portland cement grout.

2.4.5 Organic Adhesive

TCA Hdbk, Type I. Water-resistant. Comply with applicable regulations regarding toxic and hazardous materials and as specified.

2.4.6 Epoxy Resin Grout

TCA Hdbk.

2.4.7 Furan Resin Grout

TCA Hdbk and consist of an intimate mixture of furfuryl-alcohol resin with carbon filler and catalyst.

2.4.8 Sealants

Comply with applicable regulations regarding toxic and hazardous materials

and as specified.

2.5 STONE THRESHOLDS

Provide marble thresholds of size required by drawings or conditions. Categorize marble Group A as classified by MIA Design Manual. Provide a fine sand-rubbed finish marble with gray in color as approved by the Contracting Officer as well as the architect. Provide minimum 12.0 marble abrasion when tested in accordance with ASTM C241/C241M.

2.6 SPECIALTY METAL TRIM

Description: Zinc and stainless steel; refer to the Finish Legend for locations. Height as required to match adjacent materials indicated. Profiles: As indicated.

2.7 WATERPROOFING AND CRACK ISOLATION MEMBRANES

Ceramic Tile: 40 mil load bearing flexible fabric reinforced peel and stick, crack isolation membrane and primer.

Products and Manufacturers:
MAPEI Mapeguard SM
ProSpec Flex-Guard
Custom Building Products Crack Buster
Merkrete Fracture Guard 5000
Laticrete Blue 92 Anti-fracture Membrane
Bostik Goldplus Waterproofing and Crack Isolation Membrane
HBA Standard crack isolation membrane products
Or equal.

PART 3 EXECUTION

3.1 PREPARATORY WORK AND WORKMANSHIP

Inspect surface to receive tile in conformance to the requirements of TCA Hdbk for surface conditions for the type setting bed specified and for workmanship. Provide variations of tiled surfaces that fall within maximum values shown below:

TYPE	WALLS	FLOORS
Dry-Set Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Organic Adhesives	1/8 inch in 8 ft.	1/16 inch in 3 ft.
Latex Portland Cement Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Epoxy	1/8 inch in 8 ft.	1/8 inch in 10 ft.

3.2 GENERAL INSTALLATION REQUIREMENTS

Do not start tile work until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing have been installed and tested. Do not start floor tile installation in spaces requiring wall tile until after wall tile has been installed. Apply tile in colors and patterns indicated in the area shown

on the drawings. Install tile with the respective surfaces in true even planes to the elevations and grades shown. Provide special shapes as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Solidly back tile bases and coves with mortar.

3.3 INSTALLATION OF WALL TILE

Install wall tile in accordance with the TCA Hdbk as follows:

Masonry or Concrete Substrates: TCA W202 using Latex Portland Cement Mortar and Epoxy Grout.

Metal Studs or Furring Substrates: TCA W243 using Latex Portland Cement Mortar and Epoxy Grout.

3.3.1 Dry-Set Mortar and Latex-Portland Cement Mortar

Use Latex-Portland Cement to install tile in accordance with TCA Hdbk. Use Latex Portland Cement when installing porcelain ceramic tile.

3.4 INSTALLATION OF FLOOR AND BASE TILE

Install floor tile in accordance with TCA Hdbk as follows:

Tile Installation Method: TCA F122 using Latex Portland Cement Mortar and Epoxy Grout.

3.4.1 Latex-Portland Cement

Use Latex-Portland cement mortar to install tile directly over properly cured, plane, clean concrete slabs in accordance with TCA Hdbk. Use Latex Portland cement when installing porcelain ceramic tile.

3.4.2 Resinous Grout

When resinous grout is indicated, grout tile with epoxy resin grout. Rake and clean joints to the full depth of the tile and neutralize when recommended by the resin manufacturer. Install epoxy resin grout in conformance with TCA Hdbk. Install resin grout in accordance with manufacturer's printed installation instructions. Provide a coating of wax applied from the manufacturer on all tile installed and furan resin. Follow manufacturer's printed installation instructions of installed resin grout for proportioning, mixing, installing, and curing. Maintain the recommended temperature in the area and on the surface to be grouted. Protect finished grout of grout stain.

3.4.3 Ceramic Tile Grout

Prepare and install ceramic tile grout in accordance with TCA Hdbk.

3.4.4 Waterproofing and Crack Isolation Membrane

Install materials to comply with manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

Do not install tile or setting materials until membrane has cured and been tested to determine that it is fully cured and watertight.

Provide waterproofing and crack isolation membrane at all floor tile locations.

3.5 EXPANSION AND CONTRACTION JOINTS

Provide tile expansion/contraction joints at a maximum of 20 to 25 feet on center in the floor and at intersection of floor tile with wall tile in accordance with requirements of Tile Council of North America for the "Movement Joint Design Essentials" EJ171-07. Joints to align with grout joints.

Joints shall be clean and dry.

Movement Joints:

Provide 1/4" wide pre-manufactured movement joints at tile expansion and contraction joints.
Movement joints shall have perforated stainless steel flanges for embedment in the tile adhesive.
The depth of the profile is to suit the depth of the tiles and cannot be greater than the total depth of the tile and the adhesive.

3.5.1 Walls

Provide expansion joints at control joints in backing material. Wherever backing material changes, install an expansion joint to separate the different materials.

3.5.2 Floors

Provide expansion joints over construction joints, control joints, and expansion joints in concrete slabs. Provide expansion joints where tile abuts restraining surfaces such as perimeter walls, curbs and columns and at intervals of 24 to 36 feet each way in large interior floor areas and 12 to 16 feet each way in large exterior areas or areas exposed to direct sunlight or moisture. Extend expansion joints through setting-beds and fill.

3.6 CLEANING AND PROTECTING

Upon completion, thoroughly clean tile surfaces in accordance with manufacturer's approved cleaning instructions. Do not use acid for cleaning glazed tile. Clean floor tile with resinous grout or with factory mixed grout in accordance with printed instructions of the grout manufacturer. After the grout has set, provide a protective coat of a noncorrosive soap or other approved method of protection for tile wall surfaces. Cover tiled floor areas with building paper before foot traffic is permitted over the finished tile floors. Provide board walkways on tiled floors that are to be continuously used as passageways by workmen. Replace damaged or defective tiles.

3.7 WASTE MANAGEMENT

Separate waste, including metal and cardboard, in accordance with the Waste Management Plan and recycle or reuse. Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in designated containers and areas. Close and seal tightly partly used sealant and adhesive containers and store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials

defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in designated containers and areas and dispose of properly.

Collect information from manufacturer about take-back program options, and provide to Contracting Officer. Manage waste as specified in Waste Management Plan. All other waste place materials defined as hazardous or toxic waste in designated containers and dispose of properly. Close and seal tightly partly used sealant and adhesive containers and store protected in a well ventilated fire-safe area at moderate temperature.

-- End of Section --

SECTION 09 51 00

ACOUSTICAL CEILINGS
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2012a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A641/A641M	(2009a) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B633	(2011) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C423	(2009a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C635/C635M	(2013) Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM C834	(2010) Latex Sealants
ASTM E1264	(2008; E 2010) Acoustical Ceiling Products
ASTM E1477	(1998a; R 2013) Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

UNDERWRITERS LABORATORIES (UL)

UL Fire Resistance (2012) Fire Resistance Directory

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SYSTEM DESCRIPTION

Provide sound controlling units mounted on a ceiling suspension system for acoustical treatment. The unit size, texture, finish, and color must be as specified. The location and extent of acoustical treatment shall be as shown on the approved detail drawings. Submit drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan. Coordinate with paragraph RECLAMATION PROCEDURES for reclamation of mineral fiber acoustical ceiling panels to be removed from the job site.

1.3.1 Ceiling Sound Absorption

Determine the Noise Reduction Coefficient (NRC) in accordance with ASTM C423 Test Method.

1.3.2 Light Reflectance

Determine light reflectance factor in accordance with ASTM E1477 Test Method.

1.3.3 Other Submittals Requirements

The following shall be submitted:

a. Total weight and volume quantities of acoustic ceiling panels with recycle material.

b. Reports by an independent testing laboratory attesting that acoustical ceiling systems meet specified sound transmission requirements. Data attesting to conformance of the proposed system to Underwriters Laboratories requirements for the fire endurance rating listed in UL Fire Resistance may be submitted in lieu of test reports.

c. Certificate attesting that the mineral based acoustical units furnished for the project contain recycled material and showing an estimated percent of such material.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings

SD-03 Product Data

Suspended Acoustical Panel Ceiling System; (LEED NC); G
Suspended Acoustical Metal Pan Ceiling System; (LEED NC); G

SD-04 Samples

Acoustic Ceiling Panels

SD-07 Certificates

Acoustic Ceiling Panels

SD-11 Closeout Submittals

Recycled Content
Local/Regional Materials

1.5 DELIVERY, STORAGE. AND HANDLING

Deliver materials to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Carefully handle and store materials in dry, watertight enclosures. Immediately before installation, store acoustical units for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

1.6 ENVIRONMENTAL REQUIREMENTS

Maintain a uniform temperature of not less than 60 degrees F nor more than 85 degrees F and a relative humidity of not more than 70 percent for 24 hours before, during, and 24 hours after installation of acoustical units.

1.7 SCHEDULING

Complete and dry interior finish work such as plastering, concrete and terrazzo work before ceiling installation. Complete mechanical, electrical, and other work above the ceiling line; install and start operating heating, ventilating, and air conditioning systems in order to maintain temperature and humidity requirements.

1.8 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period. Include an agreement to repair or replace acoustical panels that fail within the warranty period in the standard performance guarantee or warranty. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of grid system.

1.9 EXTRA MATERIALS

Furnish spare tiles, from the same lot as those installed, of each color at the rate of 5 tiles for each 1000 tiles installed.

PART 2 PRODUCTS

2.1 SUSPENDED ACOUSTICAL PANEL CEILING SYSTEM

Submit two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color. Conform acoustical units to ASTM E1264, Class A, and the following requirements:

2.1.1 Acoustic Ceiling Panels for Suspended Acoustical Panel Ceiling System

Suspended Acoustical Panel Ceiling System AP-01:

Flame Spread: Class A, 25 or less; ASTM E84
Classification: Type XII, Form 2, Pattern E, Fire Class A; ASTM E1264
NRC: 0.95
Light Reflectance: 0.90
Recycled Content: More than 50% total recycled content.

Suspension Systems: Refer to the Finish Legend.

Suspended Acoustical Panel Ceiling System AP-02:

Flame Spread: Class A, 25 or less; ASTM E84
Classification: Type XII, Form 2, Pattern E, Fire Class A; ASTM E1264
NRC: 0.95
Light Reflectance: 0.90
Recycled Content: More than 50% total recycled content.
Suspension Systems: Refer to the Finish Legend.

Suspended Acoustical Panel Ceiling System AP-03:

Flame Spread: Class A, 25 or less; ASTM E84
Classification: Type IV, Form 2, Pattern E, Fire Class A; ASTM E1264
CAC: 40
Light Reflectance: 0.80
Recycled Content: More than 50% total recycled content.

Suspension Systems: Refer to the Finish Legend.

Suspended Acoustical Panel Ceiling System AP-04:

Material: Aspen wood fibers bonded with inorganic hydraulic cement.
Flame Spread: Class A, 25 or less; ASTM E84
Classification: Type XIV, Pattern L, Fire Class A; ASTM E1264
Suspension Systems: Refer to the Finish Legend.

2.2 SUSPENDED ACOUSTICAL METAL PAN CEILING SYSTEM

Suspended Acoustical Metal Pan Ceiling System MA-01:

Material: Electrogalvanized steel; 0.021 inches thick.
Surface Finish: Powder coated.
Fire Performance: Flame Index 25 or less, Smoke Development Index 50 or less; ASTM E84
ASTM E1264 Classification: Fire Class A; Perforated - Type XX, Pattern C.

Suspension Systems: Refer to the Finish Legend.

Suspended Acoustical Metal Pan Ceiling System MA-02:

Material: Aluminum; 0.040 inches thick.
Surface Finish: As indicated on the Finish Legend.
Fire Performance: Flame Index 25 or less, Smoke Development Index 50 or less; ASTM E84

Suspension Systems: Refer to the Finish Legend.

2.3 SUSPENSION SYSTEM FOR SUSPENDED ACOUSTICAL PANEL CEILING SYSTEMS

Provide standard exposed-grid suspension system, unless otherwise noted on the Finish Legend, conforming to ASTM C635/C635M for intermediate-duty systems. Provide surfaces exposed to view of aluminum or steel with a factory-applied color baked-enamel finish. Provide a suspension system with a maximum deflection of 1/360 of the span length.

Torsion Spring Suspension System:

Product and Manufacturer: XL7390TS; Armstrong, or equal.

Face Profile: 15/16"
Color: Refer to the Finish Legend.

2.4 HANGERS

Provide hangers and attachment capable of supporting a minimum 300 pound ultimate vertical load without failure of supporting material or attachment.

2.4.1 Wires

Conform wires to ASTM A641/A641M, Class 1 zinc coating, soft temper.

Size: Select wire diameter so its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- (3.5-mm) diameter wire.

2.4.2 Straps

Provide straps of 1 by 3/16 inch galvanized steel conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

2.4.3 Rods

Provide 3/16 inch diameter threaded steel rods, zinc or cadmium coated.

2.5 TRIM

Specialty Edge Trim: Extruded aluminum; profiles as indicated; finish to match adjacent grid system.

2.6 FINISHES

Use manufacturer's standard textures, patterns and finishes as specified for acoustical units and suspension system members. Treat ceiling suspension system components to inhibit corrosion.

2.7 ACOUSTICAL SEALANT

Conform acoustical sealant to ASTM C834, nonstaining.

PART 3 EXECUTION

3.1 INSTALLATION

Examine surfaces to receive directly attached acoustical units for unevenness, irregularities, and dampness that would affect quality and execution of the work. Rid areas, where acoustical units will be cemented, of oils, form residue, or other materials that reduce bonding capabilities of the adhesive. Complete and dry interior finish work such as plastering, concrete, and terrazzo work before installation. Complete and approve mechanical, electrical, and other work above the ceiling line prior to the start of acoustical ceiling installation. Provide acoustical work complete with necessary fastenings, clips, and other accessories required for a complete installation. Do not expose mechanical fastenings in the finished work. Lay out hangers for each individual room or space. Provide hangers to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Keep main runners and carrying channels clear of abutting walls and partitions. Provide at least two main runners for each ceiling span. Wherever required to bypass an object with the hanger wires, install a subsuspension system so that all hanger wires will be plumb.

3.1.1 Suspension System

Install suspension system in accordance with ASTM C636/C636M and as specified herein. Do not suspend hanger wires or other loads from underside of steel decking.

3.1.1.1 Plumb Hangers

Install hangers plumb and not pressing against insulation covering ducts and pipes. Where lighting fixtures are supported from the suspended ceiling system, provide hangers at a minimum of four hangers per fixture and located not more than 6 inch from each corner of each fixture.

3.1.1.2 Splayed Hangers

Where hangers must be splayed (sloped or slanted) around obstructions, offset the resulting horizontal force by bracing, countersplaying, or other acceptable means.

3.1.2 Wall Molding

Provide wall molding where ceilings abut vertical surfaces. Miter corners where wall moldings intersect or install corner caps. Secure wall molding not more than 3 inch from ends of each length and not more than 16 inch on centers between end fastenings. Provide wall molding springs at each acoustical unit in semi-exposed or concealed systems.

3.1.3 Acoustical Units

Install acoustical units in accordance with the approved installation instructions of the manufacturer. Ensure that edges of acoustical units are in close contact with metal supports, with each other, and in true alignment. Arrange acoustical units so that units less than one-half

width are minimized. Hold units in exposed-grid system in place with manufacturer's standard hold-down clips, if units weigh less than 1 psf or if required for fire resistance rating.

3.1.4 Caulking

Seal all joints around pipes, ducts or electrical outlets penetrating the ceiling. Apply a continuous ribbon of acoustical sealant on vertical web of wall or edge moldings.

3.1.5 Adhesive Application

Wipe back of tile to remove accumulated dust. Daub acoustical units on back side with four equal daubs of adhesive. Apply daubs near corners of tiles. Ensure that contact area of each daub is at least 2 inch diameter in final position. Press units into place, aligning joints and abutting units tight and uniform without differences in joint widths.

3.2 CEILING ACCESS PANELS

Locate ceiling access panels directly under the items which require access.

3.3 CLEANING

Following installation, clean dirty or discolored surfaces of acoustical units and leave them free from defects. Remove units that are damaged or improperly installed and provide new units as directed.

3.4 RECLAMATION PROCEDURES

Neatly stack ceiling tile, designated for recycling by the Contracting Officer, on 4 by 4 foot pallets not higher than 4 foot. Panels must be completely dry. Shrink wrap and symmetrically stack pallets on top of each other without falling over.

-- End of Section --

SECTION 09 65 00

RESILIENT FLOORING AND BASE
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4078	(2002; R 2008) Water Emulsion Floor Polish
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E648	(2010; E 2011) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F1066	(2004; E 2010; R 2010) Standard Specification for Vinyl Composition Floor Tile
ASTM F1482	(2004; E 2009; R 2009) Installation and Preparation of Panel Type Underlayments to Receive Resilient Flooring
ASTM F1869	(2011) Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F2170	(2011) Determining Relative Humidity in Concrete Floor Slabs in situ Probes
ASTM F2982	Standard Specification for Polyester Composition Floor Tile
ASTM F386	Standard Test Method for Thickness of Resilient Flooring Materials Having Flat Surfaces
ASTM F710	(2011) Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
ASTM F925	Standard Test Method for Resistance to Chemicals of Resilient Flooring

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED GBDC	(2009) LEED Reference Guide for Green

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SYSTEM DESCRIPTION

1.3.1 Local/Regional Materials

See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local/recycled material requirements. Flooring materials may be locally available. Flooring and accessories may contain post-consumer or post-industrial recycled content.

1.3.2 Fire Resistance Requirements

Provide a minimum average critical radiant flux of 0.45 watts per square centimeter for flooring in corridors and exits when tested in accordance with ASTM E648.

1.3.3 Other Submittal Requirements

The following shall be submitted in accordance with LEED NC:

a. documentation relative to local/regional materials credit in accordance with LEED GBDC. Include in LEED Documentation Notebook.

b. documentation relative to recycled content credit in accordance with LEED GBDC. Include in LEED Documentation Notebook.

c. documentation relative to low-emitting materials credit in accordance with LEED GBDC. Include in LEED Documentation Notebook.

d. documentation relative to rapidly renewable materials credit in accordance with LEED GBDC. Include in LEED Documentation Notebook.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Resilient Flooring and Accessories; G

SD-03 Product Data

Resilient Flooring and Accessories; (LEED NC); G
Adhesives; (LEED NC)
Vinyl Composition Tile
Wall Base

SD-04 Samples

Resilient Flooring and Accessories; G

SD-06 Test Reports

Moisture, Alkalinity and Bond Tests

SD-08 Manufacturer's Instructions

Surface Preparation
Installation

SD-10 Operation and Maintenance Data

Resilient Flooring and Accessories

SD-11 Closeout Submittals

Local/Regional Materials
Resilient Flooring and Accessories
Adhesives
Sheet Linoleum
Linoleum Tile
Cork
Recycled Content
Low Emitting Materials - Adhesives and Sealants

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in original unopened containers bearing the manufacturer's name, style name, pattern color name and number, production run, project identification, and handling instructions. Store materials in a clean, dry, secure, and well-ventilated area with ambient air temperature maintained above 68 degrees F and below 85 degrees F, stacked according to manufacturer's recommendations. Protect materials from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances. Observe ventilation and safety procedures specified in the MSDS. Do not store near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.6 ENVIRONMENTAL REQUIREMENTS

Maintain areas to receive resilient flooring at a temperature above 68 degrees F and below 85 degrees F for 3 days before application, during application and 2 days after application, unless otherwise directed by the flooring manufacturer for the flooring being installed. Maintain a minimum temperature of 55 degrees F thereafter. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

1.7 SCHEDULING

Schedule resilient flooring application after the completion of other work which would damage the finished surface of the flooring.

1.8 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that

extend beyond a one year period.

1.9 EXTRA MATERIALS

Provide extra flooring material of each color and pattern at the rate of 5 tiles for each 1000 tiles installed. Provide extra wall base material composed of 20 linear feet of each type, color and pattern. Package all extra materials in original properly marked containers bearing the manufacturer's name, brand name, pattern color name and number, production run, and handling instructions. Provide extra materials from the same lot as those installed. Leave extra stock at the site in location assigned by Contracting Officer.

PART 2 PRODUCTS

2.1 VINYL COMPOSITION TILE

Vinyl Composition Tile VT-01 and VT-02

Construction: BioBased Tile
Product Specification: Comply with ASTM F2982.
Overall Thickness: 1/8-inch nominal +/- 0.005 inches; ASTM F386
Wear Layer Thickness: 1/8-inch
Flame Spread: 0.45 watt/cm2 or more Class 1; ASTM E648
Smoke Evolution: 450 or less; ASTM E662
Recycled Content: Meets Guidelines; LEED MR4.0
Certified Low Emitting Product: Meets Guidelines; LEED EQ4.3

Vinyl Composition Tile VT-03, VT-04, VT-05, VT-06, VT-07, VT-08, VT-09, VT-10:

Construction: Vinyl Composition Tile
Product Specification: Comply with ASTM F1066Class 2 - Through Pattern,Type II.
Overall Thickness: 1/8-inch
Wear Layer Thickness: 1/8-inch
Flame Spread: 0.45 watt/cm2 or more Class 1; ASTM E648
Smoke Evolution: 450 or less; ASTM E662
Recycled Content: Meets Guidelines; LEED MR4.0
Certified Low Emitting Product: Meets Guidelines; LEED EQ4.3

2.2 WALL BASE

Rubber Straight Base RB-01 and Rubber Cover Base RC-01:

Flame/Smoke: Class B; ASTM E84
Critical Radiant Flux: Class 1; ASTM E648
Chemical Resistance: Passes; ASTM F925
Resistance to Heat/Light Aging, Chemicals, and Dimensional Stability: Meets or exceeds; ATM F1861

2.3 MOULDING

Provide tapered mouldings of vinyl or rubber and types as recommended by flooring manufacturer for both edges and transitions of flooring materials specified. Provide vertical lip on moulding of maximum 1/4 inch. Provide bevel change in level between 1/4 and 1/2 inch with a slope no greater than 1:2.

2.4 ADHESIVES

Provide adhesives for flooring, base and accessories as recommended by the manufacturer and comply with local indoor air quality standards. Interior adhesives shall meet the requirements of LEED low emitting materials credit. Submit manufacturer's descriptive data, documentation stating physical characteristics, and mildew and germicidal characteristics. Provide Material Safety Data Sheets (MSDS) for all primers and adhesives to the Contracting Officer. Highlight VOC emissions.

2.5 SURFACE PREPARATION MATERIALS

Provide surface preparation materials, such as panel type underlayment, lining felt, and floor crack fillers as recommended by the flooring manufacturer for the subfloor conditions. Comply with ASTM F1482 for panel type underlayment products.

2.6 POLISH/FINISH

Provide polish finish as recommended by the manufacturer and conform to ASTM D4078 for polish. The contractor is responsible for the initial floor waxing.

2.7 CAULKING AND SEALANTS

Provide caulking and sealants in accordance with Section 07 92 00 JOINT SEALANTS.

2.8 MANUFACTURER'S COLOR, PATTERN AND TEXTURE

Provide color, pattern and texture for resilient flooring and accessories as indicated on the drawings. Provide floor patterns as indicated on the drawings. Provide flooring in any one continuous area or replacement of damaged flooring in continuous area from same production run with same shade and pattern. Submit scaled drawings indicating patterns (including location of patterns and colors) and dimensions. Submit manufacturer's descriptive data and three samples of each indicated color and type of flooring, base, mouldings, and accessories sized a minimum 2-1/2 by 4 inch. Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Order all materials per floor in order to avoid different dye lots.

PART 3 EXECUTION

3.1 EXAMINATION

Examine and verify that site conditions are in agreement with the design package. Report all conditions that will prevent a proper installation. Do not take any corrective action without written permission from the Government. Work will proceed only when conditions have been corrected and accepted by the installer. Submit manufacturer's printed installation instructions for all flooring materials and accessories, including preparation of substrate, seaming techniques, and recommended adhesives.

3.2 SURFACE PREPARATION

Provide a smooth, true, level plane for surface preparation of the flooring, except where indicated as sloped. Floor to be flat to within 3/16 inch in 10 feet. Prepare subfloor in accordance with flooring

manufacturer's recommended instructions. Prepare the surfaces of lightweight concrete slabs (as defined by the flooring manufacturer) as recommended by the flooring manufacturer. Comply with ASTM F710 for concrete subfloor preparation. Floor fills or toppings may be required as recommended by the flooring manufacturer. Install underlayments, when required by the flooring manufacturer, in accordance with manufacturer's recommended printed installation instructions. Comply with ASTM F1482 for panel type underlayments. Before any work under this section is begun, correct all defects such as rough or scaling concrete, chalk and dust, cracks, low spots, high spots, and uneven surfaces. Repair all damaged portions of concrete slabs as recommended by the flooring manufacturer. Remove concrete curing and sealer compounds from the slabs, other than the type that does not adversely affect adhesion. Remove paint, varnish, oils, release agents, sealers, waxes, and adhesives, as required by the flooring product in accordance with manufacturer's printed installation instructions.

3.3 MOISTURE, ALKALINITY AND BOND TESTS

Determine the suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content and pH level by moisture and alkalinity tests. Conduct moisture testing in accordance with ASTM F1869 or ASTM F2170, unless otherwise recommended by the flooring manufacturer. Conduct alkalinity testing as recommended by the flooring manufacturer. Determine the compatibility of the resilient flooring adhesives to the concrete floors by a bond test in accordance with the flooring manufacturer's recommendations. Submit copy of test reports for moisture and alkalinity content of concrete slab, and bond test stating date of test, person conducting the test, and the area tested.

3.4 PLACING VINYL COMPOSITION TILES

Install tile flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's directions. Keep tile lines and joints square, symmetrical, tight, and even. Keep each floor in true, level plane, except where slope is indicated. Vary edge width as necessary to maintain full-size tiles in the field, no edge tile to be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe edge tile to walls and partitions after field flooring has been applied.

3.5 PLACING MOULDING

Provide moulding where flooring termination is higher than the adjacent finished flooring and at transitions between different flooring materials. When required, locate moulding under door centerline. Moulding is not required at doorways where thresholds are provided. Secure moulding with adhesive as recommended by the manufacturer. Prepare and apply adhesives in accordance with manufacturer's printed directions.

3.6 PLACING WALL BASE

Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Tighten base joints and make even with adjacent resilient flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand

roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

3.7 CLEANING

Immediately upon completion of installation of flooring in a room or an area, dry/clean the flooring and adjacent surfaces to remove all surplus adhesive. Clean flooring as recommended in accordance with manufacturer's printed maintenance instructions. No sooner than 5 days after installation, wash flooring with a nonalkaline cleaning solution, rinse thoroughly with clear cold water, and, except for rubber flooring and stair treads, risers and stringers, vinyl and other flooring not requiring polish finish by manufacturer, apply the number of coats of polish in accordance with manufacturer's written instructions. Clean and maintain all other flooring as recommended by the manufacturer.

3.8 WASTE MANAGEMENT

Separate offcuts and waste materials and reuse or recycle in accordance with the Waste Management Plan, keeping sheet materials larger than 2 square feet and tiles larger than 1/2 tiles separate for reuse. Identify manufacturer's policy for collection or return of construction scrap, unused material, demolition scrap, and/or packaging material. Place materials defined as hazardous or toxic waste in designated containers and dispose of properly. Close and seal tightly partly used sealant and adhesive containers and store protected in a well ventilated fire-safe area at moderate temperature.

3.9 PROTECTION

From the time of installation until acceptance, protect flooring from damage as recommended by the flooring manufacturer. Remove and replace flooring which becomes damaged, loose, broken, or curled and wall base which is not tight to wall or securely adhered.

-- End of Section --

SECTION 09 66 23

RESINOUS TERRAZZO FLOORING
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D635	(2010) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D648	(2007) Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
ASTM D695	(2010) Standard Test Method for Compressive Properties of Rigid Plastics
ASTM F1869	(2011) Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F2170	(2011) Determining Relative Humidity in Concrete Floor Slabs in situ Probes

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See Section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements. Under product data and closeout submittals, furnish documentation relative to each material credit in accordance with LEED GBDC.

1.3 SYSTEM DESCRIPTION

Apply resinous terrazzo flooring, in the colors indicated, in the areas shown on the approved detail drawings. Submit two 6 x 6 inches, (minimum) samples of each color of resinous terrazzo and two 6 inches lengths, of each type of strip. Flooring shall be an epoxy terrazzo system that conforms to the requirements specified in paragraphs 2.01A and B of NTMA Info Guide.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office

that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G
Divider Strips
Control Joint Strips

SD-03 Product Data

2 copies of NTMA Info Guide
Epoxy resin system; (LEED NC)
Mixing, Proportioning, and Installation
Cleaning and Sealing; (LEED NC)
Joint Treatment Materials
Crack Isolation Membrane
Moisture Barrier
Sealant; (LEED NC)
Manufacturer's maintenance recommendations
Primer; (LEED NC)

SD-04 Samples

Resinous Terrazzo Flooring; G

SD-11 Closeout Submittals

Low Emitting Materials - Adhesives and Sealants
Low Emitting Materials - Paints and Coatings

1.5 QUALITY ASSURANCE

1.5.1 Applicator

Applicator shall be approved by the resin manufacturer and shall have a minimum of 3 years experience in the application of the materials to be used and shall have completed 8 successful installations within the past 2 years.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in manufacturer's original unopened containers. Keep materials in a clean, dry, area with temperatures controlled between 50 and 90 degrees F.

1.7 ENVIRONMENTAL REQUIREMENTS

Areas to receive terrazzo shall be maintained at a temperature above 50 degrees F for 2 days prior to installation and for 7 days following installation. Follow all manufacturer's specific instructions and prudent safety practices for storage and handling.

PART 2 PRODUCTS

2.1 RESINOUS TERRAZZO FLOORINGZR-01, ZR-02, ZR-03, and ZR-04

Product and Manufacturer: Key Epoxy Terrazzo #108; Key Resin Company, or approved equal.

Description: 100% solids, two-component epoxy resin system containing decorative aggregates.
Nominal Thickness: 3/8 inch
Matrix Color and Pattern: Refer to the Finish Legend.
Compressive Strength: 10,000 psi minimum; ASTM D695
Flammability: Self-extinguishing; ASTM D635
Critical Radiant Flux: 1.0; ASTM D648
Water Absorption: 0.010% or less; ASTM D570

Conductive Terrazzo: Provide Key Conductive Epoxy, or equal product, as a base coat under areas indicated to receive conductive terrazzo.

2.2 PRIMER

Primer shall be a material recommended by the resin manufacturer which will penetrate the pores of the substrate and bond with the topping to form a permanent monolithic bond between the substrate and the topping.

2.3 JOINT TREATMENT MATERIALS

Exposed Contraction Joint Filler: Key#780 Epoxy Joint Filler, or equal..

Isolation Joints: Fill with urethane sealant formulated for use in floor expansion joints matching the Epoxy Matrix.

2.4 DIVIDER STRIPS

Submit drawings indicating the type, size, and layout of divider strips and control joint strips.

2.4.1 Divider Strips

Divider strips shall be zinc; height and gauge as indicated.

2.4.2 Control Joint Strips

Control joint strips shall be zinc and as deep as required. Saw cutting control joints must be done between 12 and 24 hours after placement of the structural concrete

2.5 MOISTURE BARRIER

Product and Manufacturer - Basis of Design: Key 635 MVT or Key Epocon SL as recommended by the manufacture for installation indicated; Key Resin Company, or approved equal.

2.6 CRACK ISOLATION MEMBRANE

Product and Manufacturer - Basis of Design: Key #580 Flexible Epoxy Crack Membrane; Key Resin Company, or approved equal.

Location: Provide at elevator cab locations indicated to receive Resinous Terrazzo Flooring.

PART 3 EXECUTION

3.1 PREPARATION OF CONCRETE SUBFLOOR

Test floors, prior to the application of terrazzo flooring, as follows: Verify that the moisture vapor emission rate of the slab does not exceed that as recommended by the manufacturer at time of installation of the flooring or at any future date. Moisture vapor emission and moisture content testing shall conform with the requirements of ASTM F1869 (Calcium Chloride Test) and ASTM F2170 (Relative Humidity Probe Test or RH). If average test results shows excessive level of moisture content or vapor emission rate, apply Key 635 MVT if RH reading is 85%-90%, or Key Epocon SL if over 90%.

Level tolerance: Concrete subfloor shall be level with a maximum variation from level of 1/4" in 10'-0". Any irregularity of the surface requiring patching and/or leveling shall be done using material approved by the manufacturer.

Installation of the floor topping shall not commence until the concrete substrate is at least 28 days old. The concrete surfaces shall be prepared in accordance with the instructions of the resin manufacturer. No curing agents are to be used in areas to receive terrazzo

Substrate Crack Repair: Fill hairline cracks less than 1/16" width with neat epoxy resin, Key #502 or Key #730. Treat cracks larger than 1/16" width as recommended in NTMA Technical Bulletin #111 "Crack Detailing and Joint Treatments for Thin Set Terrazzo", Detail #6. Route out all cracks larger than 1/16" width and fill with rigid epoxy. Apply Key #580 Flexible Epoxy across the crack a minimum width of 24 inches at a spread rate of 40-50 square feet per gallon to achieve 32-40 mils dry film thickness over the crack and allow to cure. Apply Key #502 Primer to cured membrane. Imbed fiberglass scrim cloth into wet primer and saturate with additional Key #502 Primer. Alternatively, scrim cloth may be gently placed onto surface of tacky Key #580 without pressing down into resin. Allow to cure. Saturate cloth during priming step.

3.2 MIXING, PROPORTIONING, AND INSTALLATION

Mixing, proportioning, and installing shall be in accordance with the approved instructions of the manufacturer. Strips shall be installed in locations indicated.

Apply crack isolation membrane over subfloor at all locations indicated to receive resinous terrazzo flooring.

3.3 CLEANING AND SEALING

Clean and seal surfaces in accordance with manufacturer's instructions and recommendations including manufacturer's maintenance recommendations.

3.4 PROTECTION

The terrazzo work shall be covered and protected from damage until completion of the work of all other trades.

-- End of Section --

SECTION 09 66 24

PRECAST RESINOUS MATRIX TERRAZZO
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D635	(2010) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D648	(2007) Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
ASTM D695	(2010) Standard Test Method for Compressive Properties of Rigid Plastics

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 SYSTEM DESCRIPTION

Apply precast resinous matrix terrazzo, in the areas shown on the approved detail drawings. Submit two 6 x 6 inches, (minimum) samples of each color of resinous terrazzo and two 6 inches lengths, of each type of strip.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G

Precast terrazzo jointing and edge configurations

SD-03 Product Data

Precast Resinous Matrix Terrazzo; (LEED NC)

Mixing, Proportioning, and Installation
Cleaning and Sealing; (LEED NC)

SD-04 Samples; G

Precast Resinous Matrix Terrazzo

SD-11 Closeout Submittals

Low Emitting Materials - Adhesives and Sealants
Low Emitting Materials - Paints and Coatings

1.5 QUALITY ASSURANCE

1.5.1 Applicator

Applicator shall be approved by the resin manufacturer and shall have a minimum of 3 years experience in the application of the materials to be used and shall have completed 8 successful installations within the past 2 years.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in manufacturer's original unopened containers. Keep materials in a clean, dry, area with temperatures controlled between 50 and 90 degrees F.

1.7 ENVIRONMENTAL REQUIREMENTS

Areas to receive terrazzo shall be maintained at a temperature above 50 degrees F for 2 days prior to installation and for 7 days following installation.

PART 2 PRODUCTS

2.1 PRECAST RESINOUS MATRIX TERRAZZOZC-01A, ZC-01B AND ZC-02B

Product and Manufacturer: Key Epoxy Terrazzo #108; Key Resin Company, or approved equal.

Description: 100% solids, two-component epoxy resin system containing decorative aggregates.
Nominal Thickness: 3/8 inch
Matrix Color and Pattern: Refer to the Finish Legend.
Compressive Strength: 10,000 psi minimum; ASTM D695
Flammability: Self-extinguishing; ASTM D635
Critical Radiant Flux: 1.0; ASTM D648
Water Absorption: 0.010% or less; ASTM D570

2.2 PRECAST TERRAZZO UNITS

General: Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer. Finish exposed-to-view edges and reveals to match face finish. Ease exposed edges to 1/8-inch (3.2-mm) radius, unless otherwise indicated.

Precast Units:

Stair tread/riser.
Base.

PART 3 EXECUTION

3.1 MIXING, PROPORTIONING, AND INSTALLATION

Mixing and proportioning shall be in accordance with the approved instructions of the manufacturer. Strips shall be installed in locations indicated.

Install precast terrazzo units using methods recommended by NTMA and manufacturer.

3.2 CLEANING AND SEALING

Clean surfaces in accordance with manufacturer's instructions and recommendations.

3.3 PROTECTION

Protect precast terrazzo units from damage until completion of the work of all other trades.

-- End of Section --

SECTION 09 68 00

CARPET
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC TM 134	(2011) Electrostatic Propensity of Carpets
AATCC TM 16	(2004; E 2010) Colorfastness to Light

ASTM INTERNATIONAL (ASTM)

ASTM E648	(2010; E 2011) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CARPET AND RUG INSTITUTE (CRI)

CRI 104	(2002) Standard for Installation Specification of Commercial Carpet

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)
LEED GBDC	(2009) LEED Reference Guide for Green Building Design and Construction
LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

SD-03 Product Data

Carpet (LEED NC); G
Surface Preparation (LEED NC)
Installation instructions
Regulatory Requirements

SD-04 Samples

Carpet; G
Moldings

SD-06 Test Reports

Moisture and Alkalinity Tests

SD-07 Certificates

Carpet
Regulatory Requirements

SD-10 Operation and Maintenance Data

Carpet
Cleaning and Protection

SD-11 Closeout Submittals

Materials and Resources
Carpet
Adhesives and Concrete Primer

1.4 QUALITY ASSURANCE

Provide the Carpet and Rug Institute (CRI) Indoor Air Quality (IAQ) label for carpet and adhesives or demonstrate compliance with testing criteria and frequencies through independent laboratory test results. Carpet and adhesives bearing the label will indicate that the carpet has been tested and meets the Regulatory Requirements and criteria of the CRI IAQ Carpet Testing Program, and minimizes the impact on indoor air quality. Submit three copies of report stating that carpet and carpet components contain recycled materials and/or involvement in a recycling or reuse program. Include in the report percentage of post-industrial and post-consumer recycled material. Include independent, third party certification of compliance with Carpet and Rug Institute's Green Label Indoor Air Quality program. Order materials per floor to avoid different dye lots.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site in the manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size, dye lot number, and related information. Remove materials from packaging and store them in a clean, dry, well ventilated area protected from damage, soiling, and moisture, and maintain at a temperature above 60

degrees F for 2 days prior to installation. Do not store carpet near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.6 AMBIENT CONDITIONS

Maintain areas in which carpeting is to be installed at a temperature above 60 degrees F and below 90 degrees F for 2 days before installation, during installation, and for 2 days after installation. Provide temporary ventilation during work of this section. Maintain a minimum temperature of 55 degrees F thereafter for the duration of the contract. Do not permit traffic or movement of furniture or equipment in carpeted area for 24 hours after installation. Complete other work which would damage the carpet prior to installation of carpet.

1.7 WARRANTY

Provide manufacturer's standard performance guarantees or warranties including minimum ten (10) year wear warranty, two (2) year material and workmanship and ten (10) year tuft bind and delamination.

1.8 EXTRA MATERIALS

Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

PART 2 PRODUCTS

2.1 CARPET

Furnish first quality carpet; free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Provide carpet materials and treatments as reasonably nonallergenic and free of other recognized health hazards. Provide a static control construction on all grade carpets which gives adequate durability and performance. Provide the Carpet and Rug Institute (CRI) Indoor Air Quality (IAQ) Label. Carpet type bearing the label will indicate that carpet has been tested and meets the criteria of the CRI Green Label Requirements for Indoor Air Quality Test Criteria. Submit certificates of compliance from a laboratory accredited by the National Laboratory Accreditation Program of the National Institute of Standards and Technology attesting that each type of carpet conforms to the standards specified. Under closeout submittals, furnish: 1) Documentation relative to recycled content credit in accordance with LEED GBDC; 2) Documentation relative to low-emitting materials credit in accordance with LEED GBDC; 3) Documentation relative to rapidly renewable credit in accordance with LEED Reference Guide; and include all three in LEED NC Documentation Notebook. Submit Manufacturer's catalog data and printed documentation stating physical characteristics, durability, resistance to fading, and flame resistance characteristics for each type of carpet material and installation accessory. When ordering material order in per-floor quantities to avoid different dye lots. Submit manufacturer's catalog data for the following items: 1) Submit samples of the following:

a. Carpet: Two full size samples of each carpet proposed for use,

showing quality, pattern, and color specified.

2.1.1 Physical Characteristics

Carpet Tile CT-01:

Size: 19.69 x 19.69 inches
Construction: Tufted Textured Loop
Soil/Stain Protection: Protekt
Antimicrobial Treatment: Intersept
Yarn System: Post-Consumer Content Type 6,6 Nylon
Dye Method: 100% Solution Dyed
Post-Industrial: 48%-48%
Post-Consumer: 1%
Total Recycle Content: 49%-49%
Tufted Yarn Weight: 14 ounces per square yard
Machine Gauge: 1/12 inches
Pile Height: 0.12 inches
Pile Thickness: 0.069 inches
Stiches: 8 per inch
Pile Density: 7304
Indoor Air Quality: Green Label Plus Certified #GLP0820
Sustainable Carpet Assessment Standard: NSF-140 Gold
Radiant Panel: Class 1; ASTM E648
Smoke Density: Less than or equal to 450; ASTM E 662
Lightfastness: Greater than or equal to 4.0 at 60 AFU's; AATCC TM 16
Static: Less than 3.0 KV; AATCC TM 134
Standard Backing: GlasBac Tile
Green Label Plus Certification Number: GLP 0820

Carpet Tile CT-02:

Size: 24 x 24 inches
Construction: Mulit-Level Pattern Loop
Protective Treatment: SSP Shaw Soil Protectiont
Fiber: Eco Solution Q Nylon
Dye Method: 80% Solution Dyed, 20% yarn dyed
Tufted Weight: 24 ounces per square yard
Gauge: 1/10
Finished Pile Thickness: 0.138 inches
Total Thickness: 0.273
Average Density: 6261
Primary Backing: Synthetic
Secondary Backing: Ecoworx Tile
Radiant Panel: Class 1; ASTM E648
Smoke Density: Less than or equal to 450; ASTM E 662
Electrostatic Propensity: Less than 3.5 KV; AATCC TM 134
Green Label Plus Certification Number: GLP 9968

Carpet Tile CT-03:

Size: 24 x 24 inches
Construction: Mulit-Level Pattern Loop
Protective Treatment: SSP Shaw Soil Protectiont
Fiber: Eco Solution Q Nylon
Dye Method: 84% Solution Dyed, 16% yarn dyed
Tufted Weight: 26 ounces per square yard
Gauge: 1/12
Finished Pile Thickness: 0.138 inches

Total Thickness: 0.320
Average Density: 6783
Primary Backing: Synthetic
Secondary Backing: Ecoworx Tile
Radiant Panel: Class 1; ASTM E648
Smoke Density: Less than or equal to 450; ASTM E 662
Electrostatic Propensity: Less than 3.5 KV; AATCC TM 134
Green Label Plus Certification Number: GLP 9968

Carpet Tile CT-04:

Size: 24 x 24 inches
Construction: Tufted
Surface Texture: Level Patterned Loop
Gauge: 1/12
Density: 7200
Sustainable Content: Contains a minium 35% pre-consumer recycled content by total weight
Stitches Per Inch: 10.3
Finished Pile Thickness: 0.085 inches
Dye Method: Solution Dyed
Backing Material: EcoFlex ICT
Fiber Type: Colorstrand SD Nylon
Face Weight: 17.0 ounces per square yard
Soil Release Technology: Sentry Plus
Indoor Air Quality: Green Label Plus 1098
Flammability: Class 1 (Glue Down); ASTM E648
Smoke Density: Less than 450; ASTM E 662
Electrostatic Propensity: Less than 3.5 KV; AATCC TM 134
Green Label Plus Certification Number: GLP 1098

2.2 ADHESIVES AND CONCRETE PRIMER

Adhesives and concrete primers shall comply with applicable regulations regarding toxic and hazardous materials. Under closeout submittals, furnish documentation relative to low-emitting materials credit in accordance with LEED GBDC. Include in LEED NC Documentation Notebook.

2.3 MOLDINGS

Install carpet moldings where floor covering material changes or carpet edge does not abut a vertical surface. Provide heavy-duty vinyl molding designed for the type of carpet being installed. Provide floor flange of a minimum 1 1/2 inches wide.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Do not install carpet on surfaces that are unsuitable and will prevent a proper installation. Prepare subfloor in accordance with flooring manufacturer's recommended instructions. Repair holes, cracks, depressions, or rough areas using material recommended by the carpet or adhesive manufacturer. Free floor of any foreign materials and sweep clean. Before beginning work, test subfloor with glue and carpet to determine "open time" and bond. Submit three copies of the manufacturer's printed installation instructions for the carpet, including preparation of substrate, seaming techniques, and recommended adhesives and tapes.

3.2 MOISTURE AND ALKALINITY TESTS

Test concrete slab for moisture content and excessive alkalinity in accordance with CRI 104. Submit three copies of test reports of moisture and alkalinity content of concrete slab stating date of test, person conducting the test, and the area tested.

3.3 PREPARATION OF CONCRETE SUBFLOOR

Do not commence installation of the carpeting until concrete substrate is at least 90 days old. Prepare the concrete surfaces in accordance with instructions of the carpet manufacturer. Match carpet, when required, and adhesives to prevent off-gassing to a type of curing compounds, leveling agents, and concrete sealer.

3.4 INSTALLATION

Perform all work by installers who are CFI certified (International Certified Floorcovering Installer Association), or manufacturer's approved installers. Conduct installation in accordance with the manufacturer's printed instructions and CRI 104. Protect edges of carpet meeting hard surface flooring with molding and install in accordance with the molding manufacturer's printed instructions. Follow ventilation, personal protection, and other safety precautions recommended by the adhesive manufacturer. Continue ventilation during installation and for at least 72 hours following installation. Submit three copies of drawings indicating areas receiving carpet, carpet types, textures and patterns, direction of pile, location of seams, and locations of edge molding. Submit installation drawings for: Carpet Moldings diagramming the location of seams, edge moldings, and carpet direction for approval prior to installation.

3.5 CLEANING AND PROTECTION

Submit three copies of carpet manufacturer's maintenance instructions describing recommended type of cleaning equipment and material, spotting and cleaning methods, and cleaning cycles.

3.5.1 Cleaning

As specified in Section 01 78 00 CLOSEOUT SUBMITTALS. After installation of the carpet, remove debris, scraps, and other foreign matter. Remove soiled spots and adhesive from the face of the carpet with appropriate spot remover. Cut off and remove protruding face yarn. Vacuum carpet clean.

3.5.2 Protection

Protect the installed carpet from soiling and damage with heavy, reinforced, nonstaining kraft paper, plywood, or hardboard sheets. Lap and secure edges of kraft paper protection to provide a continuous cover. Restrict traffic for at least 48 hours. Remove protective covering when directed by the Contracting Officer.

3.6 REMNANTS

Collect information from manufacturer about maintenance agreement take-back program options, and provide to Contracting Officer. Manage waste as specified in the Waste Management Plan. Provide remnants

remaining from the installation, consisting of scrap pieces more than 2 feet in dimension with more than 6 square feet total to the Government. Remove non-retained scraps from site and recycle appropriately.

-- End of Section --

SECTION 09 77 39

MANUFACTURED METAL WALL PANEL SYSTEM
08/10

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings

SD-03 Product Data

Installation; G
Wall Panel System; G

SD-04 Samples

Wall Panel System

SD-07 Certificates

Wall Panel System

1.2 DELIVERY, STORAGE, AND HANDLING

Protect materials delivered and placed in storage from the weather, humidity and temperature variations, dirt, dust, or other contaminants.

1.3 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

PART 2 PRODUCTS

2.1 MANUFACTURED METAL WALL PANEL SYSTEM - ACOUSTICAL

Wall Panel System:

Model and Manufacturer - Basis of Design: Armstrong MetalWorks WH1000 Wall Panel System; Armstrong World Industries, Inc., or equal.

Finish and Color: Refer to the Finish Legend.
Panel Type: Refer to the Finish Legend.
Noise Reduction Coefficient: NRC of 60-65 with black acoustical fleece; ASTM C423.
Flame Spread: Less than or equal to 25 per ASTM E84; Class A per ASTM E1264.

Surface Finish: Scrubbable, architectural-quality, electrostatically applied polyester powder coat paint applied to entire panel after forming (post coat).
Substrate: P25 gauge minimum, galvanized steel substrate.
Panel Shape: Formed as flat rectangles and installed in a flat or segmented (faceted) fashion following the contour of the wall.
Edge Detail: Long edges returned and notched for mounting on wall rails. Short edges returned for panel strength. Provide factory adhered gasket material and button spacers on panel sideboards to form consistent reveals between panels.

Provide wall panel system consisting of prefinished components manufactured to the dimensions and configurations shown on the approved detail drawings; submit drawings showing plan locations, elevations and details of method of anchorage, location of openings, include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections.

PART 3 EXECUTION

3.1 INSTALLATION

All metal panels and mounting components shall be installed in strict accordance with the manufacturer's printed instructions and current recommendations.

Installed panels shall be free from damaged edges or other defects detrimental to appearance and function.

Deflection of any mounting components shall not exceed 1/360 of the span.

3.2 CLEANING AND ADJUSTING

Clean metal wall panels, including trim, in accordance with manufacturer's instructions and recommendations. Remove and replace damaged components that cannot be successfully restored ot the satisfaction of the Contracting Officer.

-- End of Section --

SECTION 09 83 13

ACOUSTICAL WALL TREATMENT
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C423	(2009a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings

SD-03 Product Data

Installation; G
Fixed Sound Absorptive Panels; G

SD-04 Samples

Fixed Sound Absorptive Panels; G

SD-07 Certificates

Fixed Sound Absorptive Panels

1.4 DELIVERY, STORAGE, AND HANDLING

DAT:

Protect materials delivered and plac
ed in storage from the weather, humidity and temperature variations, dirt, dust, or other contaminants.

1.5 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

PART 2 PRODUCTS

2.1 Fixed Sound Absorptive Panels

Product and Manufacturer: Soundsoak 85 - FR-701, 32091FR; Armstrong, or equal.

Panel Description:

Composition: Composite of vinyl, mineral fiber, and fiberglass.

NRC Rating: 0.80 minimum ASTM C423.
Flame Spread: ASTM E84; composite rating 25 or less flame spread; 200 or less smoke developed.
Thickness: 1-inch.

Fabric Facing: Grey Mix 238 - FR701 2100 - Gilford of Main, or equal.

Accessories:

Molding: Item No. 4064. 3/4" J-Molding, color FG (Frost Gray) - Armstrong; or equal.

Provide acoustical wall panels consisting of prefinished, factory assembled, seamless fabric covered, fiber glass or mineral fiber core system as described below manufactured to the dimensions and configurations shown on the approved detail drawings; submit drawings showing plan locations, elevations and details of method of anchorage, location of doors and other openings, base detail and shape and thickness of materials.

a. Fire rating for the complete composite system: Class A, 200 or less smoke density and flame spread less than 25, when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

Walls shall be clean, smooth, oil free and prepared in accordance with panel manufacturer's instructions. Do not begin installation until all wet work, such as, plastering, painting, and concrete are completely dry.

3.2 INSTALLATION

Panel installation shall be by personnel familiar with and normally engaged in installation of acoustical wall panels. Apply panels in accordance with the manufacturer's installation instructions. Submit manufacturer's installation instructions and recommended cleaning

instructions.

3.3 CLEANING

Following installation, dirty or stained panel surfaces shall be cleaned in accordance with manufacturer's instructions and left free from defects. Panels that are damaged, discolored, or improperly installed shall be removed and new panels provided as directed.

-- End of Section --

SECTION 09 90 00

PAINTS AND COATINGS
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100	(2001; Supplements 2002-2008) Documentation of the Threshold Limit Values and Biological Exposure Indices

ASME INTERNATIONAL (ASME)

ASME A13.1	(2007; R 2013) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM D4263	(1983; R 2012) Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4444	(2013) Use and Calibration of Hand-Held Moisture Meters
ASTM D523	(2008) Standard Test Method for Specular Gloss
ASTM F1869	(2011) Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

MASTER PAINTERS INSTITUTE (MPI)

MPI 107	(Oct 2009) Rust Inhibitive Primer (Water-Based)
MPI 141	(Oct 2009) Interior High Performance Latex MPI Gloss Level 5
MPI 144	(Oct 2009) Institutional Low Odor / VOC Interior Latex, MPI Gloss Level 2
MPI 145	(Oct 2009) Institutional Low Odor / VOC Interior Latex, MPI Gloss Level 3
MPI 146	(Oct 2009) Institutional Low Odor/VOC Interior Latex, MPI Gloss Level 4
MPI 147	(Oct 2009) Institutional Low Odor / VOC Interior Latex, Semi-Gloss, MPI Gloss

	Level 5
MPI 153	(Oct 2009) Interior W.B. Light Industrial Coating, Semi-Gloss, MPI Gloss Level 5
MPI 163	(Oct 2009) Exterior W.B. Light Industrial Coating, Semi-Gloss, MPI Gloss Level 5
MPI 23	(Oct 2009) Surface Tolerant Metal Primer
MPI 39	(Oct 2009) Interior Latex-Based Wood Primer
MPI 4	(Oct 2009) Interior/Exterior Latex Block Filler
MPI 72	(Oct 2009) Polyurethane, Two Component, Pigmented, Gloss
MPI 77	(Oct 2009) Epoxy Gloss
MPI 79	(Oct 2009) Alkyd Anti-Corrosive Metal Primer
MPI 9	(Oct 2009) Exterior Alkyd, Gloss, MPI Gloss Level 6

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting of Steel
SSPC PA Guide 3	(1982; E 1995) A Guide to Safety in Paint Application
SSPC SP 1	(1982; E 2004) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2007) Near-White Blast Cleaning
SSPC SP 12/NACE No.5	(2002) Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating
SSPC SP 2	(1982; E 2000; E 2004) Hand Tool Cleaning
SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC VIS 3	(2004) Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning
SSPC VIS 4/NACE VIS 7	(1998; E 2000; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by

Waterjetting

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(1970; Rev B) Color Code for Pipelines & for Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-313	(Rev D; Notice 1) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

Samples of specified materials may be taken and tested for compliance with specification requirements.

SD-03 Product Data

Coating; (LEED NC)
Manufacturer's Technical Data Sheets; (LEED NC)

SD-04 Samples

Color samples; G
Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated.

SD-07 Certificates

Applicator's qualifications

Qualification Testing laboratory for coatings

SD-08 Manufacturer's Instructions

Application instructions

Mixing

Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.

Manufacturer's Material Safety Data Sheets

Submit manufacturer's Material Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

SD-10 Operation and Maintenance Data

Coatings

Preprinted cleaning and maintenance instructions for all coating systems shall be provided.

SD-11 Closeout Submittals

Local/Regional Materials
Construction Waste Management
Recycle, Reuse or Manufacturer Take Back Program

1.4 APPLICATOR'S QUALIFICATIONS

1.4.1 Contractor Qualification

Submit the name, address, telephone number, FAX number, and e-mail address of the contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on on a minimum of three similar projects within the past three years. List information by individual and include the following:

a. Name of individual and proposed position for this work.

b. Information about each previous assignment including:

Position or responsibility

Employer (if other than the Contractor)

Name of facility owner

Mailing address, telephone number, and telex number (if non-US) of facility owner

Name of individual in facility owner's organization who can be contacted as a reference

Location, size and description of structure

Dates work was carried out

Description of work carried out on structure

1.5 QUALITY ASSURANCE

1.5.1 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph "Sampling Procedures." Test each chosen product as specified in the paragraph "Testing Procedure." Products which do not conform, shall be removed from the job site and replaced with new products that conform to the referenced specification. Testing of replacement products that failed initial testing shall be at no cost to the Government.

1.5.1.1 Sampling Procedure

The Contracting Officer will select paint at random from the products that have been delivered to the job site for sample testing. The Contractor shall provide one quart samples of the selected paint materials. The samples shall be taken in the presence of the Contracting Officer, and labeled, identifying each sample. Provide labels in accordance with the paragraph "Packaging, Labeling, and Storage" of this specification.

1.5.1.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph "Qualification Testing" laboratory for coatings. The qualification testing lab report shall include the backup data and summary of the test results. The summary shall list all of the reference specification requirements and the result of each test. The summary shall clearly indicate whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If the Contractor chooses MPI to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

1.6 REGULATORY REQUIREMENTS

1.6.1 Environmental Protection

As specified in the Waste Management Plan and as follows. Do not use

kerosene or any such organic solvents to clean up water based paints.Properly dispose of paints or solvents in designated containers. Close and seal partially used containers of paint to maintain quality as necessary for reuse. Store
in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste in designated containers.

1.6.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.6.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.6.4 Asbestos Content

Materials shall not contain asbestos.

1.6.5 Mercury Content

Materials shall not contain mercury or mercury compounds.

1.6.6 Silica

Abrasive blast media shall not contain free crystalline silica.

1.6.7 Human Carcinogens

Materials shall not contain ACGIH 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.7 PACKAGING, LABELING, AND STORAGE

Paints shall be in sealed containers that legibly show the contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinners shall be stored in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F.

1.8 SAFETY AND HEALTH

Apply coating materials using safety methods and equipment in accordance with the following:

Work shall comply with applicable Federal, State, and local laws and regulations. The Activity Hazard Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.8.1 Safety Methods Used During Coating Application

Comply with the requirements of SSPC PA Guide 3.

1.8.2 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

a. The applicable manufacturer's Material Safety Data Sheets (MSDS) or local regulation.

b. 29 CFR 1910.1000.

c. ACGIH 0100, threshold limit values.

1.9 ENVIRONMENTAL CONDITIONS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation.

1.9.1 Coatings

Do not apply coating when air or substrate conditions are:

a. Less than 5 degrees F above dew point;

b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.

1.10 LOCATION AND SURFACE TYPE TO BE PAINTED

1.10.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.

b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.

c. Existing coated surfaces that are damaged during performance of the work.

1.10.1.1 Exterior Painting

Includes new surfaces, existing coated surfaces, of the buildings and appurtenances. Also included are existing coated surfaces made bare by cleaning operations.

1.10.1.2 Interior Painting

Includes new surfaces of the buildings and appurtenances as indicated and existing coated surfaces made bare by cleaning operations. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

a. Exposed columns, girders, beams, joists, and metal deck; and

b. Other contiguous surfaces.

1.10.2 Painting Excluded

Do not paint the following unless indicated otherwise.

a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.

b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, crawl spaces, elevator shafts and chases.

c. Steel to be embedded in concrete.

d. Copper, stainless steel, aluminum, brass, and lead except existing coated surfaces.

e. Hardware, fittings, and other factory finished items.
f. Surfaces in the following areas shall not be painted: structural steel to receive fireproofing.

1.10.3 Mechanical and Electrical Painting

Includes field coating of interior and exterior new surfaces.

a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.

(1) Exposed piping, conduit, and ductwork;

(2) Supports, hangers, air grilles, and registers;

(3) Miscellaneous metalwork and insulation coverings.

b. Do not paint the following, unless indicated otherwise:

(1) New zinc-coated, aluminum, and copper surfaces under insulation

(2) New aluminum jacket on piping

(3) New interior ferrous piping under insulation.

1.10.3.1 Fire Extinguishing Sprinkler Systems

Clean, pretreat, prime, and paint new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories. Apply coatings to clean, dry surfaces, using clean brushes. Clean the surfaces to remove dust, dirt, rust, and loose mill scale. Immediately after cleaning, provide the metal surfaces with one coat primer per schedules. Shield sprinkler heads with protective covering while painting is in progress. Upon completion of painting, remove protective covering from sprinkler heads. Remove sprinkler heads which have been painted and replace with new sprinkler heads. Provide primed surfaces with the following:

a. Piping in Unfinished Areas: Provide primed surfaces with one coat of

red alkyd gloss enamel applied to a minimum dry film thickness of 1.0 mil in attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and spaces where walls or ceiling are not painted or not constructed of a prefinished material. In lieu of red enamel finish coat, provide piping with 2 inch wide red enamel bands or self-adhering red plastic bands spaced at maximum of 20 foot intervals.

b. Piping in Finished Areas: Provide primed surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 1.0 mil. Provide piping with 2 inch wide red enamel bands or self-adhering red plastic bands spaced at maximum of 20 foot intervals throughout the piping systems.

1.10.4 MISCELLANEOUS PAINTING

Lettering Building Number(s)

Lettering shall be provided as scheduled on the drawings, shall be Gothic type, and shall be black enamel . Samples shall be approved before application.

1.10.5 Definitions and Abbreviations

1.10.5.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.10.5.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing shall only be accomplished by MPI testing lab.

1.10.5.3 Coating

A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid/liquid suspensions on various substrates (metals, plastics, wood, paper, leather, cloth, etc.). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendaring, and roller coating. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes emulsions, enamels, stains, varnishes, sealers, epoxies, and other coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

1.10.5.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.10.5.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five (5) levels are generically defined under the Assessment sections in the MPI Maintenance Repainting Manual.

1.10.5.6 EPP

Environmentally Preferred Products, a standard for determining environmental preferability in support of Executive Order 13101.

1.10.5.7 EXT

MPI short term designation for an exterior coating system.

1.10.5.8 INT

MPI short term designation for an interior coating system.

1.10.5.9 micron / microns

The metric measurement for 0.001 mm or one/one-thousandth of a millimeter.

1.10.5.10 mil / mils

The English measurement for 0.001 in or one/one-thousandth of an inch, equal to 25.4 microns or 0.0254 mm.

1.10.5.11 mm

The metric measurement for millimeter, 0.001 meter or one/one-thousandth of a meter.

1.10.5.12 MPI Gloss Levels

MPI system of defining gloss. Seven (7) gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units at 60 degrees	Units at 85 degrees
G1	Matte or Flat	0 to 5	10 max
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	
G7	High Gloss		

Gloss is tested in accordance with ASTM D523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.10.5.13 MPI System Number

The MPI coating system number in each Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN). The Division number follows the CSI Master Format.

1.10.5.14 Paint

See Coating definition.

1.10.5.15 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.10.5.16 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents. Refer to Section 01 33 29 LEED DOCUMENTATION for all material requirements. Comply with applicable regulations regarding toxic and hazardous materials.

Colors: Provide color samples for paint indicated.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect, hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.3 PREPARATION OF METAL SURFACES

3.3.1 New Ferrous Surfaces

a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Clean in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to SSPC SP 2, SSPC SP 3, SSPC SP 6/NACE No.3, or SSPC SP 10/NACE No. 2. Brush-off blast remaining surface in accordance with SSPC SP 7/NACE No.4; Water jetting to SSPC SP 12/NACE No.5 WJ-4 may be used to remove loose coating and other loose materials. Use inhibitor as recommended by coating manufacturer to prevent premature rusting. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with .

3.3.2 Final Ferrous Surface Condition:

For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 3.

For abrasive blast cleaned surfaces, the requirements are stated in SSPC SP 7/NACE No.4, SSPC SP 6/NACE No.3, and SSPC SP 10/NACE No. 2. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 1.

For waterjet cleaned surfaces, the requirements are stated in SSPC SP 12/NACE No.5. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 4/NACE VIS 7.

3.4 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE

3.4.1 Concrete and Masonry

a. Curing: Concrete, stucco and masonry surfaces shall be allowed to cure at least 30 days before painting, except concrete slab on grade, which shall be allowed to cure 90 days before painting.

b. Surface Cleaning: Remove the following deleterious substances.

(1) Dirt, Chalking, Grease, and Oil: Wash new surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cuphousehold detergent, and 4 quarts of warm water. Then rinse thoroughly with fresh water. For large areas, water blasting may be used.

(2) Fungus and Mold: Wash new surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, 1 quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.

(3) Paint and Loose Particles: Remove by wire brushing.

(4) Efflorescence: Remove by scraping or wire brushing followed by washing with a 5 to 10 percent by weight aqueous solution of

hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.

c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.

d. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water. Do not apply epoxies to damp vertical surfaces as determined by ASTM D4263 or horizontal surfaces that exceed 3 lbs of moisture per 1000 square feet in 24 hours as determined by ASTM F1869. In all cases follow manufacturers recommendations. Allow surfaces to cure a minimum of 30 days before painting.

3.4.2 Gypsum Board and Stucco

a. Surface Cleaning: Stucco shall be clean and free from loose matter; gypsum board shall be dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of the first coat material. A damp cloth or sponge may be used if paint will be water-based.

b. Repair of Minor Defects: Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching or spackling compound and sand smooth.

c. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not surfaces with droplets of water. Do not apply epoxies to damp surfaces as determined by ASTM D4263.

3.5 PREPARATION OF WOOD AND PLYWOOD SURFACES

3.5.1 New Plywood and Wood Surfaces, Except Floors:

a. Wood surfaces shall be cleaned of foreign matter.

Surface Cleaning: Surfaces shall be free from dust and other deleterious substances and in a condition approved by the Contracting Officer prior to receiving paint or other finish. Do not use water to clean uncoated wood. Scrape to remove loose coatings. Lightly sand to roughen the entire area of previously enamel-coated wood surfaces.

b. Removal of Fungus and Mold: Wash existing coated surfaces with a solution composed of 3 ounces (2/3 cup) trisodium phosphate, 1 ounce (1/3 cup) household detergent, 1 quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.

c. Moisture content of the wood shall not exceed 12 percent as measured by a moisture meter in accordance with ASTM D4444, Method A, unless otherwise authorized.

d. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up before applying water-thinned paints.

e. Cracks and Nailheads: Set and putty stop nailheads and putty cracks

after the prime coat has dried.

f. Cosmetic Repair of Minor Defects:

(1) Knots and Resinous Wood : Prior to application of coating, cover knots and stains with two or more coats of 3-pound-cut shellac varnish, plasticized with 5 ounces of castor oil per gallon. Scrape away existing coatings from knotty areas, and sand before treating. Prime before applying any putty over shellacked area.

(2) Open Joints and Other Openings: Fill with whiting putty, linseed oil putty. Sand smooth after putty has dried.

(3) Checking: Where checking of the wood is present, sand the surface, wipe and apply a coat of pigmented orange shellac. Allow to dry before paint is applied.

g. Prime Coat For New Exterior Surfaces: Prime coat before wood becomes dirty, warped, or weathered.

3.5.2 Interior Wood Surfaces, Stain Finish

Interior wood surfaces to receive stain shall be sanded. Oak and other open-grain wood to receive stain shall be given a coat of wood filler not less than 8 hours before the application of stain; excess filler shall be removed and the surface sanded smooth.

3.6 APPLICATION

3.6.1 Coating Application

Comply with manufacturer's application instructions. Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application.

Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.

Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

Thoroughly work coating materials into joints, crevices, and open spaces. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete.

Touch up damaged coatings before applying subsequent coats. Interior areas shall be broom clean and dust free before and during the application of coating material.

a. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.

b. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Each coat shall cover surface of preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.

c. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

d. Thermosetting Paints: Topcoats over thermosetting paints (epoxies and urethanes) should be applied within the overcoating window recommended by the manufacturer.

e. Floors: For nonslip surfacing on level floors, as the intermediate coat is applied, cover wet surface completely with almandite garnet, Grit No. 36, with maximum passing U.S. Standard Sieve No. 40 less than 0.5 percent. When the coating is dry, use a soft bristle broom to sweep up excess grit, which may be reused, and vacuum up remaining residue before application of the topcoat. For nonslip surfacing on ramps, provide MPI 77 with non-skid additive, applied by roller in accordance with manufacturer's instructions.

3.6.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. The written permission shall include quantities and types of thinners to use.

3.6.3 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

3.6.4 Coating Systems

a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

Table

Division 3. Exterior Concrete Paint Table
Division 4. Exterior Concrete Masonry Units Paint Table

Table

Division 5.	Exterior Metal, Ferrous and Non-Ferrous Paint Table
Division 9:	Exterior Stucco Paint Table
Division 3.	Interior Concrete Paint Table
Division 4.	Interior Concrete Masonry Units Paint Table
Division 5.	Interior Metal, Ferrous and Non-Ferrous Paint Table
Division 6.	Interior Wood Paint Table
Division 9:	Interior Gypsum Board and Textured Surfaces Paint Table

b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness where specified, refers to the minimum dry film thickness.

c. Coatings for Surfaces Not Specified Otherwise: Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.

d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:

(1) One coat of primer.

(2) One coat of undercoat or intermediate coat.

(3) One topcoat to match adjacent surfaces.

e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.

3.7 COATING SYSTEMS FOR METAL

Apply coatings of Tables in Division 5 for Exterior and Interior.

a. Apply specified ferrous metal primer on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.

b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.

c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.

d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.

e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces.

On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

3.8 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in Division 3, 4 and 9 for Exterior and Interior.

3.9 COATING SYSTEMS FOR WOOD AND PLYWOOD

a. Apply coatings of Tables in Division 6 for Exterior and Interior.

b. Prior to erection, apply two coats of specified primer to treat and prime wood and plywood surfaces which will be inaccessible after erection.

c. Apply stains in accordance with manufacturer's printed instructions.

3.10 PIPING IDENTIFICATION

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with MIL-STD-101ASME A13.1. Place stenciling in clearly visible locations. On piping not covered by MIL-STD-101ASME A13.1, stencil approved names or code letters, in letters a minimum of 1/2 inch high for piping and a minimum of 2 inches high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

3.11 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

3.12 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows, coordinate with manufacturer for take-back program. Set aside scrap to be returned to manufacturer for recycling into new product. When such a service is not available, local recyclers shall be sought after to reclaim the materials. Set aside extra paint for future color matches or reuse by the Government. Where local options exist for leftover paint recycling, collect all waste paint by type and provide for delivery to recycling or collection facility for reuse by local organizations.

3.13 PAINT TABLES

All DFT's are minimum values. Use only interior paints and coatings that meet VOC requirements of low emitting materials credit. Acceptable products are listed in the MPI Green Approved Products List, available at http://www.specifygreen.com/APL/ProductIdxByMPInum.asp.

3.13.1 EXTERIOR PAINT TABLES

DIVISION 3 - EXTERIOR CONCRETE PAINT TABLE

Elastomeric Coating: At parapet back faces, as indicated on the Drawings.

Products and Manufacturers:Provide one of the following, or equal.

AllGuard Silicone Elastomeric Coating system; Dow Corning, or equal

Composition: One-component, pigmented, 100% water-based silicone elastomer.
Primer: AllGuard Primer.
Fillers and Sealers: As recommended by system manufacturer.

Silflex; BASF

Composition: One-component, pigmented, 100% water-based silicone elastomer.
Primer: As recommended by system manufacturer.
Fillers and Sealers: As recommended by system manufacturer.

Sto Silicone Elastomeric; STO Corp.

Composition: One-component, pigmented, 100% water-based silicone elastomer.
Primer: As recommended by system manufacturer.
Fillers and Sealers: As recommended by system manufacturer.

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

STEEL / FERROUS SURFACES

A. Steel Doors and Frames

1. Alkyd

New; MPI EXT 5.1Q-G6 (Gloss)

Primer:	Intermediate:	Topcoat:
MPI 23	MPI 9	MPI 9

System DFT: 5.25 mils

B. Exterior Steel Canopy - High-Performance Paint

1. Polyurethane

Manufacturer: TNEMEC or equal.

System Description: Polyurethane topcoat over primer and intermediate coat.

Primer: Tneme-Zinc 90-97; 2.5 - 3.5 DFT
Intermediate Coat: Series N69 Hi-Build Epoxoline II; 3.0-5.0 DFT
Topcoat: Endurashield UVX Series 750 (semigloss); 3.0-4.0 DFT

C. Surfaces adjacent to painted surfaces; Mechanical, Electrical, Fire extinguishing sprinkler systems including valves, conduit, hangers, supports, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment.

1. Waterborne Light Industrial Coating
MPI EXT 5.1C-G5(Semigloss)

Primer:	Intermediate:	Topcoat:

STEEL / FERROUS SURFACES

MPI 79	MPI 163	MPI 163

System DFT: 5 mils

DIVISION 9: EXTERIOR STUCCO PAINT TABLE

A. New stucco:

Elastomeric Coating: At parapet back faces, as indicated on the Drawings.

Products and Manufacturers:Provide one of the following, or equal.

AllGuard Silicone Elastomeric Coating system; Dow Corning, or equal

Composition: One-component, pigmented, 100% water-based silicone elastomer.
Primer: AllGuard Primer.
Fillers and Sealers: As recommended by system manufacturer.

Silflex; BASF

Composition: One-component, pigmented, 100% water-based silicone elastomer.
Primer: As recommended by system manufacturer.
Fillers and Sealers: As recommended by system manufacturer.

Sto Silicone Elastomeric; STO Corp.

Composition: One-component, pigmented, 100% water-based silicone elastomer.
Primer: As recommended by system manufacturer.
Fillers and Sealers: As recommended by system manufacturer.

3.13.2 INTERIOR PAINT TABLES

DIVISION 4: INTERIOR CONCRETE MASONRY UNITS PAINT TABLE

A. New Concrete masonry:

1. Institutional Low Odor / Low VOC Latex

New; MPI INT 4.2E-G2 (Flat)

Filler	Primer:	Intermediate:	Topcoat:
MPI 4	N/A	MPI 144	MPI 144

System DFT: 4 mils

New; MPI INT 4.2E-G3 (Eggshell)

Filler	Primer:	Intermediate:	Topcoat:
MPI 4	N/A	MPI 145	MPI 145

System DFT: 4 mils

New; MPI INT 4.2E-G4 (Satin)

Filler	Primer:	Intermediate:	Topcoat:
MPI 4	N/A	MPI 146	MPI 146

System DFT: 4 mils

New; MPI INT 4.2E-G5 (Semigloss)

Filler	Primer:	Intermediate:	Topcoat:
MPI 4	N/A	MPI 147	MPI 147

System DFT: 4 mils

DIVISION 4: INTERIOR CONCRETE MASONRY UNITS PAINT TABLE

DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

INTERIOR STEEL / FERROUS SURFACES

A. Metal, Mechanical, Electrical, Fire extinguishing sprinkler systems including valves, conduit, hangers, supports, Surfaces adjacent to painted surfaces (Match surrounding finish), exposed copper piping, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment:

1. Light Indusrial Coating, Interior, Water Based Acrylic

MPI INT 5.1R-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 107	MPI 153	MPI 153

System DFT: 5 mils

DIVISION 6: INTERIOR WOOD PAINT TABLE

A. New Wood and plywood not otherwise specified:

1. High Performance Architectural Latex

MPI INT 6.4S-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 39	MPI 141	MPI 141

System DFT: 4.5 mils

C. New Wood Doors; Pigmented finish:

1. Pigmented Polyurethane
New; MPI INT 6.1E-G6 (Gloss)

Primer:	Intermediate:	Topcoat:
MPI 72	MPI 72	MPI 72

System DFT: 4.5 mils

Note: Sand between all coats per manufacturers recommendations.

D. Existing, previously painted Wood Doors; Pigmented finish:

DIVISION 9: INTERIOR GYPSUM BOARD PAINT TABLE

A. New Wallboard: Latex

MPI INT 9.2M-G3 (Eggshell)

Primer:	Intermediate:	Topcoat:
MPI 149	MPI 145	MPI 145

System DFT: 4 mils

B. New Wallboard: Epoxy

1. Waterbased Catalyzed Epoxy
New; MPI INT 9.2L-G5(Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 107	MPI 153	MPI 153

System DFT: 4 mils

DIVISION 9: INTERIOR GYPSUM BOARD PAINT TABLE

-- End of Section --

SECTION 09 96 00

HIGH PERFORMANCE PAINTING AND COATING
02/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C 920	(2008) Standard Specification for Elastomeric Joint Sealants
ASTM D 2697	(2003; R 2008) Volume Nonvolatile Matter in Clear or Pigmented Coatings

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(Oct 2009) Alkyd Anti-Corrosive Metal Primer

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-P-21035	(1991; Rev B; Notice 2 2003) Paint, High Zinc Dust Content, Galvanizing Repair (Metric)

NATIONAL ASSOCIATION OF PIPE FABRICATORS (NAPF)

NAPF 500-03-04	(2006) Surface Preparation Standard for Abrasive Blast Cleaning of Ductile Iron Pipe

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 1	(1982; E 2004) Solvent Cleaning
SSPC SP 3	(1982; E 2004) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 10/NACE No. 2	(2007) Near-White Blast Cleaning
SSPC SP 11	(1987; E 2004) Power Tool Cleaning to Bare Metal

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in

	Government Procurement
FS TT-P-102	(Rev F) Paint, Oil, (Alkyd Modified, Exterior, Low VOC)
FS TT-P-664	(Rev D) Lacquer-Resisting L&C Free Alkyd Primer

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material Safety Data Sheets shall be submitted to the Contracting Officer.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items including designated name, formula or specification number, manufacturer's instructions and name of manufacturer. Data shall include detailed analysis of each coating material required, with constituents measured as percentages of the total weight of coating; and details of application, thinning, and average coverage per gallon.

Inhibitive Metal Primer
Enamel

1.3 DELIVERY, HANDLING AND STORAGE

Materials shall be delivered in their original, unbroken containers bearing the manufacturer's name and product identification.

All paint materials, thinners, and cleaners shall be stored in tightly closed containers in a covered, well-ventilated area where they will not be exposed to excessive heat, sparks, flame, or direct sunlight. Water-based materials shall be protected against freezing.

Material Safety Data Sheets shall be submitted by the Contracting Officer.

1.4 CONTRACTOR PERSONNEL QUALIFICATION

Personnel assigned to the work shall be certified by the Contractor to have had adequate previous experience in the successful application of paints and coatings similar to those specified.

1.5 WARRANTY

Contractor shall guarantee all work against defects in labor and material for a period of one year.

PART 2 PRODUCTS

2.1 GENERAL

The following are suggested paint manufacturers and their products. Other paint manufacturers' products of equal quality will be considered when approved by the Contracting Officer. All thinners and cleaners shall be products of the coating manufacturer. Primer and finish coats of the paint system shall be products of the same manufacturer.

2.2 EXTERIOR PRODUCTS

	FEDERAL SPECIFICATION	PITTSBURGH	SHERWIN WILLIAMS	ICI / GLIDDEN
Enamel	FS TT-P-102	1-934	A-2	2518
Inhibitive Metal Primer, MPI 79	FS TT-P-664 FS TT-P-664	--	B50NN26 B50W21	4160

2.3 HIGH PERFORMANCE PRODUCTS

2.3.1 Submerged and Alternately Submerged Metal Coating Systems

System No. 1: Submerged and alternately submerged metal - raw water (nonpotable) or raw sewage with shop applied primer:

a. Type: hydrophobic aromatic polyurethane, 2-coat system.

b. Service Conditions: For use with metal pipes or structures alternately submerged in raw sewage or raw water (nonpotable) and exposed to a moist saturated hydrogen sulfide atmosphere, as in raw sewage wet wells. Minimum temperature resistance of the coating shall be 140 degrees F for moist heat conditions.

1. All ferrous metal surfaces inside of raw sewage wetwells and valve vaults.

c. Surface Preparation (Shop): Brush-off blast cleaning in accordance with NAPF 500-03-04 to a minimum surface profile of 1.5 mils.

d. Shop Prime: Apply Tnemec Series N69 Hi-Build Epoxoline II polyamidoamine epoxy at 4.0 to 6.0 mils dft.

e. Spot Prime: Pressure wash to remove all dirt grease and contamination. Power Tool clean all bare and damaged areas per SSPC SP 3. Featheredge to tightly adhered coating. Thoroughly abrade the entire surface before proceeding. All surfaces must be clean, dry and thoroughly abraded prior to the application of any coatings. Spot prime all bare areas with one coat of Tnemec Series 446 Perma-Shield MCU hydrophobic aromatic polyurethane at 4.0 to 6.0 mils dft

f. Intermediate Coat: Apply Tnemec Series 446 Perma-Shield MCU hydrophobic aromatic polyurethane at 7.0 to 9.0 mils dft.

g. Finish Coat: Apply Tnemec Series 446 Perma-Shield MCU hydrophobic aromatic polyurethane at 7.0 to 9.0 mils dft.

2.3.2 Exposed Metal Coating Systems

System No. 10: Exposed Metal, Corrosive Environment:

a. Type: High-build epoxy intermediate coat having a minimum volume solids of 84 percent, with an inorganic zinc prime coat and a pigmented polyurethane finish coat having a minimum volume solids of 73 percent.

b. Service Conditions: For use with metal structures or pipes subjected to water condensation, chemical fumes such as hydrogen sulfide, salt spray, and chemical contact.

c. Surface Preparation: Solvent clean in accordance with SSPC SP 1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP 10/NACE No. 2.

d. Prime Coat: Self-curing, two-component inorganic zinc-rich coating recommended by the manufacturer for overcoating with a high-build epoxy finish coat. Minimum zinc content shall be 12 pounds per gallon. Apply to a thickness of 3 mils. Products: Tnemec Series 90-97; Sherwin-Williams Zinc-Clad II Plus, or equal.

e. Intermediate Coat: Tnemec Series 135; Sherwin-Williams Macropoxy 646 B58-600/B58V600 or equal. Film thickness 5.0 to 8.0 mils/coat. Minimum solids by volume should be 84 percent.

f. Finish Coat: Two-component pigmented acrylic or aliphatic polyurethane, recommended by the manufacturer for overcoating a high-build epoxy coating. Apply to a thickness of at least 3 mils. Products: Tnemec Series 740 Sherwin-Williams Hi-Solids Polyurethane B65-300 Series/B60V30; or equal

System No. 18: Exposed Metal Organic Zinc Primer for Shop Coating and Field Touch-Up:

a. Type: Organic zinc primer having a minimum zinc content of 14 pounds per gallon.

b. Service Conditions: For use as a shop-applied primer or field touch-up primer over inorganic zinc prime coatings on exposed metal

c. Surface Preparation: Solvent clean in accordance with SSPC SP 1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP 10/NACE No. 2.

d. Coating: Coating shall be of the two- or three-component converted epoxy, epoxy phenolic, or urethane type. Products: Tnemec 90-97; Sherwin-Williams Zinc-Clad III HS B69A100/B69D11/B69D11; or equal. Applied to a minimum dry-film thickness of 3 mils. Organic zinc primer shall be manufactured by the prime coat manufacturer.

2.3.3 Buried Metal Coating Systems

System No. 21: Buried Metal:

a. Type: High solids Cycloaliphatic Amine epoxy or phenolic epoxy having minimum volume solids of 80 percent (ASTM D 2697).

b. Service Conditions: Buried metal, such as valves, flanges, bolts, nuts, structural steel, and fittings.

c. Surface Preparation: Solvent clean in accordance with SSPC SP 1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP 10/NACE No. 2.

d. Coating System: Apply three or more coats of Tnemec 104 HS (6.0 to 8.0 mils per coat); Sherwin-Williams Tank Clad HS B62-80 Series/B60V80 Series at 5.0 to 8.0 mils/coat; or equal; 30 mils total. Maximum thickness of an individual coating shall not exceed the manufacturer's recommendation.

System No. 24: Buried Metal:

a. Type: Corrosion-resisting grease.

b. Service Conditions: Buried metal, such as bolts, bolt threads, tie rods, and nuts.

c. Surface Preparation: Solvent clean in accordance with SSPC SP 1 to remove contaminants from the surface. Power Tool Clean in accordance with SSPC SP 3 as a minimum. Abrasive blasting in accordance with SSPC SP 6/NACE No.3 is preferred.

d. Coating: NO-OX-ID GG-2 as manufactured by Sanchem, Inc. Apply to a minimum thickness of 1/4-inch.

2.3.4 PVC, CPVC, and FRP Coating System

System No. 41: PVC, CPVC, and FRP, Ultraviolet Exposure or Color Coding:

a. Type: Epoxy primer with minimum volume solids of 54 percent and a pigmented polyurethane enamel having a minimum volume solids of 73 percent.

b. Service Conditions: PVC or CPVC or FRP exposed to sunlight.

c. Surface Preparation: Clean the surface in accordance with SSPC SP 1. Then, lightly abrade the surface with medium-grain sandpaper.

d. Prime Coat: One coat of Tnemec Series N69 Epoxoline; Sherwin-Williams Macropoxy 646 B58 Series/B58V600; or equal. Apply to a minimum dry-film thickness of 4 mils.

e. Finish Coat: One coat of Tnemec Series 740; Sherwin-Williams Hi-Solids Polyurethane B65-300 Series/B60V30; or equal. Apply to a dry-film thickness of 3 to 5 mils.

2.3.5 Coating Systems for Nonferrous Metals

System No. 51: Insulate Aluminum (Insulation) from Concrete and Carbon Steel:

Type: Bituminous paint having a minimum volume solids of 68 percent coal-tar pitch based.

b. Service Conditions: Coat areas of aluminum grating, stairs,

structural members or aluminum fabrications, in contact with concrete or carbon steel with this system.

c. Surface Preparation: Solvent or steam clean in accordance with SSPC SP 1; do not use alkali cleaning. Then dust blast. Option to hand or power scarify.

d. Finish Coat: Tnemec 46-465; or equal. Apply two coats to a minimum dry-film thickness of 8.0 to 12.0 mils per coat.

System No. 55: Repair of Galvanized Steel Surfaces:

a. Type: Cold galvanizing compound consisting of paint containing oils, solvents, and zinc dust and complying with MIL-P-21035. Minimum metallic zinc content in the cured coating shall be 90 percent.

b. Service Conditions: Repair of damaged galvanized coatings on steel surfaces.

c. Surface Preparation: Clean damaged surfaces in accordance with SSPC SP 1 and SSPC SP 11.

d. Coating System: Apply Z.R.C. Galvanizing Compound; RAMCO Specialty Products "Zinckit"; NuWave "Galv-Match-Plus"; Devcon "Cold Galvanizing"; Clearco "Cold Galvanizing Spray"; or equal; to a minimum dry-film thickness of 3 mils. Apply as specified in ASTM A780/A780M, Annex A2.

PART 3 EXECUTION

3.1 GENERAL

Manufacturer's recommendations for surface preparation, thinning, mixing, handling, and applying his product shall be considered a part of this specification. In case of conflict between the manufacturer's recommendations and the requirements of this specification, the latter shall take precedence.

3.2 PROTECTION

Contractor shall remove and reinstall, or provide acceptable protection for, all hardware, accessories, lighting, and electrical components, factory-finished materials, plumbing fixtures and fittings, and any other materials that may become splattered or damaged by the painting work. "WET PAINT" signs shall be posted to indicate newly painted surfaces.

Every precaution shall be taken to prevent damage to adjacent buildings, shrubs and motor vehicles. Roping, barricading or covering to preclude damage to personal and real property during surface preparation and painting shall be the Contractor's responsibility. When spray painting, the Contractor must give 24 hours advance warning, coordinated with the Contracting Officer or his representative, and post signs to ensure parking arrangements can be made. Repairs to damaged surfaces shall be effected at no additional cost to the Government.

3.3 SURFACE PREPARATION

3.3.1 General Surface Preparation

All surfaces shall be clean, dry, and free from contaminants and foreign matter. Mildew and chalking shall be removed and the surface thoroughly sterilized. All chipped, peeling, or blistered paint shall be removed and the surface spot-primed. Hard, glossy surfaces shall be dulled and roughened to ensure proper adhesion.

3.3.2 Metal Surfaces

All heavy rust and loose mill scale shall be removed from steel in accordance with SSPC SP 3, Power Tool Cleaning.

Minor aluminum oxide film and corrosion shall be removed by hand or power tool cleaning.

Previously unpainted galvanized and aluminum surfaces shall be treated with wash primer in accordance with manufacturer's instructions.

3.3.3 Masonry Surfaces

All surfaces shall be free from form-release compounds, laitance, and other contaminants.

Large cracks, voids and other major surface imperfections shall be repaired before painting. All repairs to cracks and openings in cement block or masonry surfaces shall require preparation of a "V" type opening with the top of the "V" one-half the depth of the crack or opening. All non-tenacious material shall be removed, then the "V" shall be filled using epoxy gel grout in accordance with manufacturer's instructions.

3.3.4 Sealing

All cracks, crevices, and joints such as those along the perimeter of windows and doors shall be sealed with a paintable latex type caulking conforming to ASTM C 920.

3.4 MIXING AND APPLICATION

3.4.1 General

All painting shall be accomplished in accordance with the painting schedule.

No exterior painting shall be allowed in rainy weather or when rain is imminent. No paints or coatings shall be applied when the temperature or humidity is outside the limits recommended by the manufacturer.

Paints and coatings shall be applied by brush, roller, or airless spray.

Each coat of material applied shall be free from runs, sags, bubbles, and foreign contaminants; variations in color, gloss and texture; dry overspray, brush, and roller marks; holidays (missed areas); or other evidence of poor application.

All paints and coatings shall be thoroughly worked into corners and crevices.

Paints and coatings shall be neatly "cut-in" around doors, windows, ceilings, etc.

All newly painted surfaces shall be adequately protected from damage.

3.4.2 Procedures

Coatings shall be applied as follows:

a. Material shall be thoroughly stirred to produce a uniform mixture.

b. Material shall be thinned for workability and improved spray characteristics, but only according to the manufacturer's instructions.

c. Each coat shall be applied uniformly at the minimum wet-film thickness specified by the manufacturer.

d. Special attention shall be given when coating sharp edges, corners, and crevices to ensure complete coverage.

e. Finish coats shall show good hiding characteristics and uniform appearance.

3.4.3 Exterior Surfaces

Metal surfaces shall be primed with alkyd primer in accordance with manufacturer's instructions, and topcoated with two coats enamel in accordance with manufacturer's instructions.

Paint shall be allowed to dry overnight before re-coating.

3.4.4 Interior Surfaces

Wood and metal surfaces shall have two coats of enamel paint applied in accordance with manufacturer's instructions. A twelve hour drying time shall be required between coats. Surfaces to be painted with enamel paint include any metal or wood paintable surface. Items to be painted include (but are not limited to) doors, jambs, handrails, and grilles.

Masonry surfaces shall have two coats of epoxy paint applied in accordance with manufacturer's instructions on wall surfaces, ceilings and appurtenances (excluding vinyl cove base) with colors other than that specified. A twelve hour drying time shall be required between coats. One coat of epoxy shall be applied on areas where existing color is the same as that specified. Areas requiring only one coat of epoxy shall be patched and spot primed or touched up before painting to insure one coat coverage. A four hour minimum drying time shall be required between the spot primed coat and the finish coat. Surfaces to painted with epoxy paint include concrete, concrete masonry, gypsum drywall systems and plaster. Items to be painted include (but are not limited to) walls, ceilings, pipes and columns.

3.5 SPOT-PAINTING

Spot-painting to correct damaged surfaces will be allowed only when touchup area blends into the surrounding finish. Otherwise, the entire area shall be recoated. Touchup shall be accomplished using the same

method of application as was used to apply the original material.

3.6 ACCEPTANCE PROVISIONS

3.6.1 Inspection

Contractor shall provide for inspection of his work to ensure that the requirements of this section have been fulfilled.

3.6.2 Cleanup

Contractor shall be responsible for removal of all paint or coating splatter and spills from floors, adjacent walls, hardware, and all other finished surfaces.

Contractor shall leave the work area clean and free from all rubbish and accumulated material left from his work.

3.7 PAINT SCHEDULE

3.7.1 Exterior Paint Schedule

Colors shall be in accordance with FED-STD-595.

SURFACE	PRIMER	FINISH COAT	FINISH COLOR AND SHEEN
Exterior masonry (rough/ porous)	Latex block filler	Acrylic emulsion latex	Gray - flat
Exterior metal - Metal paint shall be with System No. 10.	Inorganic zinc primer	Intermediate and finish high-build epoxy	Gray - semi-gloss

3.7.2 Interior Paint Schedule

Colors shall be in accordance with FED-STD-595 manufacturer's product name/number.

SURFACE	PRIMER	FINISH COAT	FINISH COLOR AND SHEEN
Interior metal - Metal paint shall be with System No. 10.	Inorganic zinc primer	Intermediate and finish high-build epoxy	Semi-gloss

3.7.3 Process Piping Paint Schedule

The exact coating to be applied in any location is not designed by the descriptive phrases in the coating system titles such as "corrosive

environment," "buried metal," or "submerged metal." The Contractor shall coat surfaces with the specific coating systems as described below:

A. Coat mechanical equipment such as pumps, fans, and air compressors as described in the various mechanical equipment specifications. The color of finish coat shall match the color of the connecting piping or as designated by the Government.

B. Coat aboveground and exposed piping or piping in vaults and structures as described in the various piping specifications as shown in the Process Paint Schedule below. The color of the finish coat shall be as shown in the Process Paint Schedule below.

C. Coat valves as described in the various valve specifications. System No. 10 shall be used if coating is not specified in the valve specification. Aboveground valves, or valves in vaults and structures, shall match the color of the connecting piping.

D. Coat aluminum surfaces in contact with concrete according to System No. 51.

E. Coat buried flanges, nuts and bolts, valves, flexible piping couplings, exposed rebar in thrust blocks, and valve boxes as specified in the particular specifications for the above items. If the particular specifications do not specify a coating system, coat buried bolt threads, tie bolt threads, and nuts according to System No. 24.

Service	Pipe/Duct Material	Pipe Material Abbrev	Exposed Pipe Paint System	Color Code
Ammonium Sulfate	Polyvinyl Chloride	PVC	41	Light Green Bands
Ammonium Sulfate	Reinforced Polyvinyl Chloride Hose	PVC Hose	N/A	Light Green Bands
Ammonium Sulfate Containment	Polyvinyl Chloride	PVC	41	Light Green Bands
Sodium Hypochlorite	Polyvinyl Chloride	PVC	41	Yellow
Sodium Hypochlorite	Reinforced Polyvinyl Chloride Hose	PVC Hose	N/A	Yellow Bands
Sodium Hypochlorite Containment	Polyvinyl Chloride	PVC	41	Yellow Bands
Water Main	Ductile Iron	DI	10	Dark Blue
Fire Protection	Ductile Iron or Steel	DI or STL	10	Red

-- End of Section --

SECTION 10 10 00

VISUAL COMMUNICATIONS SPECIALTIES
02/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

GYPSUM ASSOCIATION (GA)

GA 214	(2010) Recommended Levels of Gypsum Board Finish

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 SYSTEM DESCRIPTION

The term visual display board when used herein includes marker boards; submit manufacturer's descriptive data and catalog cuts plus manufacturer's installation instructions, and cleaning and maintenance instructions. Visual display boards shall be from manufacturer's standard product line. Submit certificate of compliance signed by Contractor attesting that visual display boards conform to the requirements specified.

1.3 SUSTAINABILITY REQUIREMENTS

Materials in this technical specification may contribute towards contract compliance with sustainability requirements.

1.3.1 LEED REQUIREMENTS

See Section 01 33 29 LEED DOCUMENTATION for project LEED NC recycled content, requirements.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Visual Display Board

SD-04 Samples

Aluminum Trim

White Markerboard
Submit 7 x 9 inch samples of vinyl wall covering indicated.
Submit 6 inch long samples of trim.

SD-11 Closeout Submittals

Energy Star documentation.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in the manufacturer's original unopened containers and store them in a clean dry area with temperature maintained above 50 degrees F. Stack materials according to manufacturer's recommendations. Visual display boards shall be allowed to acclimate to the building temperature for 24 hours prior to installation.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 White Markerboard

Vinyl wall covering shall have a Class A flame spread rating of 0-50 and smoke development rating of 0-450 in accordance with ASTM E84.

Product and Manufacturer - Basis of Design: Walltalkers Erase-Rite; RJF International Corporation, or equal.

Description: Pigmented vinyl capped with dry erase low gloss film.
Backing: Non-woven.
Vinyl Color: White
Aluminum Trim: Extruded aluminum; clear anodized finish.

2.1.2 Aluminum

Aluminum frame extrusions shall be alloy 6063-T5 or 6063-T6, conform to ASTM B221, and be a minimum 0.06 inches thick. Exposed aluminum shall have an anodized, satin finish. Straight, single lengths shall be used. Corners shall be mitered and shall have a hairline closure.

PART 3 EXECUTION

3.1 INSTALLATION

Examine substrates and installation conditions to ensure surface conditions meet or exceed a Level 4 finish, per GA 214: Recommended Levels of Gypsum Board Finish, and permanent lighting should be installed and operational.

Test substrate with suitable moisture meter and verify that moisture content does not exceed four percent.

Verify substrate surface is clean, dry, smooth, structurally sound, and free from surface defects and imperfections that would show through the finished surface.

Evaluate all painted surfaces for the possibility of pigment bleed-through.

Do not begin installation until unsatisfactory condition have been corrected.

Perform installation and assembly in accordance with manufacturer's printed instructions. Visual display boards shall be attached to the walls with suitable devices to anchor each unit. Furnish and install trim items, accessories and miscellaneous items incidental to or necessary for a sound, secure, complete and finished installation. Installation shall not be initiated until completion of room painting and finishing operations. Visual display boards shall be installed in locations and at mounting heights indicated. Visual display boards shall be installed level and plumb. Damaged units shall be repaired or replaced as directed by the Contracting Officer.

3.2 CLEANING

Writing surfaces shall be cleaned in accordance with manufacturer's instructions.

-- End of Section --

SECTION 10 11 43

VISUAL DISPLAY WALL PANELS
02/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Visual Display Wall Panels; G

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in the manufacturer's original unopened containers and store them in a clean dry area with temperature maintained above 50 degrees F. Stack materials according to manufacturer's recommendations. Visual display wall panels shall be allowed to acclimate to the building temperature for 24 hours prior to installation.

1.4 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

PART 2 PRODUCTS

2.1 VISUAL DISPLAY WALL PANELS

Slotted Display Wall Panel - Product and Manufacturer - Basis of Design: Slatwall; Slatwall Systems, Phoenix, AZ, or equal.

3/4 inch (19 mm) thick medium density fiberboard grooved to receive standard-sized fixture mounting brackets for display. MDF paneling to be consistent with the following:

Formaldehyde Emission: Less than 0.3 ppm.

Density: 46-48 pounds per cubic foot (737 kg/cu m) average.
Flame Spread: 200, maximum, when tested in accordance with ASTM E84 (Class C, Class III).
Inner Bond Strength: 100 psi to 105 psi average.
Screw Holding Strength at Edge: 250-275 pounds
Screw Holding Strength at Face: 300 pounds
Moisture Content: 4 to 8 percent.

Slatwall Direction: As indicated.
Panel Finish: Low pressure laminate.
Panel Finish Color: Refer to the Room Finish Legend.
Groove Finish: Extruded aluminum T-shaped insert; mill finish.
Vinyl Trim: Manufacturer's standard vinyl trim; color to be selected by the Contracting Officer.
Slatwall Inserts: Aluminum; T-shaped spaced 4 inches on center.

PART 3 EXECUTION

3.1 INSTALLATION

Perform installation and assembly in accordance with manufacturer's printed instructions. Use concealed fasteners. Visual display wall panels shall be attached to the walls with suitable devices to anchor each unit. furnish and install trim items, accessories and miscellaneous items in total, including but not limited to hardware and anchorages incidental to or necessary for a sound, secure, complete and finished installation. Installation shall not be initiated until completion of room painting and finishing operations. Visual display wall panels shall be installed in locations and at mounting heights indicated. Damaged units shall be repaired or replaced as directed by the Contracting Officer's Representative.

3.2 CLEANING

Clean exposed surfaces in accordance with manufacturer's instructions.

-- End of Section --

SECTION 10 14 01

EXTERIOR SIGNAGE
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN WELDING SOCIETY (AWS)

AWS C1.1M/C1.1	(2012) Recommended Practices for Resistance Welding
AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2008) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A1011/A1011M	(2012b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability and Ultra-High Strength
ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B108/B108M	(2012; E 2012) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B26/B26M	(2012) Standard Specification for Aluminum-Alloy Sand Castings

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

1.2 GENERAL REQUIREMENTS

All exterior signage shall be provided by a single manufacturer. Exterior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation. Submit one 12 inch length of framing and one letter for illuminated signs and one sample of each type of sign. Each sample shall consist of a complete sign panel with letters and symbols. Samples may be installed in the work, provided each sample is identified and location recorded. Submit three color samples for each material requiring color and12 inch square sample of sign face color sample.

1.2.1 Wind Load Requirements

Exterior signage shall be designed to withstand 160 mph windload and in accordance with Florida Building Code, current to date of installation for Risk Category IV. Submit design analysis and supporting calculations performed in support of specified signage signed and sealed by Florida registered Structural Engineer.

1.2.2 Character Proportions and Heights

Letters and numbers on indicated signs for handicapped-accessible buildings shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G

Drawings showing elevations of each sign type of sign; dimensions, details,and methods of mounting or anchoring; shape and thickness of materials; and details of construction. A schedule showing the location, each sign type, and message shall be included.

SD-03 Product Data

Modular Exterior Signage System

Manufacturer's descriptive data and catalog cuts.

Installation

Manufacturer's installation instructions and cleaning instructions.

Exterior Signage; G

Exterior signage schedule in electronic media with spread sheet format. Spread sheet shall include sign location, sign type, and message.

Wind Load Requirements

Design analysis and supporting calculations performed in support of specified signage.

SD-04 Samples

Exterior Signage; G

One sample of each type of sign. Each sample shall consist of a complete sign panel with letters and symbols. Samples may be installed in the work, provided each sample is identified and location recorded. Provide separate color samples for each material requiring color and a 12 inch square sample of sign face color.

SD-10 Operation and Maintenance Data

Protection and Cleaning

Provide copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include simplified diagrams for the equipment as installed.

1.4 QUALIFICATIONS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1.5 DELIVERY AND STORAGE

Materials shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's instructions.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.7 EXTRA STOCK

Extra stock is not required for exterior signage.

PART 2 PRODUCTS

2.1 MODULAR EXTERIOR SIGNAGE SYSTEM

Exterior signage shall consist of a system of coordinated directional, identification, and regulatory type signs located where shown. Dimensions, details, materials, message content, and design of signage shall be as shown. Submit manufacturer's descriptive data and catalog cuts.

2.1.1 Panel And Post/Panel Type Signs

2.1.1.1 Posts

One-piece aluminum posts shall be provided with minimum 0.125 inch wall thickness. Posts shall be designed to accept panel framing system described.

2.1.1.2 Panel Framing System

Panel framing consisting of aluminum extrusions and brackets and interlocking track components shall be designed to interlock with posts with concealed fasteners.

2.1.1.3 Panels

Message panels shall be provided in sizes shown on drawings. Panels shall be fabricated a minimum of 0.125 inch aluminum. Panels shall be designed to be interchangeable.Panels shall be heliarc welded to framing system. Face panels shall be removable to provide access for maintenance.

2.1.1.4 Finishes

Post finish shall be two-component acrylic polyurethane oranodized conforming to AA DAF45 with UV inhibiting clear coat. Metal panel system finish shall be two-component acrylic polyurethane with high quality UV inhibitors with UV inhibiting clear coat.

2.1.1.5 Mounting

Permanent mounting shall be provided by direct burial method embedding posts in concrete footers in accordance with Section 03 33 00. Removable mounting shall be provided by an aluminum sleeve and flange embedded in concrete as shown. Breakaway mounting shall be provided as for any signs required to conform to M.U.T.C.D.

2.2 ILLUMINATION

Concealed lighting shall be provided within fabricated letters and shapes. Lighting shall be controlled by a photocell device. Back lighting shall

be provided by 120 LED lamps,individually connected to one common remote raceway / power source.All components shall be integrally mounted, high power factor and rated for use down to minus 20 degrees F ambient starting temperature. Wiring within the sign shall be in metal raceways. Electrical equipment shall be UL or FM listed and comply with NFPA 70. Illumination shall be evenly distributed. A switch on the raceway cabinet of the sign shall be provided to turn off power in the sign. Switch shall be readily accessible for ease of maintenance.

2.3 GRAPHICS FOR EXTERIOR SIGNAGE SYSTEMS

2.3.1 Graphics

Signage graphics shall conform to the following:

a. Custom fabricated and plate aluminum letters, 1/2 and two inch thick shall be provided and fastened to the message panel with concealed fasteners. LED Illuminated letters shall project one inch from face of panel. Plate letters shall be stud mounted to backer panel with 1/2" offset.

b. Pressure sensitive precision cut vinyl letters with reflecting surface shall be provided.

c. Message shall be applied to panel using the digital print or silkscreen process. Silkscreened images shall be executed with photo screens prepared from original art. Handcut screens will not be accepted. Original art shall be defined as artwork that is a first generation pattern of the original specified art. Edges and corners shall be clean. Rounded corners, cut or ragged edges, edge buildup, bleeding or surfaces pinholes will not be accepted.

d. Routed shapes and forms shall be cut out from panel. Panel cutouts shall be backed with 0.125 inch clear acrylic where cutouts occur.

e. Routed letters shall be cut out from panel. Acrylic letters 1/2 inch thick shall be projected through the cutout area and chemically welded to 0.125 inch thick acrylic backup sheet.

2.3.2 Messages

See drawings and schedule for message content. Typeface for panel signs: Helvetica medium. Type size as indicated. Typeface for monument and building icon signs: Custom and as indicated. Type size as indicated.

2.4 METAL PLAQUES

Design and location of plaques shall be as shown.

2.5 DIMENSIONAL BUILDING LETTERS

2.5.1 Fabrication

Letters shall be fabricated from 0.5 inch aluminum sheet. Letters shall be cleaned by chemical etching or cleaned ultrasonically in a special degreasing bath. Letters shall be packaged for protection until installation.

2.5.2 Typeface

Typeface shall be helvetica medium as indicated.

2.5.3 Size

Letter size shall be as indicated.

2.5.4 Finish

Anodized aluminum and two-component acrylic polyurethane with clear coat finish shall be provided.

2.5.5 Mounting

Threaded studs,steel U-bracket, cap screws, and expansion bolts of number and size as recommended by manufacturer, shall be used for concealed anchorage. Letters which project from the building line shall have stud spacer sleeves. Letters, studs, and sleeves shall be of the same material. Templates for mounting shall be supplied.

2.6 ALUMINUM ALLOY PRODUCTS

Aluminum alloy products shall conform to ASTM B209 for sheet or plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings. Aluminum extrusions shall be provided at least 1/8 inch thick and aluminum plate or sheet at least 16 gauge thick. Welding for aluminum products shall conform to AWS C1.1M/C1.1.

2.7 ANODIC COATING

Anodized finish shall conform to AA DAF45 as follows:

Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.4 mil or thicker.

2.8 ORGANIC COATING

Surfaces shall be cleaned, primed, and given a two-component acrylic polyurethane with high quality UV inhibiting finish in accordance with NAAMM AMP 500, AMP 505, with total dry film thickness not less than 1.2 mils.

2.9 STEEL PRODUCTS

Structural steel products shall conform to ASTM A36/A36M. Sheet and strip steel products shall conform to ASTM A1011/A1011M. Welding for steel products shall conform to AWS D1.2/D1.2M.

2.10 ANCHORS AND FASTENERS

Exposed anchor and fastener materials shall be compatible with metal to which applied and shall match in color and finish and shall be non-rusting, non-corroding, and non-staining. Exposed fasteners shall be tamper-proof.

2.11 SHOP FABRICATION AND MANUFACTURE

2.11.1 Factory Workmanship

Work shall be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled shall be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Welding to or on structural steel shall be in accordance with AWS D1.1/D1.1M. Welding shall be continuous along the entire area of contact. Exposed welds shall be ground smooth. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practical. Items specified to be galvanized shall be by hot-dip process after fabrication if practical. Galvanization shall be in accordance with ASTM A123/A123M and ASTM A653/A653M, as applicable. Other metallic coatings of steel sheet shall be in accordance with ASTM A924/A924M. Joints exposed to the weather shall be formed to exclude water. Drainage and weep holes shall be included as required to prevent condensation buildup.

2.11.2 Dissimilar Materials

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.

2.11.3 Shop Painting

Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel, and zinc-coated work, shall be given one coat of zinc-molybdate primer or an approved rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice. Surfaces of items to be embedded in concrete shall not be painted. Upon completion of work, damaged surfaces shall be recoated.

2.12 COLOR, FINISH, AND CONTRAST

Color shall be as indicated on the drawings. Color listed is not intended to limit the selection of equal colors from other manufacturers. For buildings required to be handicapped-accessible, the characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION

3.1 INSTALLATION

Signs, plaques, or dimensional letters shall be installed in accordance with approved manufacturer's instructions at locations shown on the approved detail drawings. Submit drawings showing elevations of each type of sign; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction. A schedule showing the location, each sign type, and message shall be included. Circuits installed underground shall conform to the requirements of Section 33 71 02.00 20 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Steel conduits installed underground and illuminated signage mounted directly on

buildings shall be in conformance with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs mounted on other surfaces shall not be installed until finishes on such surfaces have been completed. Submit manufacturer's installation instructions and cleaning instructions.

3.1.1 Anchorage

Anchorage and fastener materials shall be in accordance with approved manufacturer's instructions for the indicated substrate. Anchorage not otherwise specified or indicated shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Sign surfaces shall be cleaned in accordance with manufacturer's instructions. After signs are completed and inspected, The Contractor shall cover all project identification, directional, and other signs which may mislead the public. Covering shall be maintained until instructed to be removed by the Contracting Officer's Representative or until the facility is to be opened for business. Submit six copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include simplified diagrams for the equipment as installed. Signs shall be cleaned, as required, at time of cover removal.

3.2 FIELD PAINTED FINISH

Miscellaneous metals and frames shall be field painted in accordance with Section 09 90 00 PAINTS AND COATINGS. Anodized metals, masonry, and glass shall be protected from paint. Finish shall be free of scratches or other blemishes.

-- End of Section --

SECTION 10 14 02

INTERIOR SIGNAGE
02/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes
AA PK-1	(2009) Pink Sheets: Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings & Ingot

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2604	(2010) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2009; Errata 2010) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2008) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM C1036	(2010; E 2012) Standard Specification for Flat Glass
ASTM D635	(2010) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SYSTEM DESCRIPTION

Submit samples of each of the following sign types showing typical quality, workmanship and color: Directional sign, Standard Room sign, Changeable message strip sign; submit interior signage samples. Provide interior signage of the design, detail, sizes, types, and message content shown on the detail drawings, attachments, signage placement drawings (as applicable), conforming to the requirements specified, and placed at the locations indicated. The samples may be installed in the work, provided each sample is identified and location recorded. Submit drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, mounting height, shape and thickness of materials, and details of construction. A schedule showing the location, each sign type, and message shall be included. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation. Signage shall be obtained from a single manufacturer with edges and corners of finished letterforms and graphics true and clean. Recyclable materials shall conform to EPA requirements in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

Drawings showing elevations of each sign, dimensions, details and methods of mounting or anchoring, mounting height, shape and thickness of materials, and details of construction. A schedule showing the location, each sign type, and message shall be included.

SD-03 Product Data

Installation; G

Manufacturer's descriptive data, catalogs cuts, installation and cleaning instructions.

SD-04 Samples

Interior Signage; G

One sample of each of the following sign types showing typical quality, workmanship and color. The samples may be installed in the work, provided each sample is identified and location recorded.

a. Standard Room Sign and standard LEED Informational Sign

b. Standard Cubicle / Panel Hung Sign

c. Mounting bracket and its sign, for projecting sign types

d. Standard Evacuation Map Case and Standard Floor Directory case

Software; G

SD-10 Operation and Maintenance Data

Approved Manufacturer's Instructions;
Protection and Cleaning; G

Copies of operating instructions outlining the step-by-step procedures required for system operation. The instruction shall include simplified diagrams for the system as installed. Provide copies of maintenance instructions listing routine procedures, repairs and guides. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the facility, name of the Contractor, and contract number.

1.4 DELIVERY, STORAGE, AND HANDLING

Materials shall be packaged to prevent damage and deterioration during shipment, handling, storage and installation. Product shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

1.5 EXTRA MATERIALS

Provide 25 extra frames and extra stock of the following: blank plates of each color and size for Room and cubicle identification sign types; 25 changeable message strips for Directory sign types. Provide 25 paper inserts and one copy of the software for user produced signs and for creating text and symbols for IBM compatible computers for Owner production of paper inserts after project completion.Provide one set of any specialized equipment necessary for removal of signage parts and pieces.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of such products that essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening.

2.2 ROOM IDENTIFICATION/DIRECTIONAL/INFORMATIONAL SIGNAGE SYSTEM

2.2.1 Standard Room Signs

Signs shall consist of acrylic plastic 0.080 inch thickness minimum conforming to ANSI Z97.1 or laminated thermosetting Type MP plastic and shall conform to the following:

a. Frames shall be 1/32 inch molded acrylic and 3/8 inch wide as indicated.

b. End caps shall be molded acrylic with square style corners.

2.2.2 Changeable Message Strip Signs

Changeable message strip signs shall be of same construction as standard room signs to include a clear sleeve that will accept a paper or plastic insert identifying changeable text. The insert shall be furnished by Government. Provide paper and software for creating text and symbols for computers for Owner production of paper inserts after project completion. Sliding inserts or slide knobs that slide horizontally exposing different graphic information shall be provided as identified in the signage placement schedule and drawings .

2.2.3 Type of Mounting For Signs

Provide extruded aluminum brackets for hanging, projecting, and double-sided signs. Mounting for framed, hanging, and projecting signs shall be by mechanical fasteners. Wall-surface mounted signs shall be mounted with Velcro or other materials that are not corrosive to sign material and mounting surface. Signs mounted on glass shall have a blank coverplate for the back surface of the same size, material and finish as the sign face so to conceal the attachment. Fabric Panel Mounted signs shall be with aluminum hook device sized to panel frame and thickness or Velcro or other non-corrosive/non-pilling material as applicable. For LEED Informational graphics, signs shall be mounted utilizing a stainless steel stand-off system.

2.2.4 Graphics

Signage graphics for modular signs shall conform to one or a combination of the following:

a. Subsurface copy (non-tactile): Copy is transferred to the back face of clear acrylic sheeting forming the panel face to produce precisely formed opaque image.

b. Silkscreened First Surface Copy (non-tactile): Message shall be applied to panel using the digital printed process. Edges and corners shall be clean.

c. Surface Applied Photopolymer: Integral graphics and braille achieved by photomechanical stratification processes. Photopolymer used for ADA compliant graphics shall be of the type that has a minimum durometer reading of 90. Tactile graphics shall be raised 1/32 inch from the first surface of plaque by photomechanical stratification process.

d. Engraved Copy: Machine engrave letters, numbers, symbols, and other

graphics into panel sign on face to produce precisely formed copy and sharp images, incised to uniform depth. Melamine plastic engraving stock used for ADA compliant graphic shall be three-ply lamination contrasting color core meeting ASTM D635.

e. Solid Aluminum Letters: 1/4 and 1/2 inch thick shall be provided and fastened to the message panel with concealed fasteners or if wall mounted, letters shall be individually stud-mounted.

2.2.5 Character Proportions and Heights

Letters and numbers on signs conform to 36 CFR 1191.

2.2.6 Raised and Braille Characters and Pictorial Symbol Signs (Pictograms)

Raised letters and numbers on signs shall conform to 36 CFR 1191.

2.2.7 Backer Plates for LEED Informational Signs shall be of aluminum sheet with edges filed smooth. Finish with two coat polyurethane metallic paint system and clearcoat. Predrill for mounting using stainless steel stand-off system.

2.2.8 Acrylic Face Plates for LEED Informational Signs shall be clear non-glare with beveled / polished edges as shown. Predrill for mounting using stainless steel stand-off system.

2.3 BUILDING DIRECTORIES

Building directories shall be lobby directories or floor directories, and shall be provided with a changeable directory listing consisting of the areas, offices and personnel located within the facility. Dimensions, details, and materials of sign and message content shall be as shown on the drawingsand signage placement schedule.

2.3.1 Header Panel

Header panel shall have background metal to match frame and shall have raised letterscut aluminum letters.

2.3.2 Doors

2.3.2.1 Door Glazing

Door glazing shall be in accordance with ASTM C1036, C1048, Type 1, Class 1, Quality 3, minimum thickness conforming to manufacturer's guidelines for size and capacity shown in drawings.

2.3.2.2 Door Construction

Extruded aluminum door frame shall be of same finish as surrounding frame. Corners shall be mitered , reinforced, and assembled with concealed fasteners. Hinges shall be standard with the manufacturer, in finish to match frames and trim. Glazing shall be set in frame with resilient glazing channels.Extruded aluminum frames and trim shall be assembled with corners reinforced and mitered to a hairline fit, with no exposed fasteners.

2.3.2.3 Door Locks

Door locks shall be manufacturer's standard, and shall be keyed alike. Provide two sets of keys.

2.3.3 Illuminated Units

Illuminated directory units shall not be installed in this project.

2.3.4 Negative Graphics Directory System

Directory of 'negative graphics' shall not be installed in this project.

2.3.4.1 Construction

The directory shall be constructed of an aluminum frame with satin anodized finish of depth shown in drawings. Unit shall be surface mounted. Unit shall have header lettering as shown at height as indicated on drawings. Unit shall have a face door frame with concealed hinges and locking system. Door frame shall be aluminum with satin finish.

2.3.4.2 Message Strips

Message strips shall not be photo negative type updatable by user.

2.3.5 Changeable Letter/Message Strip Directory System

Directory shall consist of a non-illuminated unit with step or groove, laser or rotary engraved removable name strips cast vinyl to receive molded changeable letter tiles. Design of unit shall be as shown in the drawings.

2.3.5.1 Construction

The directory shall be constructed of an aluminum frame with satin anodized finish depth as shown in drawings. Unit shall be surface mounted. Unit shall have a header with lettering as shown at height indicated on drawings. Unit shall have a concealed hinge door and locking system lift off frame with tempered safety glass. Door frame shall be aluminum with with swing support.

2.3.5.2 Message Strips

Namestrips shall be updatable by user and option by manufacturer. Namestrips shall be acrylic and sized in accordance with manufacturer's standard Helvetica Medium letters.

2.3.6 Touchscreen Electronic Directory System

Touchscreen electronic directory system shall not be used on this project.

2.3.6.1 Directory Unit

Directory unit with touchscreen shall not be used on this project.

2.3.6.2 Update Terminal

Update terminal unit shall not be included in this project.

2.4 DIMENSIONAL BUILDING LETTERS

2.4.1 Fabrication

Letters shall be fabricated from .25 and .5 inch aluminum sheet. Letters shall be cleaned by chemical etching or cleaned ultrasonically in a special degreasing bath. Letters shall be packaged for protection until installation.

2.4.2 Typeface

Typeface shall be helvetica medium.

2.4.3 Size

Letter size shall be as indicated on drawings.

2.4.4 Finish

Anodized aluminumor two-component acrylic polyurethane with clear coat finish shall be provided.

2.4.5 Mounting

Threaded studs cap screws, and expansion bolts of number and size recommended by manufacturer, shall be supplied for concealed anchorage. Letters which project from the mounting surface shall have stud spacer sleeves. Letters, studs, and sleeves shall be of the same material. Templates for mounting shall be supplied.

2.5 PRESSURE SENSITIVE LETTERS

Ensure that edges and corners of finished letterforms and graphics are true and clean. Do not use letterforms and graphics with rounded positive or negative corners, nicked, cut, or ragged edges.

2.5.1 Typeface

Helvetica medium.

2.5.2 Size

As indicated.

2.6 ALUMINUM ALLOY PRODUCTS

Aluminum extrusions shall be at least 1/8 inch thick, and aluminum plate or sheet shall be at least 0.0508 inch thick. Extrusions shall conform to ASTM B221; plate and sheet shall conform to ASTM B209. Where anodic coatings are specified, alloy shall conform to AA PK-1 alloy designation 514.0. Exposed anodized aluminum finishes shall be as shown. Welding for aluminum products shall conform to AWS D1.2/D1.2M.

2.7 ANODIC COATING

Anodized finish shall conform to AA DAF45 as follows:

a. Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.4

mil or thicker.

b. Integral color anodized designation AA-M10-C22-A32, Architectural Class 0.4 to 0.7 mil.

c. Electrolytically deposited color-anodized designation AA-M10-C22-A34, Architectural Class II 0.4 to 0.7 mil.

2.8 ORGANIC COATING

Organic coating shall conform to AAMA 2604, with total dry film thickness not less than 1.2 mils.

2.9 FABRICATION AND MANUFACTURE

2.9.1 Factory Workmanship

Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

2.9.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

2.10 COLOR, FINISH, AND CONTRAST

Color shall be as indicated on the drawings. Finish of all signs shall be eggshell, matte, or other non-glare finish as required in handicapped-accessible buildings.

PART 3 EXECUTION

3.1 INSTALLATION

Signs shall be installed plumb and true and in accordance with approved manufacturer's instructions at locations shown on the detail drawings and sign location drawings. Mounting height and mounting location shall conform to 36 CFR 1191. Required blocking shall be installed. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed. Signs installed on glass surfaces shall be installed with matching blank back-up plates in accordance with manufacturer's instructions.

3.1.1 Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish. Where recommended by signage manufacturer, foam tape pads may be used for anchorage. Foam tape pads shall be minimum 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam. Adhesive surfaces shall be protected with

a5 mil green flatstock treated with silicone. Foam pads shall be sized for the signage in accordance with signage manufacturer's recommendations. Signs mounted to painted gypsum board surfaces shall be removable for painting maintenance. Signs mounted to lay-in ceiling grids shall be mounted with clip connections to ceiling tees.

3.1.2 Protection and Cleaning

Protect the work against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Sign surfaces shall be cleaned at completion of sign installation in accordance with the manufacturer's approved instructions.

-- End of Section --

SECTION 10 14 05
SIGNAGE MESSAGE SCHEDULE FOR SITE AND BUILDING

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS

GENERAL NOTES ALL MESSAGES SHALL REQUIRE GOVERNMENT REVIEW AS SUBMITTALS.

1 Messages herein are identified with the sign designator that cross references its location to the 'W' series 'F Size' signage location plans. Ground level floor plan is W111. Site Plan is W101.

2 Messages for any individual cubicle work station names are to be coordinated with Government. Contractor to install at time of furniture installation to each cubicle set as applicable.

3 Refer to 'W' series 'F' Size detail drawings for elevations of each or similar sign types to understand layout information, use of caps and lower cases, and all other graphic details to be utilized for each sign type.

4 All messages indicated are for Government final coordination. ALL MESSAGES AND DOOR NUMBERS shall be submitted by fabricator during the submittal process in electronic schedule format for the preliminary and subsequent edit and final reviews by the Government.

SHEET W101 SITE PLAN

SA
Sign Type SA -MONUMENT SIGN - ENTRANCE IDENTIFICATION

101	SA	01	"LOGO" (symbol 22) KENNEDY SPACE CENTER HEADQUARTERS	

SB
Sign Type SB - PREFERRED PARKING - DIRECTOR

101	SB	01	(symbol 22) DIRECTOR	

SC p
Sign Type SC - PREFERRED PARKING - ELECTRIC VEHICLE / CHARGE STATION

101	SC	01	(symbol 15)	(14 locations)
	THRU		ELECTRIC VEHICLE CHARGING STATION	
101	SC	14		

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
SD				
Sign Type SD - PREFERRED PARKING - FUEL EFFICIENT VEHICLE				
101	SD	01	(symbol 16)	(8 locations)
	THRU		FUEL EFFICIENT VEHICLE ONLY	
101	SD	08		
SE				
Sign Type SE - PREFERRED PARKING - CAR POOL VEHICLE				
101	SE	01	(symbol 16)	(22 locations)
	THRU		CAR POOL VEHICLE ONLY	
101	SE	22		
BF				
Sign Type SF - FIRE DEPARTMENT CONNECTION PANEL SIGN				
101	SF	01	FDC	
SG				
Sign Type SG - LEED EQ NO SMOKING / WALL MOUNTED				
101	SG	01	(SYMBOL 7) NO SMOKING ZONE	
101	SG	02	(SYMBOL 7) NO SMOKING ZONE	
101	SG	03	(SYMBOL 7) NO SMOKING ZONE	
101	SG	04	(SYMBOL 7) NO SMOKING ZONE	
101	SG	05	(SYMBOL 7) NO SMOKING ZONE	
101	SG	06	(SYMBOL 7) NO SMOKING ZONE	
101	SG	07	(SYMBOL 7) NO SMOKING ZONE	
101	SG	08	(SYMBOL 7) NO SMOKING ZONE	
101	SG	09	(SYMBOL 7) NO SMOKING ZONE	
SH				
Sign Type SH -LEED EQ NO SMOKING POST MOUNTED				
101	SH	01	(SYMBOL 7) ENTERING NO SMOKING ZONE	
101	SH	02	(SYMBOL 7) ENTERING NO SMOKING ZONE	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
101	SH	03	(SYMBOL 7) ENTERING NO SMOKING ZONE	
101	SH	04	(SYMBOL 7) ENTERING NO SMOKING ZONE	
101	SH	05	(SYMBOL 7) ENTERING NO SMOKING ZONE	
101	SH	06	(SYMBOL 7) ENTERING NO SMOKING ZONE	
101	SH	07	(SYMBOL 7) ENTERING NO SMOKING ZONE	
101	SH	08	(SYMBOL 7) ENTERING NO SMOKING ZONE	
101	SH	09	(SYMBOL 7) ENTERING NO SMOKING ZONE	
101	SH	10	(SYMBOL 7) ENTERING NO SMOKING ZONE	
101	SH	11	(SYMBOL 7) ENTERING NO SMOKING ZONE	

Sign Type SI - NOT USED

101	SI	01	not used

Sign Type SJ - NOT USED

101	SJ	01	not used

Sign Type SK -IDENTIFICATION - BUILDING MOUNTED LOGO IDENTIFICATION

101	SK	01	"LOGO"

Sign Type SL - PREFERRED PARKING - GOVERNMENT SERVICE VEHICLES

101	SL	01	(symbol 22)
	THRU		GOVERNMENT SERVICE VEHICLE ONLY
101	SL	01	

Sign Type SM-not used

101	SM	01	not used

SHEET W111 LEVEL 1 AREA 1

BA

Sign Type BA -BUILDING ENTRANCE IDENTIFICATION

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS	
111	BA	01	### (address)	to be determined	This may be by government
111	BA	02	### (address)	to be determined	This may be by government

BB

Sign Type BB - VINYL DYE CUT COPY

111	BB	01	not used

BC

Sign Type BC - LEED MESSAGE

111	BC	01	Entering a smoke-free environment. No Smoking Within 50 Feet of Entrance.
111	BC	02	Entering a smoke-free environment. No Smoking Within 50 Feet of Building
111	BC	03	Entering a smoke-free environment. No Smoking Within 25 Feet of Building
111	BC	04	Entering a smoke-free environment. No Smoking Within 25 Feet of Building

BD

Sign Type BD1 - LARGE WALL MOUNTED BUILDING DIRECTORY

111	BD1	01	copy to be furnished by government

Sign Type BD2 -SMALL WALL MOUNTED BUILDING DIRECTORY

111	BD2	01	copy to be furnished by government
111	BD2	02	copy to be furnished by government

BE

Sign Type BE - WALL MOUNTED DIRECTIONAL

111	BE	01	not used

BF

Sign Type BF - CONFERENCE / IN USE

111	BF	01	1238 CONFERENCE with in use / available insert

BG

Sign Type BG - LEED / INFORMATIONAL

111	BG	01	Sustainable Design	rotate 90 degrees

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			The selection and development of a building's site are fundamental components of sustainable building practices. Site considerations implemented for this building include protection of waterways, soi,; and plants during construction. Dedicated parking encourages use of electronic vehicles and carpooling. Open space is landscaped with indigenous vegetation providing refuge for wildlife, and lighting systems are designed to reduce light pollution.	
111	BG	02	Water Efficiency	rotate 90 degrees
			Consumption of water use continues to increase, which depletes natural water bodies. Water conservation strategies employed in this building include installation of low flow plumbig fixtures, which saves fresh water and reduces the load on municipal waste water treatment infrastructure. The landscape is comprised of indigenous and climate appropriate vegetation, eliminating the need for an irrigation system.	
111	BG	03	Energy and Atmosphere	rotate 90 degrees
			The U.S. Department of Energy states that buildings consume approximately 39% of the energy and 79% of the electricity produced in the U.S. annually. This building incorporates energy efficient lighting and windows, high efficiency fans, motors, pumps, and an exhaust air recovery system, which in total provide 30% more efficiency than a conventional building. XX% of energy is provided from renewable sources.	
111	BG	04	Indoor Environmental Quality	rotate 90 degrees

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			The quality of the indoor environment has a significant influence on the well-being and productivity of occupants. Measures taken to ensure a healthy indoor environment include HVAC systems which maintain fresh air intake and eliminate airborne contaminants. The adhesives, sealants, paints, and carpet installed in the building emit low v.o.c.'s; and 90% of the interior spaces allow for views to the exterior, providing ample daylight.	
111	BG	05	Materials and Resources During the life cycle of a material, its extraction, processing, transportation use, and disposal can create negative environmental impacts. During construction, XX% of construction waste was recycled. More than XX% of materials used in this building contain recycled content, and more than XX% of materials were manufacturered within 500 miles of the building site. The majority of wood used is FSC certified.	rotate 90 degrees
BH				
Sign Type BH1 -IDENTIFICATION - MECHANICAL / ELECTRICAL / COMMS / JANITOR				
111	BH1	01	1219	
111	BH1	02	1211	
111	BHI	03	1221	
111	BH1	04	1040	
111	BH1	05	1414R	
111	**BH1**	**06**	1444	
Sign Type BH2 - IDENTIFICATION - DEPARTMENT / TENANT				
111	BH2	01	1022 CREDIT UNION (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
111	BH2	02	1236 GRAPHICS PRINTING (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
111	BH2	03	1433 POST OFFICE (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
111	BH2	04	1443 POST OFFICE (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
111	BH2	05	not used	
111	BH2	06	1240 MANAGERS OFFICE (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
Sign Type BH3 - IDENTIFICATION - OFFICE / GENERAL ROOMS				
111	BH3	01	1208	
111	BH3	02	1212	
111	BH3	03	**1022D**	
111	BH3	04	**1208B**	
111	BH3	05	1208A	OR 1212?
111	BH3	06	1214	
111	BH3	07	1400M	
111	BH3	08	1400L	
111	BH3	09	1400C	
111	BH3	10	1400J	
111	BH3	11	**1400D**	
111	BH3	12	**1417B**	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
111	BH3	13	**1400D**	
111	BH3	14	1417E	
111	BH3	15	1443C	
111	BH3	16	1417E	
111	BH3	17	1417F	
111	BH3	18	1400J	
111	BH3	19	1240F	
111	BH3	20	1242	
111	BH3	21	1244	
111	BH3	22	1443A	
111	BH3	23	1433A	
111	BH3	24	1417P	
111	BH3	25	1417S	
111	BH3	26	1443	

Sign Type BH4 -IDENTIFICATION - OFFICE WITH NAME INSERT

111	BH4	01	1242 (Name Insert TBD)	GRAPHICS LEAD
111	BH4	02	1246A (Name Insert TBD)	XXXX
111	BH4	03	1246G (Name Insert TBD)	XXXX
111	BH4	04	1246F (Name Insert TBD)	XXXX
111	BH4	05	1246E (Name Insert TBD)	XXXX
111	BH4	06	1246D	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name Insert TBD)	XXXX
111	BH4	07	1246C (Name Insert TBD)	XXXX
111	BH4	08	1246B (Name Insert TBD)	XXXX
111	BH4	09	**1240E** (Name Insert TBD)	XXXX
111	BH4	10	**1240A** (Name Insert TBD)	
111	BH4	11	**1240B** (Name Insert TBD)	
111	BH4	12	**1240C** (Name Insert TBD)	
111	BH4	13	**1022A** (Name Insert TBD)	
111	BH4	14	1022B (Name Insert TBD)	
111	BH4	15	not used	
111	BH4	16	not used	
111	BH4	17	1443B (Name Insert TBD)	XXXX
111	BH4	18	1417M (Name Insert TBD)	XXXX
Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR				
111	BH5	01	EXIT	
111	BH5	02	EXIT	
111	BH5	03	EXIT	
111	BH5	04	EXIT	
111	BH5	05	EXIT	
111	BH5	06	not used	
Sign Type BH6 -IDENTIFICATION- RESTROOM				
111	BH6	01	**1218** (symbol 2,4) MEN	
111	BH6	02	**1222** (symbol 3,4) WOMEN	
111	BH6	03	**1417N**	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE (symbol 5) RESTROOM	REMARKS
Sign Type BH7 - IDENTIFICATION - STAIRWELL				
111	BH7	01	1010 EAST EXIT STAIR 1st FLOOR	
111	BH7	02	1231 WEST EXIT STAIR 1st FLOOR	
Sign Type BH8 - IDENTIFICATION - ELEVATOR IDENTIFICATION				
111	BH8	01	1020 ELEVATOR 2	
111	BH8	02	1016 ELEVATOR 1	
111	BH8	03	1423 ELEVATORS 5,6	OR 1223?
111	BH8	04	1427 ELEVATORS 5,6	
111	BH8	05	1223 ELEVATORS 5,6	
111	BH8	06	1223A ELEVATOR 6	
111	BH8	07	1423A ELEVATOR 5	
111	BH8	08	1223A ELEVATOR 6	
BJ				
Sign Type BJ1 REGULATORY - STAIR LEVEL / EXIT INSTRUCTIONS				
111	BJ1	01	EXIT STAIR # ROOF ACCESS	
			FLOOR 1	*FLOOR 1 IS TACTILE AND IN BRAILLE*
			★ EXIT THIS LEVEL FLOORS 1 - ROOF	
111	BJ1	02	EXIT STAIR # ROOF ACCESS	
			FLOOR 1	*FLOOR 1 IS TACTILE AND IN BRAILLE*
			★ EXIT THIS LEVEL STAIR SERVES FLOORS 1 - ROOF	
111	BJ1	03	not used	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BJ2 REGULATORY - ELEVATOR, IN CASE OF FIRE...				
111	BJ2	01	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
111	BJ2	02	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
111	BJ2	03	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
111	BJ2	04	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
111	BJ2	05	not used	
Sign Type BJ3 - MAXIMUM OCCUPANCY				
111	BJ3	01	MAXIMUM OCCUPANCY ###	verify number with architect
Sign Type BJ4 - REGULATORY - MEDICAL TRANSIT ELEVATOR				
111	BJ4	01	(symbol 18)	mount on hoist way, both sides above level number
111	BJ4	02	(symbol 18)	mount on hoist way, both sides above level number
Sign Type BJ5 - FIRE EXTINGUISHER				
111	BJ5	01-08	(symbol 21)	for estimate purposes include 8, see note on dwgs.
Sign Type BJ6 - STAIR RE-ENTRY MESSAGE				
111	BJ6	01	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
111	BJ6	02	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
BK				
Sign Type BK - LEED RECYCLE				

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
111	BK	01	(symbol 9) not used RECYCLE	

BL
Sign Type BK - EVACUATION MAP CASE

111	BL	01	EVACUATION MAP (insert)	Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government
111	BL	02	EVACUATION MAP (insert)	Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government
111	BL	03	EVACUATION MAP (insert)	Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government

BM
Sign Type BM - DIMENSIONAL LETTERS

111	BM	01	to be determined	5 1/2" +- Medium Letters
111	BM	02	to be determined	5 1/2" +- Medium Letters
111	BM	03	to be determined	5 1/2" +- Medium Letters
111	BM	04	to be determined	5 1/2" +- Medium Letters
111	BM	05	to be determined	5 1/2" +- Medium Letters
111	BM	06	Left Panel: "I believe this nation should commit itself to achieving the goal, before this decade is over, of landing a man on the Moon and returning him safely to Earth." Right Panel: "Ask not what your country can do for you: Ask what you can do for your country."	1 1/2" +- Small Letters

SHEET W112 LEVEL 1 AREA 2

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
BA				
Sign Type BA -BUILDING ENTRANCE IDENTIFICATION				
112	BA	01	### address	This may be by government
BB				
Sign Type BB - VINYL DYE CUT COPY				
112	BB	01	**not used**	
BC				
Sign Type BC - LEED MESSAGE				
112	BC	01	Entering a smoke-free environment. No Smoking Within 25 Feet of Entrance.	
112	BC	02	Entering a smoke-free environment. No Smoking Within 25 Feet of Entrance.	
112	BC	03	Entering a smoke-free environment. No Smoking Within 25 Feet of Entrance.	
112	BC	04	Entering a smoke-free environment. No Smoking Within 25 Feet of Entrance.	
BD				
Sign Type BD - WALL MOUNTED BUILDING DIRECTORY				
112	BD	01	not used	
BE				
Sign Type BE - WALL MOUNTED DIRECTIONAL				
112	BE	01	not used	
BF				
Sign Type BF - CONFERENCE / IN USE				
112	BF	01	not used with in use / available insert	
BG				
Sign Type BG - LEED / INFORMATIONAL				
112	BG	01	not used	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
BH				
Sign Type BH1 -IDENTIFICATION COMMON AREA - MECHANICAL / ELECTRICAL / COMMS / JANITOR				
112	BH1	01	1458	
112	BH1	02	1452	
112	BH1	03	1452	
112	BH1	04	1451	
112	BH1	05	1454	
112	BH1	06	1457	
112	BH1	07	1260	
112	BH1	08	1464	
112	BH1	09	1457	
Sign Type BH2 - IDENTIFICATION - DEPARTMENT / TENANT				
112	BH2	01	1254 PRINT PRODUCTION (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
112	BH2	02	1453 MAIL ROOM (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
112	BH2	03	1262 PRINT PRODUCTION (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
112	BH2	04	1460 MAIL ROOM (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
Sign Type BH3 - IDENTIFICATION - OFFICE / GENERAL ROOMS				
112	BH3	01	1256	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
112	BH3	02	1246	OR 1254A?
112	BH3	03	1246	

Sign Type BH4 -IDENTIFICATION - OFFICE WITH NAME INSERT

112	BH4	01	1453C (Name Insert TBD)	XXXX
112	BH4	02	**1453B** (Name Insert TBD)	XXXX
112	BH4	03	**1453A** (Name Insert TBD)	XXXX
112	BH4	04	**1256E** (Name Insert TBD)	XXXX
112	BH4	05	**1256F** (Name Insert TBD)	XXXX
112	BH4	06	**1256** (Name Insert TBD)	XXXX
112	BH4	07	**1256H** (Name Insert TBD)	XXXX
112	BH4	08	**1256D** (Name Insert TBD)	XXXX
112	BH4	09	**1256C** (Name Insert TBD)	XXXX
112	BH4	10	**1256A** (Name Insert TBD)	XXXX
112	BH4	11	**1256B** (Name Insert TBD)	XXXX

Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR

112	BH5	01	EXIT
112	BH5	02	EXIT
112	BH5	03	EXIT
112	BH5	04	EXIT

Sign Type BH6 -IDENTIFICATION- RESTROOM

112	BH6	01	not used

Sign Type BH7 - IDENTIFICATION - STAIRWELL

112	BH7	01	not used

BJ

Sign Type BJ1 - STAIR LEVEL IDENTIFICATION - not used

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BJ2- ELEVATOR REGULATORY - not used				
Sign Type BJ3 - MAXIMUM OCCUPANCY - not used				
Sign Type BJ4 - MED TRANSIT ELEVATOR - not used				
Sign Type BJ5 - FIRE EXTINGUISHER				
112	BJ5	01-08	(symbol 21)	For estimate purposes include 8, see note on dwgs.
Sign Type BJ6 - STAIR RE-ENTRY				
			not used	
BK				
Sign Type BK - LEED RECYCLE				
112	BK	01	not used	
BL				
Sign Type BL - EVACUATION MAP CASE				
112	BL	01	EVACUATION MAP (insert)	For estimate purposes include 3, see note on dwgs. Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government
BM				
Sign Type BM - DIMENSIONAL LETTERS				
112	BM	01	not used	
SHEET W113 LEVEL 1 AREA 3				
BC				
Sign Type BC - LEED MESSAGE				
113	BC	01	Entering a smoke-free environment. No Smoking Within 25 Feet of Entrance.	
113	BC	02	Entering a smoke-free environment. No Smoking Within 25 Feet of Entrance.	
Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR				
113	BH5	01	EXIT	
113	BH5	02	EXIT	
SHEET W121 LEVEL 2 AREA 1				

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
BA				
Sign Type BA -BUILDING ENTRANCE IDENTIFICATION				
121	BA	01	not used	
BB				
Sign Type BB - VINYL DYE CUT COPY				
121	BB	01	not used	
BC				
Sign Type BC - LEED MESSAGE				
121	BC	01	not used	
BD				
Sign Type BD2 - SMALL WALL MOUNTED BUILDING DIRECTORY				
121	BD2	01	text to be furnished by government	
121	BD2	02	text to be furnished by governement	
BE				
Sign Type BE - WALL MOUNTED DIRECTIONAL				
121	BE	01	not used	
BF				
Sign Type BF - CONFERENCE IN / USE				
121	BF	01	2009 CONFERENCE with in use / available insert	
121	BF	02	2025 CONFERENCE with in use / available insert	
121	BF	03	2240 CONFERENCE with in use / available insert	
BG				
Sign Type BG - LEED / INFORMATIONAL				
121	BG	01	not used	
BH				
Sign Type BH1 -IDENTIFICATION COMMON AREA - MECHANICAL / ELECTRICAL / COMMS / JANITOR				
121	BH1	01	2205	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
121	BH1	02	2211	
121	BH1	03	2215	
121	BH1	04	2217	
121	BH1	05	not used	
121	BH1	06	2223	

Sign Type BH2 - IDENTIFICATION - DEPARTMENT / TENANT

121	BH2	01	2200 text to be furnished by government (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
121	BH2	02	2400 ENGINEERING (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
121	BH2	03	2406 ENGINEERING (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
121	BH2	04	2423 AV STORAGE (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
121	BH2	05	not used	

Sign Type BH3 - IDENTIFICATION - OFFICE / GENERAL ROOMS

121	BH3	01	2226A	
121	BH3	02	2235A	
121	BH3	03	2423	

Sign Type BH4 -IDENTIFICATION - OFFICE WITH NAME INSERT

121	BH4	01	2206E (Name Insert TBD)	XXXX
121	BH4	02	2206F (Name Insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
121	BH4	03	2206G (Name Insert TBD)	XXXX
121	BH4	04	2206D (Name Insert TBD)	XXXX
121	BH4	05	2206A (Name Insert TBD)	XXXX
121	BH4	06	2206B (Name Insert TBD)	XXXX
121	BH4	07	2206C (Name Insert TBD)	XXXX
121	BH4	08	2206 (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	XXXX
121	BH4	09	2400B (Name Insert TBD)	XXXX
121	BH4	10	2400C (Name Insert TBD)	XXXX
121	BH4	11	2400D (Name Insert TBD)	XXXX
121	BH4	12	2400E (Name Insert TBD)	XXXX
121	BH4	13	2400H (Name Insert TBD)	XXXX
121	BH4	14	2210A (Name Insert TBD)	XXXX
121	BH4	15	2210B (Name Insert TBD)	XXXX
121	BH4	16	2210C (Name Insert TBD)	XXXX
121	BH4	17	2210F (Name Insert TBD)	XXXX
121	BH4	18	2210E (Name Insert TBD)	XXXX
121	BH4	19	2210D (Name Insert TBD)	XXXX
121	BH4	20	2210 (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	XXXX
121	BH4	21	2406C (Name Insert TBD)	XXXX
121	BH4	22	2406D	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name Insert TBD)	XXXX
121	BH4	23	2406E (Name Insert TBD)	XXXX
121	BH4	24	2406F (Name Insert TBD)	XXXX
121	BH4	25	2406G (Name Insert TBD)	XXXX
121	BH4	26	2216B (Name Insert TBD)	XXXX
121	BH4	27	2216C (Name Insert TBD)	XXXX
121	BH4	28	2216F (Name Insert TBD)	XXXX
121	BH4	29	2216E (Name Insert TBD)	XXXX
121	BH4	30	2216D (Name Insert TBD)	XXXX
121	BH4	31	2216A (Name Insert TBD)	XXXX
121	BH4	32	2210 (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	XXXX
121	BH4	33	2220A (Name Insert TBD)	XXXX
121	BH4	34	2220B (Name Insert TBD)	XXXX
121	BH4	35	2220 C (Name Insert TBD)	XXXX
121	BH4	36	2220 F (Name Insert TBD)	XXXX
121	BH4	37	2220 E (Name Insert TBD)	XXXX
121	BH4	38	2200D (Name Insert TBD)	XXXX
121	BH4	39	2216 (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	XXXX
121	BH4	40	2220 (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	XXXX
121	BH4	41	2423A	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name Insert TBD)	XXXX
121	BH4	42	2400A (Name Insert TBD)	XXXX
121	BH4	43	2406H (Name Insert TBD)	XXXX
121	BH4	44	2226B (Name Insert TBD)	XXXX
121	BH4	45	2226C (Name Insert TBD)	XXXX
121	BH4	46	2226F (Name Insert TBD)	XXXX
121	BH4	47	2226 G (Name Insert TBD)	XXXX
121	BH4	48	2226D (Name Insert TBD)	XXXX
121	BH4	49	2226 (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	XXXX
121	BH4	50	2220 (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	XXXX
121	BH4	51	2423B (Name Insert TBD)	XXXX
121	BH4	52	2430 (Name Insert TBD)	XXXX
121	BH4	53	2428A (Name Insert TBD)	XXXX
121	BH4	54	2235C (Name Insert TBD)	XXXX
121	BH4	55	2235F (Name Insert TBD)	XXXX
121	BH4	56	2235E (Name Insert TBD)	XXXX
121	BH4	57	2428B (Name Insert TBD)	XXXX
121	BH4	58	2432 (Name Insert TBD)	XXXX
121	BH4	59	2237 (Name Insert TBD)	XXXX
121	BH4	60	2239 (Name Insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
121	BH4	61	2438 (Name Insert TBD)	XXXX
121	BH4	62	2436 (Name Insert TBD)	XXXX
121	BH4	63	2434 (Name Insert TBD)	XXXX
121	BH4	64	not used	XXXX

Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR

121	BH5	01	not used

Sign Type BH6 -IDENTIFICATION- RESTROOM

121	BH6	01	**2207** (symbol 4,3) WOMEN
121	BH6	02	**2209** (symbol 2,3) MEN

Sign Type BH7 - IDENTIFICATION - STAIRWELL

121	BH7	01	2010 EAST EXIT STAIR 2nd FLOOR
121	BH7	02	2431 WEST EXIT STAIR **2nd FLOOR**
121	BH7	03	2433 WEST EXIT STAIR # 2nd FLOOR

Sign Type BH8 - IDENTIFICATION - ELEVATOR IDENTIFICATION

121	BH8	01	2020 ELEVATOR 2
121	BH8	02	2016 ELEVATOR 1
121	BH8	03	2227 ELEVATORS 5,6
121	BH8	04	2229 ELEVATOR 6
121	BH8	05	2429 ELEVATOR 5
121	BH8	06	2427 ELEVATORS 5,6

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
121	BH8	07	2426 ELEVATORS 5,6	
121	BH8	08	2428 ELEVATORS 5,6	

BJ

Sign Type BJ1 REGULATORY - STAIR LEVEL / EXIT INSTRUCTIONS

121	BJ1	01	EXIT STAIR # ROOF ACCESS	
			FLOOR 2	*FLOOR 2 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	
121	BJ1	02	EXIT STAIR # ROOF ACCESS	
			FLOOR 2	*FLOOR 2 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	
121	BJ1	03	EXIT STAIR # ROOF ACCESS	
			FLOOR 2	*FLOOR 2 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	

Sign Type BJ2 REGULATORY - ELEVATOR, IN CASE OF FIRE...

121	BJ2	01	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
121	BJ2	02	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	

Sign Type BJ3 - MAXIMUM OCCUPANCY

121	BJ3	01	not used	

Sign Type BJ4 - REGULATORY - MEDICAL TRANSIT ELEVATOR

121	BJ4	01	(symbol 18)	mount on hoist way both sides above level number

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BJ5 - FIRE EXTINGUISHER				
121	BJ5	01-08	(symbol 21)	For estimate purposes include 8, see note on dwgs.
Sign Type BJ6 - STAIR RE-ENTRY MESSAGE				
121	BJ6	01	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
121	BJ6	02	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
121	BJ6	03	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
BK				
Sign Type BK - LEED RECYCLE				
121	BK	01	RECYCLE	
BL				
Sign Type BL - EVACUATION MAP CASE				
121	BL	01	EVACUATION MAP (insert)	For estimate purposes, include 3. See note on dwgs. Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government
BM				
Sign Type BM - DIMENSIONAL LETTERS				
121	BM	01	not used	
SHEET W131 LEVEL 3				
BA				
Sign Type BA -BUILDING ENTRANCE IDENTIFICATION				
131	BA	00	not used	
BB				
Sign Type BB - VINYL DYE CUT COPY				
131	BB	01	not used	
BC				
Sign Type BC - LEED MESSAGE				
131	BC	01	not used	
BD				

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BD1 - LARGE WALL MOUNTED BUILDING DIRECTORY				
			not used	
Sign Type BD2 -SMALL WALL MOUNTED BUILDING DIRECTORY				
131	BD2	01	TBD	
131	BD2	02	TBD	
Sign Type BE - WALL MOUNTED DIRECTIONAL				
131	BE	01	not used	
BF				
Sign Type BF - CONFERENCE IN / USE				
131	BF	01	3009 CONFERENCE with in use / available insert	
131	BF	02	3025 CONFERENCE with in use / available insert	
131	BF	03	3007A CONFERENCE with in use / available insert	
131	BF	04	3438 CONFERENCE with in use / available insert	
131	BF	05	3436 CONFERENCE with in use / available insert	
131	BF	06	2442 CONFERENCE with in use / available insert	
BG				
Sign Type BG - LEED / INFORMATIONAL				
131	BG	01	not used	
BH				
Sign Type BH1 -IDENTIFICATION COMMON AREA - MECHANICAL / ELECTRICAL / COMMS / JANITOR				
131	BH1	01	3213	
131	BH1	02	3417	
131	BH1	03	3413	
131	BH1	04	3421	
Sign Type BH2 - IDENTIFICATION - DEPARTMENT / TENANT				
131	BH2	01	3007	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			DIRECTORATE (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
131	BH2	02	3200 XXXX (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
131	BH2	03	**3400** ADMINISTRATION (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
Sign Type BH3 - IDENTIFICATION - OFFICE / GENERAL ROOMS				
131	BH3	01	3402A	
131	BH3	02	3402B	
131	BH3	03	3413	
131	BH3	04	3414A	
131	BH3	05	3424H	
131	BH3	06	3435	
131	BH3	07	3240A	
131	BH3	08	not used	
131	BH3	09	3239	
Sign Type BH4 -IDENTIFICATION - OFFICE WITH NAME INSERT				
131	BH4	01	3007D (Name insert TBD)	
131	BH4	02	3007E (Name insert TBD)	
131	BH4	03	3007F (Name insert TBD)	
131	BH4	04	3007G (Name insert TBD)	
131	BH4	05	3007H (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
131	BH4	06	3007J (Name insert TBD)	
131	BH4	07	3206C (Name insert TBD)	XXXX
131	BH4	08	3206 D (Name insert TBD)	XXXX
131	BH4	09	3007B (Name insert TBD)	XXXX
131	BH4	10	3206 A (Name insert TBD)	XXXX
131	BH4	11	3206H (Name insert TBD)	
131	BH4	12	3206F (Name insert TBD)	
131	BH4	13	3206E (Name insert TBD)	
131	BH4	14	3206 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
131	BH4	15	3406 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
131	BH4	16	3406E (Name insert TBD)	XXXX
131	BH4	17	3406F (Name insert TBD)	XXXX
131	BH4	18	3406G (Name insert TBD)	XXXX
131	BH4	19	3406H (Name insert TBD)	XXXX
131	BH4	20	3210H (Name insert TBD)	XXXX
131	BH4	21	3210G (Name insert TBD)	XXXX
131	BH4	22	3210F (Name insert TBD)	XXXX
131	BH4	23	3210 H (Name insert TBD)	XXXX
131	BH4	24	3210 (Name insert TBD) (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name insert TBD) (Name insert TBD)	
131	BH4	25	3210 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
131	BH4	26	3410 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
131	BH4	27	3410A (Name insert TBD)	XXXX
131	BH4	28	3410B (Name insert TBD)	XXXX
131	BH4	29	3410C (Name insert TBD)	XXXX
131	BH4	30	3410D (Name insert TBD)	XXXX
131	BH4	31	3410E (Name insert TBD)	
131	BH4	32	3410F (Name insert TBD)	
131	BH4	33	3410H (Name insert TBD)	
131	BH4	34	3216A (Name insert TBD)	XXXX
131	BH4	35	3210 A (Name insert TBD)	XXXX
131	BH4	36	3216D (Name insert TBD)	XXXX
131	BH4	37	3216 C (Name insert TBD)	XXXX
131	BH4	38	3216B (Name insert TBD)	XXXX
131	BH4	39	3210 B (Name insert TBD)	XXXX
131	BH4	40	3210 C (Name insert TBD)	XXXX
131	BH4	41	3210 D (Name insert TBD)	XXXX
131	BH4	42	3414H (Name insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS	
131	BH4	43	3414G (Name insert TBD)		XXXX
131	BH4	44	3414F (Name insert TBD)		XXXX
131	BH4	45	3414E (Name insert TBD)		XXXX
131	BH4	46	3414B (Name insert TBD)		
131	BH4	47	3414D (Name insert TBD)		
131	BH4	48	3420A (Name insert TBD)		XXXX
131	BH4	49	3420B (Name insert TBD)		XXXX
131	BH4	50	3420C (Name insert TBD)		XXXX
131	BH4	51	3420D (Name insert TBD)		XXXX
131	BH4	52	3420E (Name insert TBD)		XXXX
131	BH4	53	3216C (Name insert TBD)		
131	BH4	54	3216A (Name insert TBD)		
131	BH4	55	3216 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)		
131	BH4	56	3414 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)		
131	BH4	57	3420 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)		
131	BH4	58	3220E (Name insert TBD)		
131	BH4	59	3220H (Name insert TBD)		
131	BH4	60	3220 (Name insert TBD) (Name insert TBD)		

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name insert TBD) (Name insert TBD)	
131	BH4	61	3420 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX
131	BH4	62	3420H (Name insert TBD)	XXXX
131	BH4	63	3420G (Name insert TBD)	XXXX
131	BH4	64	3420F (Name insert TBD)	XXXX
131	BH4	65	3226E (Name insert TBD)	
131	BH4	66	3226F (Name insert TBD)	
131	BH4	67	3226G (Name insert TBD)	
131	BH4	68	3226E (Name insert TBD)	
131	BH4	69	3220A (Name insert TBD)	XXXX
131	BH4	70	3220B (Name insert TBD)	XXXX
131	BH4	71	3220C (Name insert TBD)	XXXX
131	BH4	72	3220D (Name insert TBD)	XXXX
131	BH4	73	3226 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
131	BH4	74	3424 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
131	BH4	75	3424B (Name insert TBD)	XXXX
131	BH4	76	3424C (Name insert TBD)	XXXX
131	BH4	77	3226D (Name insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS	
131	BH4	78	3226C (Name insert TBD)		XXXX
131	BH4	79	3226B (Name insert TBD)		XXXX
131	BH4	80	3226A (Name insert TBD)		XXXX
131	BH4	81	3234H (Name insert TBD)		XXXX
131	BH4	82	3234G (Name insert TBD)		XXXX
131	BH4	83	3234F (Name insert TBD)		XXXX
131	BH4	84	3234E (Name insert TBD)		XXXX
131	BH4	85	3226 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)		
131	BH4	86	3234 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)		
131	BH4	87	3240E (Name insert TBD)		
131	BH4	88	3234D (Name insert TBD)		
131	BH4	89	3243B (Name insert TBD)		
131	BH4	90	3234A (Name insert TBD)		XXXX
131	BH4	91	3402C (Name insert TBD)		
131	BH4	92	3424A (Name insert TBD)		XXXX
131	BH4	93	3240E (Name insert TBD)		
131	BH4	94	3240F (Name insert TBD)		
131	BH4	95	not used		

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
131	BH4	96	3240H (Name insert TBD)	OFFICE
131	BH4	97	3406B (Name insert TBD)	OFFICE
131	BH4	98	3406D (Name insert TBD)	OFFICE
131	BH4	99	3424D (Name insert TBD)	OFFICE
131	BH4	100	**3206B** (Name insert TBD)	OFFICE
131	BH4	101	**3424E** (Name insert TBD)	**OFFICE**

Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR

131	BH5	01	not used
131	BH5	02	not used

Sign Type BH6 -IDENTIFICATION- RESTROOM

131	BH6	01	**3407** (symbol 2,4) MEN
131	BH6	02	3409 (symbol 3,4) WOMEN

Sign Type BH7 - IDENTIFICATION - STAIRWELL

131	BH7	01	**3010** EAST STAIR # 3rd FLOOR
131	BH7	02	**3431** WEST EXIT STAIR # 3rd FLOOR
131	BH7	03	3431 WEST EXIT STAIR # 3rd FLOOR

Sign Type BH8 - IDENTIFICATION - COMMON SERVICES

131	BH8	01	3020 ELEVATOR 2
131	BH8	02	3016 ELEVATOR 1
131	BH8	03	3227 ELEVATORS 5, 6

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
131	BH8	04	3229 ELEVATOR 6	
131	BH8	05	3429 ELEVATOR 5	
131	BH8	06	3427 ELEVATORS 5, 6	

BJ

Sign Type BJ1 REGULATORY - STAIR LEVEL / EXIT INSTRUCTIONS

131	BJ1	01	EXIT STAIR# ROOF ACCESS	
			FLOOR 3	*FLOOR 3 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	
131	BJ1	02	not used	
131	BJ1	03	EXIT STAIR # ROOF ACCESS	
			FLOOR 3	*FLOOR 3 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	

Sign Type BJ2 REGULATORY - ELEVATOR, IN CASE OF FIRE...

131	BJ2	01	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
131	BJ2	02	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
131	BJ2	03	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	

Sign Type BJ3 - MAXIMUM OCCUPANCY

131	BJ3	01	MAXIMUM OCCUPANCY ###	

Sign Type BJ4 - REGULATORY - MEDICAL TRANSIT ELEVATOR

131	BJ4	01	(symbol 18)	mount on hoist way both sides above level number

Sign Type BJ5 - FIRE EXTINGUISHER

131	BJ5	01 - 08	(symbol 21)	For estimate purposes, include 8. See note on dwgs.

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BJ6 - STAIR RE-ENTRY MESSAGE				
131	BJ6	01	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
131	BJ6	02	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
131	BJ6	03	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
BK **Sign Type BK - LEED RECYCLE**				
131	BK	01	RECYCLE	
BL **Sign Type BL - EVACUATION MAP CASE**				
131	BL	01-03	EVACUATION MAP (insert)	For estimate purpose, include 3. See note on dwgs. Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government
BM **Sign Type BM - DIMENSIONAL LETTERS**				
131	BM	01	not used	
SHEET W141 LEVEL FOUR				
BA **Sign Type BA -BUILDING ENTRANCE IDENTIFICATION**				
141	BA	00	not used	
BB **Sign Type BB - VINYL DYE CUT COPY**				
141	BB	01	not used	
BC **Sign Type BC - LEED MESSAGE**				
141	BC	01	not used	
BD **Sign Type BD1 - LARGE WALL MOUNTED BUILDING DIRECTORY**				
			not used	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BD2 -SMALL WALL MOUNTED BUILDING DIRECTORY				
141	BD2	01	not used	
141	BD2	02	Text shall be furnished by Government.	
Sign Type BE - WALL MOUNTED DIRECTIONAL				
141	BE	01	not used	
BF				
Sign Type BF - CONFERENCE IN / USE				
141	BF	01	4009 CONFERENCE with in use / available insert	
141	BF	02	4025 CONFERENCE with in use / available insert	
141	BF	03	4007A CONFERENCE with in use / available insert	
141	BF	04	4438 CONFERENCE with in use / available insert	
141	BF	05	4436 CONFERENCE with in use / available insert	
141	BF	06	4436 CONFERENCE with in use / available insert	
BG				
Sign Type BG - LEED / INFORMATIONAL				
141	BG	01	not used	
BH				
Sign Type BH1 -IDENTIFICATION COMMON AREA - MECHANICAL / ELECTRICAL / COMMS / JANITOR				
141	BH1	01	4213	
141	BH1	02	4413	
141	BH1	03	4417	
141	BH1	04	4421	
141	BH1	05	**not used**	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BH2 - IDENTIFICATION - DEPARTMENT / TENANT				
141	BH2	01	4007 DIRECTORATE (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
141	BH2	02	4400 XXXX (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
141	BH2	03	**4200** XXXX (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
Sign Type BH3 - IDENTIFICATION - OFFICE / GENERAL ROOMS				
141	BH3	01	**4211**	
141	BH3	02	4211	
141	BH3	03	4435	
141	BH3	04	4240A	
141	BH3	05	4441	
141	BH3	06	not used	
141	BH3	07	4216A	
Sign Type BH4 -IDENTIFICATION - OFFICE WITH NAME INSERT				
141	BH4	01	4007E (Name insert TBD)	
141	BH4	02	4007F (Name insert TBD)	
141	BH4	03	4007G (Name insert TBD)	
141	BH4	04	3007H (Name insert TBD)	
141	BH4	05	4007J (Name insert TBD)	
141	BH4	06	4210G (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS	
141	BH4	07	4210H (Name insert TBD)		XXXX
141	BH4	08	4206B (Name insert TBD)		XXXX
141	BH4	09	4206C (Name insert TBD)		XXXX
141	BH4	10	4007C (Name insert TBD)		
141	BH4	11	4206D (Name insert TBD)		
141	BH4	12	4206A (Name insert TBD)		
141	BH4	13	4206E (Name insert TBD)		
141	BH4	14	4206G (Name insert TBD)		
141	BH4	15	4206 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)		
141	BH4	16	4406 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)		
141	BH4	17	4406H (Name insert TBD)		XXXX
141	BH4	18	4406G (Name insert TBD)		XXXX
141	BH4	19	4406F (Name insert TBD)		XXXX
141	BH4	20	4406E (Name insert TBD)		XXXX
141	BH4	21	4210F (Name insert TBD)		XXXX
141	BH4	22	4210E (Name insert TBD)		XXXX
141	BH4	23	4210 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)		
141	BH4	24	4410A (Name insert TBD)		

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
141	BH4	25	4410B (Name insert TBD)	
141	BH4	26	4410C (Name insert TBD)	
141	BH4	27	4410D (Name insert TBD)	XXXX
141	BH4	28	4410E (Name insert TBD)	XXXX
141	BH4	29	4410F (Name insert TBD)	XXXX
141	BH4	30	4410G (Name insert TBD)	XXXX
141	BH4	31	4216E (Name insert TBD)	
141	BH4	32	4216F (Name insert TBD)	
141	BH4	33	4210D (Name insert TBD)	
141	BH4	34	4210C (Name insert TBD)	XXXX
141	BH4	35	4210B (Name insert TBD)	XXXX
141	BH4	36	4216G (Name insert TBD)	XXXX
141	BH4	37	4216 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
141	BH4	38	4410 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
141	BH4	39	4416 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
141	BH4	40	4416B (Name insert TBD)	XXXX
141	BH4	41	4416C (Name insert TBD)	XXXX
141	BH4	42	4416D (Name insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS	
141	BH4	43	4416E (Name insert TBD)		XXXX
141	BH4	44	4416F (Name insert TBD)		XXXX
141	BH4	45	4416G (Name insert TBD)		XXXX
141	BH4	46	4416H (Name insert TBD)		
141	BH4	47	4420B (Name insert TBD)		
141	BH4	48	4420C (Name insert TBD)		
141	BH4	49	4420D (Name insert TBD)		XXXX
141	BH4	50	4220D (Name insert TBD)		XXXX
141	BH4	51	4220C (Name insert TBD)		XXXX
141	BH4	52	4220B (Name insert TBD)		XXXX
141	BH4	53	4226H (Name insert TBD)		XXXX
141	BH4	54	4226G (Name insert TBD)		XXXX
141	BH4	55	4226F (Name insert TBD)		XXXX
141	BH4	56	4226E (Name insert TBD)		
141	BH4	57	4226 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)		
141	BH4	58	4420F (Name insert TBD)		
141	BH4	59	4420G (Name insert TBD)		
141	BH4	60	4420H (Name insert TBD)		
141	BH4	61	4220E (Name insert TBD)		XXXX
141	BH4	62	not used		

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
141	BH4	63	4216B (Name insert TBD)	XXXX
141	BH4	64	4216D (Name insert TBD)	XXXX
141	BH4	65	4220F (Name insert TBD)	
141	BH4	66	4220H (Name insert TBD)	
141	BH4	67	4420 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
141	BH4	68	4426A (Name insert TBD)	
141	BH4	69	4426D (Name insert TBD)	
141	BH4	70	4426C (Name insert TBD)	
141	BH4	71	4426B (Name insert TBD)	
141	BH4	72	4420E (Name insert TBD)	
141	BH4	73	4234C (Name insert TBD)	
141	BH4	74	4234B (Name insert TBD)	
141	BH4	75	4234G (Name insert TBD)	XXXX
141	BH4	76	4234E (Name insert TBD)	XXXX
141	BH4	77	4426B (Name insert TBD)	XXXX
141	BH4	78	4426C (Name insert TBD)	XXXX
141	BH4	79	4426D (Name insert TBD)	XXXX
141	BH4	80	4234H (Name insert TBD)	XXXX
141	BH4	81	4234 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
141	BH4	82	4226F (Name insert TBD)	
141	BH4	83	4426H (Name insert TBD)	
141	BH4	84	4426E (Name insert TBD)	
141	BH4	85	4240F (Name insert TBD)	
141	BH4	86	4240G (Name insert TBD)	
141	BH4	87	4234D (Name insert TBD)	
141	BH4	88	4234A (Name insert TBD)	
141	BH4	89	4240H (Name insert TBD)	
141	BH4	90	4234 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXXX XXXX
141	BH4	91	4240D (Name insert TBD)	XXXX
141	BH4	92	4240 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	OFFICE
141	BH4	93	4239 (Name insert TBD)	XXXX
141	BH4	94	4402B (Name insert TBD)	XXXX
141	BH4	95	4402A (Name insert TBD)	XXXX
141	BH4	96	4406B (Name insert TBD)	XXXX
141	BH4	97	4406D (Name insert TBD)	XXXX
141	BH4	98	4402 (Name insert TBD)	XXXX
141	BH4	99	4420A (Name insert TBD)	XXXX
141	BH4	100	4420 (Name insert TBD) (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name insert TBD) (Name insert TBD)	
141	BH4	101	4426 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
141	BH4	102	4226 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
141	BH4	103	not used	
141	BH4	104	4226A (Name insert TBD)	XXXX
141	BH4	105	4007B (Name insert TBD)	XXXX
141	BH4	106	4240E (Name insert TBD)	XXXX
141	BH4	107	4210A (Name insert TBD)	XXXX
141	BH4	108	4216H (Name insert TBD)	XXXX
141	BH4	109	4210 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX
141	BH4	110	4410 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX
141	BH4	111	4416 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX
141	BH4	112	4410H (Name insert TBD)	XXXX
141	BH4	113	4416A (Name insert TBD)	XXXX
141	BH4	114	4220 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR				
141	BH5	01	not used	
141	BH5	02	not used	
Sign Type BH6 -IDENTIFICATION- RESTROOM				
141	BH6	01	**4407** (symbol 2,4) MEN	
141	BH6	02	4409 (symbol 3,4) WOMEN	
Sign Type BH7 - IDENTIFICATION - STAIRWELL				
141	BH7	01	**4010** EAST EXIT STAIR 4th FLOOR	
141	BH7	02	**4431** WEST EXIT STAIR **4th FLOOR**	
141	BH7	03	**4431** WEST EXIT STAIR **4th FLOOR**	
Sign Type BH8 - IDENTIFICATION - COMMON SERVICES				
141	BH8	01	4020 ELEVATOR 2	
141	BH8	02	4016 ELEVATOR 1	
141	BH8	03	4227 ELEVATORS 5, 6	
141	BH8	04	4229 ELEVATOR 6	
141	BH8	05	4429 ELEVATOR 5	
141	BH8	06	4427 ELEVATORS 5, 6	
BJ				
Sign Type BJ1 REGULATORY - STAIR LEVEL / EXIT INSTRUCTIONS				
141	BJ1	01	EXIT STAIR# ROOF ACCESS	
			FLOOR 4	*FLOOR 3 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE STAIR SERVES FLOORS 1 - ROOF	REMARKS
141	BJ1	02	EXIT STAIR # ROOF ACCESS	
			FLOOR 4	*FLOOR 3 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	
141	BJ1	03	EXIT STAIR # ROOF ACCESS	
			FLOOR 4	*FLOOR 3 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	

Sign Type BJ2 REGULATORY - ELEVATOR, IN CASE OF FIRE...

141	BJ2	01	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
141	BJ2	02	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
141	BJ2	03	not used	

Sign Type BJ3 - MAXIMUM OCCUPANCY

141	BJ3	01	MAXIMUM OCCUPANCY ###	

Sign Type BJ4 - REGULATORY - MEDICAL TRANSIT ELEVATOR

141	BJ4	01	(symbol 18)	mount on hoist way both sides above level number

Sign Type BJ5 - FIRE EXTINGUISHER

141	BJ5	01-08	(symbol 21)	For estimate purpose, include 8. See notes on dwgs.

Sign Type BJ6 - STAIR RE-ENTRY MESSAGE

141	BJ6	01	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
141	BJ6	02	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
141	BJ6	03	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.

BK
Sign Type BK - LEED RECYCLE

141	BK	01	RECYCLE	

BL
Sign Type BL - EVACUATION MAP CASE

141	BL	01	EVACUATION MAP (insert)	For estimate purpose, include 3. See notes on dwgs. Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government

BM
Sign Type BM - DIMENSIONAL LETTERS

141	BM	01	not used	

SHEET W151 LEVEL FIVE

BA
Sign Type BA -BUILDING ENTRANCE IDENTIFICATION

151	BA	00	not used	

BB
Sign Type BB - VINYL DYE CUT COPY

151	BB	01	not used	

BC
Sign Type BC - LEED MESSAGE

151	BC	01	not used	

BD
Sign Type BD1 - LARGE WALL MOUNTED BUILDING DIRECTORY
not used

Sign Type BD2 -SMALL WALL MOUNTED BUILDING DIRECTORY

151	BD2	01	TBD	
151	BD2	02	not used	

Sign Type BE - WALL MOUNTED DIRECTIONAL

151	BE	01	not used	

BF
Sign Type BF - CONFERENCE IN / USE

151	BF	01	5009	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			CONFERENCE with in use / available insert	
151	BF	02	5025 CONFERENCE with in use / available insert	
151	BF	03	5007A CONFERENCE with in use / available insert	

BG

Sign Type BG - LEED / INFORMATIONAL

151	BG	01	not used

BH

Sign Type BH1 -IDENTIFICATION COMMON AREA - MECHANICAL / ELECTRICAL / COMMS / JANITOR

151	BH1	01	5213
151	BH1	02	5413
151	BH1	03	5417
151	BH1	04	5421

Sign Type BH2 - IDENTIFICATION - DEPARTMENT / TENANT

151	BH2	01	5007 DIRECTORATE (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)
151	BH2	02	5200 XXXX (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)
151	BH2	03	**5400** ADMINISTRATION (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)

Sign Type BH3 - IDENTIFICATION - OFFICE / GENERAL ROOMS

151	BH3	01	5211
151	BH3	02	5211
151	BH3	03	5420A

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
151	BH3	04	5220H	
151	BH3	05	5434	
151	BH3	06	5440	
151	BH3	07	5007G	
151	BH3	08	5206H	
Sign Type BH4 -IDENTIFICATION - OFFICE WITH NAME INSERT				
151	BH4	01	5007D (Name insert TBD)	
151	BH4	02	5007E (Name insert TBD)	
151	BH4	03	5007F (Name insert TBD)	
151	BH4	04	5007G (Name insert TBD)	XXXX
151	BH4	05	5206B (Name insert TBD)	XXXXX
151	BH4	06	5206C (Name insert TBD)	XXXX
151	BH4	07	5007J (Name insert TBD)	XXXX
151	BH4	08	5206D (Name insert TBD)	XXXX
151	BH4	09	5210C (Name insert TBD)	
151	BH4	10	5007B (Name insert TBD)	XXXX
151	BH4	11	5206F (Name insert TBD)	
151	BH4	12	5206E (Name insert TBD)	
151	BH4	13	5026A (Name insert TBD)	
151	BH4	14	5206 (Name insert TBD) (Name insert TBD) (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE (Name insert TBD)	REMARKS
151	BH4	15	5406 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	16	5406C (Name insert TBD)	
151	BH4	17	5406B (Name insert TBD)	
151	BH4	18	5406A (Name insert TBD)	
151	BH4	19	5406E (Name insert TBD)	XXXX
151	BH4	20	5406F (Name insert TBD)	XXXX
151	BH4	21	5406G (Name insert TBD)	XXXX
151	BH4	22	5406H (Name insert TBD)	XXXX
151	BH4	23	5402B (Name insert TBD)	XXXX
151	BH4	24	5402A (Name insert TBD)	XXXX
151	BH4	25	5210H (Name insert TBD)	XXXX
151	BH4	26	5210G (Name insert TBD)	XXXX
151	BH4	27	5210F (Name insert TBD)	XXXX
151	BH4	28	5210E (Name insert TBD)	XXXX
151	BH4	29	5210 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	30	5410 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX
151	BH4	31	5410A (Name insert TBD)	XXXX
151	BH4	32	5410B	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name insert TBD)	XXXX
151	BH4	33	5410C (Name insert TBD)	XXXX
151	BH4	34	5410D (Name insert TBD)	XXXX
151	BH4	35	5210D (Name insert TBD)	XXXX
151	BH4	36	5210 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	37	5210B (Name insert TBD)	
151	BH4	38	5210A (Name insert TBD)	XXXX
151	BH4	39	5416B (Name insert TBD)	XXXX
151	BH4	40	5416C (Name insert TBD)	XXXX
151	BH4	41	5416D (Name insert TBD)	XXXX
151	BH4	42	5410F (Name insert TBD)	XXXX
151	BH4	43	5410E (Name insert TBD)	XXXX
151	BH4	44	5410G (Name insert TBD)	XXXX
151	BH4	45	5410H (Name insert TBD)	XXXX
151	BH4	46	5416F (Name insert TBD)	
151	BH4	47	5416E (Name insert TBD)	
151	BH4	48	5416H (Name insert TBD)	
151	BH4	49	5426 (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	50	5216H (Name insert TBD)	XXXX
151	BH4	51	5216G	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name insert TBD)	XXXX
151	BH4	52	5216F (Name insert TBD)	XXXX
151	BH4	53	5216E (Name insert TBD)	XXXX
151	BH4	54	5216D (Name insert TBD)	XXXX
151	BH4	55	5216B (Name insert TBD)	XXXX
151	BH4	56	5216A (Name insert TBD)	XXXX
151	BH4	57	5216 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	58	5416 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	59	5420D (Name insert TBD)	XXXX
151	BH4	60	5420B (Name insert TBD)	XXXX
151	BH4	61	5226G (Name insert TBD)	XXXX
151	BH4	62	5220E (Name insert TBD)	XXXX
151	BH4	63	5220F (Name insert TBD)	XXXX
151	BH4	64	5226F (Name insert TBD)	XXXX
151	BH4	65	5226E (Name insert TBD)	XXXX
151	BH4	66	5220B (Name insert TBD)	XXXX
151	BH4	67	5220C (Name insert TBD)	XXXX
151	BH4	68	5220D (Name insert TBD)	XXXX
151	BH4	69	5226H (Name insert TBD)	XXXX
151	BH4	70	5226	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
151			(Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	71	5220 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	72	5420 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	73	5420H (Name insert TBD)	XXXX
151	BH4	74	5420G (Name insert TBD)	XXXX
151	BH4	75	5420F (Name insert TBD)	XXXX
151	BH4	76	5420E (Name insert TBD)	XXXX
151	BH4	77	5234E (Name insert TBD)	XXXX
151	BH4	78	5234F (Name insert TBD)	XXXX
151	BH4	79	5234G (Name insert TBD)	XXXX
151	BH4	80	5234H (Name insert TBD)	XXXX
151	BH4	81	5226D (Name insert TBD)	XXXX
151	BH4	82	5226C (Name insert TBD)	XXXX
151	BH4	83	5226B (Name insert TBD)	XXXX
151	BH4	84	5226A (Name insert TBD)	XXXX
151	BH4	85	5226 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	86	5426F (Name insert TBD)	XXXX
151	BH4	87	5426H	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name insert TBD)	XXXX
151	BH4	88	5426E (Name insert TBD)	XXXX
151	BH4	89	5426D (Name insert TBD)	XXXX
151	BH4	90	5426C (Name insert TBD)	XXXX
151	BH4	91	5234C (Name insert TBD)	XXXX
151	BH4	92	5234B (Name insert TBD)	XXXX
151	BH4	93	5234A (Name insert TBD)	XXXX
151	BH4	94	5234 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	95	5240E (Name insert TBD)	
151	BH4	96	5240B (Name insert TBD)	XXXX
151	BH4	97	5240F (Name insert TBD)	XXXX
151	BH4	98	**5240A** (Name insert TBD)	XXXX
151	BH4	99	5240G (Name insert TBD)	XXXX
151	BH4	100	5240H (Name insert TBD)	XXXX
151	BH4	101	5240 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
151	BH4	102	**5240** (Name insert TBD) (Name insert TBD)	XXXX
151	BH4	103	**5426A** (Name insert TBD)	XXXX
151	BH4	104	5426B (Name insert TBD)	XXXX
151	BH4	105	5234 (Name insert TBD) (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			(Name insert TBD) (Name insert TBD)	
151	BH4	106	5220A (Name insert TBD)	
151	BH4	107	**5234D** (Name insert TBD)	
151	BH4	108	5239 (Name insert TBD)	
151	BH4	109	5439 (Name insert TBD)	XXXX
151	BH4	110	5210C (Name insert TBD)	XXXX
151	BH4	111	5410 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX
151	BH4	112	5402 (Name insert TBD)	XXXX

Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR

151	BH5	01	not used
151	BH5	02	not used

Sign Type BH6 -IDENTIFICATION- RESTROOM

151	BH6	01	**5407** (symbol 2,4) MEN
151	BH6	02	5409 (symbol 3,4) WOMEN

Sign Type BH7 - IDENTIFICATION - STAIRWELL

151	BH7	01	**5010** EAST EXIT STAIR 5th FLOOR
151	BH7	02	**5433** WEST EXIT STAIR 5th FLOOR
151	BH7	03	**5431** WEST EXIT STAIR 5th FLOOR

Sign Type BH8 - IDENTIFICATION - COMMON SERVICES

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
151	BH8	01	5020 ELEVATOR 2	
151	BH8	02	5016 ELEVATOR 1	
151	BH8	03	5227 ELEVATORS 5, 6	
151	BH8	04	5229 ELEVATOR 6	
151	BH8	05	5429 ELEVATOR 5	
151	BH8	06	5427 ELEVATORS 5, 6	

BJ

Sign Type BJ1 REGULATORY - STAIR LEVEL / EXIT INSTRUCTIONS

151	BJ1	01	EXIT STAIR# ROOF ACCESS	
			FLOOR 5	*FLOOR 3 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	
151	BJ1	02	EXIT STAIR # ROOF ACCESS	
			FLOOR 5	*FLOOR 3 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	
151	BJ1	03	EXIT STAIR # ROOF ACCESS	
			FLOOR 5	*FLOOR 3 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	

Sign Type BJ2 REGULATORY - ELEVATOR, IN CASE OF FIRE...

151	BJ2	01	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
151	BJ2	02	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
151	BJ2	03	not used	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BJ3 - MAXIMUM OCCUPANCY				
151	BJ3	01	not used	
Sign Type BJ4 - REGULATORY - MEDICAL TRANSIT ELEVATOR				
151	BJ4	01	(symbol 18)	mount on hoist way both sides above level number
Sign Type BJ5 - FIRE EXTINGUISHER				
151	BJ5	01-08	(symbol 21)	For estimate purpose, include 8. See note on dwgs.
Sign Type BJ6 - STAIR RE-ENTRY MESSAGE				
151	BJ6	01	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
151	BJ6	02	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
151	BJ6	03	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
BK **Sign Type BK - LEED RECYCLE**				
151	BK	01	RECYCLE	
BL **Sign Type BL - EVACUATION MAP CASE**				
151	BL	01	EVACUATION MAP (insert)	For estimate purpose, include 3. See note on dwgs. Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government
BM **Sign Type BM - DIMENSIONAL LETTERS**				
151	BM	01	not used	
SHEET W161 LEVEL SIX				
BA **Sign Type BA -BUILDING ENTRANCE IDENTIFICATION**				
161	BA	00	not used	
BB **Sign Type BB - VINYL DYE CUT COPY**				

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
161	BB	01	not used	
BC				
Sign Type BC - LEED MESSAGE				
161	BC	01	not used	
BD				
Sign Type BD1 - LARGE WALL MOUNTED BUILDING DIRECTORY				
			not used	
Sign Type BD2 -SMALL WALL MOUNTED BUILDING DIRECTORY				
161	BD2	01	TBD	
161	BD2	02	TBD	
Sign Type BE - WALL MOUNTED DIRECTIONAL				
161	BE	01	not used	
BF				
Sign Type BF - CONFERENCE IN / USE				
161	BF	01	6009 CONFERENCE with in use / available insert	
161	BF	02	6025 CONFERENCE with in use / available insert	
161	BF	03	6007A CONFERENCE with in use / available insert	
161	BF	04	6440 CONFERENCE with in use / available insert	
BG				
Sign Type BG - LEED / INFORMATIONAL				
161	BG	01	not used	
BH				
Sign Type BH1 -IDENTIFICATION COMMON AREA - MECHANICAL / ELECTRICAL / COMMS / JANITOR				
161	BH1	01	6213	
161	BH1	02	6413	
161	BH1	03	6417	
161	BH1	04	6421	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BH2 - IDENTIFICATION - DEPARTMENT / TENANT				
161	BH2	01	6007 DIRECTORATE (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
161	BH2	02	6200 XXXX (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
161	BH2	03	**6400** ADMINISTRATION (Name Insert TBD) (Name Insert TBD) (Name Insert TBD)	
Sign Type BH6 - IDENTIFICATION - OFFICE / GENERAL ROOMS				
161	BH3	01	6007G	
161	BH3	02	6410H	
161	BH3	03	6211	
161	BH3	04	6211	
161	BH3	05	6434	
161	BH3	06	6436	
161	BH3	07	6240A	
161	BH3	08	6216A	
Sign Type BH4 -IDENTIFICATION - OFFICE WITH NAME INSERT				
161	BH4	01	6007D (Name insert TBD)	
161	BH4	02	6007E (Name insert TBD)	
161	BH4	03	6007F (Name insert TBD)	
161	BH4	04	not used	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
161	BH4	05	6007 (Name insert TBD)	
161	BH4	06	6007B (Name insert TBD)	XXXX
161	BH4	07	6206G (Name insert TBD)	XXXX
161	BH4	08	6206E (Name insert TBD)	XXXX
161	BH4	09	6206A (Name insert TBD)	XXXX
161	BH4	10	6206 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	11	6406 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	12	6402B (Name insert TBD)	
161	BH4	13	6402A (Name insert TBD)	
161	BH4	14	6402 (Name insert TBD)	XXXX
161	BH4	15	6406B (Name insert TBD)	
161	BH4	16	6406D (Name insert TBD)	XXXX
161	BH4	17	6406A (Name insert TBD)	XXXX
161	BH4	18	6406E (Name insert TBD)	XXXX
161	BH4	19	6406F (Name insert TBD)	XXXX
161	BH4	20	6406G (Name insert TBD)	XXXX
161	BH4	21	6406H (Name insert TBD)	XXXX
161	BH4	22	6206B (Name insert TBD)	XXXX
161	BH4	23	6206C (Name insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
161	BH4	24	6206D (Name insert TBD)	
161	BH4	25	6210C (Name insert TBD)	
161	BH4	26	6210D (Name insert TBD)	
161	BH4	27	6210B (Name insert TBD)	XXXX
161	BH4	28	6210A (Name insert TBD)	XXXX
161	BH4	29	6210E (Name insert TBD)	XXXX
161	BH4	30	6210F (Name insert TBD)	XXXX
161	BH4	31	6210G (Name insert TBD)	
161	BH4	32	6210H (Name insert TBD)	
161	BH4	33	6210 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	34	6410 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX
161	BH4	35	6410A (Name insert TBD)	XXXX
161	BH4	36	6410B (Name insert TBD)	XXXX
161	BH4	37	6410C (Name insert TBD)	XXXX
161	BH4	38	6410D (Name insert TBD)	XXXX
161	BH4	39	6410E (Name insert TBD)	XXXX
161	BH4	40	6410F (Name insert TBD)	XXXX
161	BH4	41	6216D (Name insert TBD)	XXXX
161	BH4	42	6216B (Name insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
161	BH4	43	6216H (Name insert TBD)	XXXX
161	BH4	44	6216G (Name insert TBD)	XXXX
161	BH4	45	6216F (Name insert TBD)	XXXX
161	BH4	46	6216E (Name insert TBD)	
161	BH4	47	6210 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	48	6416 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	49	6416A (Name insert TBD)	XXXX
161	BH4	50	6416D (Name insert TBD)	XXXX
161	BH4	51	6416H (Name insert TBD)	XXXX
161	BH4	52	6416G (Name insert TBD)	XXXX
161	BH4	53	6416F (Name insert TBD)	
161	BH4	54	6416E (Name insert TBD)	
161	BH4	55	6420A (Name insert TBD)	
161	BH4	56	6420B (Name insert TBD)	
161	BH4	57	6420C (Name insert TBD)	
161	BH4	58	6420D (Name insert TBD)	
161	BH4	59	6216 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	60	6220H (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
161	BH4	61	6220F (Name insert TBD)	XXXX
161	BH4	62	6220E (Name insert TBD)	XXXX
161	BH4	63	6220D (Name insert TBD)	XXXX
161	BH4	64	6220C (Name insert TBD)	XXXX
161	BH4	65	6220B (Name insert TBD)	
161	BH4	66	6220A (Name insert TBD)	XXXX
161	BH4	67	6226 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	68	6220 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	69	6240H (Name insert TBD)	XXXX
161	BH4	70	6420G (Name insert TBD)	XXXX
161	BH4	71	6420F (Name insert TBD)	XXXX
161	BH4	72	6420E (Name insert TBD)	XXXX
161	BH4	73	6426A (Name insert TBD)	
161	BH4	74	6426B (Name insert TBD)	
161	BH4	75	6426C (Name insert TBD)	XXXX
161	BH4	76	6426D (Name insert TBD)	XXXX
161	BH4	77	6226E (Name insert TBD)	XXXX
161	BH4	78	6226F (Name insert TBD)	XXXX
161	BH4	79	6226G (Name insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
161	BH4	80	6228H (Name insert TBD)	XXXX
161	BH4	81	6420 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	82	6420 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	83	6226D (Name insert TBD)	
161	BH4	84	6226B (Name insert TBD)	
161	BH4	85	6226A (Name insert TBD)	
161	BH4	86	6234F (Name insert TBD)	
161	BH4	87	6234G (Name insert TBD)	
161	BH4	88	6234H (Name insert TBD)	
161	BH4	89	6234 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	90	6426 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX
161	BH4	91	6426F (Name insert TBD)	
161	BH4	92	6426H (Name insert TBD)	XXXX
161	BH4	93	6426E (Name insert TBD)	XXXX
161	BH4	94	6234C (Name insert TBD)	XXXX
161	BH4	95	6234A (Name insert TBD)	
161	BH4	96	6234B (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
161	BH4	97	not used	
161	BH4	98	6234D (Name insert TBD)	
161	BH4	99	6234 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	100	6240C (Name insert TBD)	
161	BH4	101	6240E (Name insert TBD)	
161	BH4	102	6240F (Name insert TBD)	
161	BH4	103	6240G (Name insert TBD)	
161	BH4	104	6240H (Name insert TBD)	
161	BH4	105	6240 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	106	6239 (Name insert TBD)	
161	BH4	107	6439 (Name insert TBD)	
161	BH4	108	6234E (Name insert TBD)	
161	BH4	109	6226 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
161	BH4	110	6007J (Name insert TBD)	

Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR

161	BH5	01	not used	
161	BH5	02	not used	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BH6 -IDENTIFICATION- RESTROOM				
161	BH6	01	**6407** (symbol 2,4) MEN	
161	BH6	02	6409 (symbol 6,4) WOMEN	
Sign Type BH7 - IDENTIFICATION - STAIRWELL				
161	BH7	01	**6010** EAST EXIT STAIR **6th FLOOR**	
161	BH7	02	**6433** WEST EXIT STAIR 6th FLOOR	
161	BH7	03	**6431** WEST EXIT STAIR **6th FLOOR**	
Sign Type BH8 - IDENTIFICATION - COMMON SERVICES				
161	BH8	01	6020 ELEVATOR 2	
161	BH8	02	6016 ELEVATOR 1	
161	BH8	03	6227 ELEVATORS 5, 6	
161	BH8	04	6229 ELEVATOR 6	
161	BH8	05	6429 ELEVATORS 5	
161	BH8	06	6427 ELEVATORS 5, 6	
BJ				
Sign Type BJ1 REGULATORY - STAIR LEVEL / EXIT INSTRUCTIONS				
161	BJ1	01	EXIT STAIR# ROOF ACCESS FLOOR 6 ↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	 *FLOOR 6 IS TACTILE AND IN BRAILLE*
161	BJ1	02	EXIT STAIR # ROOF ACCESS FLOOR 6 ↓ EXIT LEVEL 1	 *FLOOR 6 IS TACTILE AND IN BRAILLE*

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE STAIR SERVES FLOORS 1 - ROOF	REMARKS
161	BJ1	03	EXIT STAIR # ROOF ACCESS	
			FLOOR 6	*FLOOR 6 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	

Sign Type BJ2 REGULATORY - ELEVATOR, IN CASE OF FIRE...

161	BJ2	01	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
161	BJ2	02	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT USE ELEVATOR	
161	BJ2	03	not used	

Sign Type BJ6 - MAXIMUM OCCUPANCY

161	BJ6	01	MAXIMUM OCCUPANCY ###	

Sign Type BJ4 - REGULATORY - MEDICAL TRANSIT ELEVATOR

161	BJ4	01	(symbol 18)	mount on hoist way both sides above level number

Sign Type BJ5 - FIRE EXTINGUISHER

161	BJ5	01 - 08	(symbol 21)	For estimate purpose, include 8. See note on dwgs.

Sign Type BJ6 - STAIR RE-ENTRY MESSAGE

161	BJ6	01	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
161	BJ6	02	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
161	BJ6	03	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.

BK

Sign Type BK - LEED RECYCLE

161	BK	01	RECYCLE	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
BL				
Sign Type BL - EVACUATION MAP CASE				
161	BL	01 - 03	EVACUATION MAP (insert)	For estimate purpose, include 3. See note on dwgs. Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government
BM				
Sign Type BM - DIMENSIONAL LETTERS				
161	BM	01	not used	
SHEET W171 LEVEL 7				
BA				
Sign Type BA -BUILDING ENTRANCE IDENTIFICATION				
171	BA	00	not used	
BB				
Sign Type BB - VINYL DYE CUT COPY				
171	BB	01	not used	
BC				
Sign Type BC - LEED MESSAGE				
171	BC	01	not used	
BD				
Sign Type BD1 - LARGE WALL MOUNTED BUILDING DIRECTORY				
			not used	
Sign Type BD2 -SMALL WALL MOUNTED BUILDING DIRECTORY				
171	BD2	01	Text to be furnished by Government	
171	BD2	02	Text to be furnished by Government	
BF				
Sign Type BF - CONFERENCE IN / USE				
171	BF	01	7007 CONFERENCE ROOM with in use / available insert	
171	BF	02	7025 CONFERENCE ROOM with in use / available insert	
171	BF	03	7026A CONFERENCE ROOM with in use / available insert	
171	BF	04	7216	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
			CONFERENCE ROOM with in use / available insert	
171	BF	05	7212 **CONFERENCE ROOM** with in use / available insert	
171	BF	06	7238A DEPOSITION ROOM with in use / available insert	
BG				
Sign Type BG - LEED / INFORMATIONAL				
171	BG	01	not used Header: Sustainable Design On-Site Renewable Energy To reduce the environmental and	
BH				
Sign Type BH1 -IDENTIFICATION COMMON AREA - MECHANICAL / ELECTRICAL / COMMS / JANITOR				
171	BH1	01	7417	
171	BH1	02	not used	
171	BH1	03	7413	
171	BH1	04	7421	
171	BH1	05	7215	
Sign Type BH2 - IDENTIFICATION - DEPARTMENT / TENANT				
171	BH2	01	7009 EXECUTIVE OFFICES (Name insert TBD) (Name insert TBD) (Name insert TBD)	
171	BH2	02	7400 XXXX (Name insert TBD) (Name insert TBD) (Name insert TBD)	verify department name
171	BH2	03	7434 LEGAL DEPARTMENT (Name insert TBD) (Name insert TBD) (Name insert TBD)	
171	BH2	04	7434D LAW LIBRARY (Name insert TBD) (Name insert TBD) (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BH3 - IDENTIFICATION - OFFICE / GENERAL ROOMS				
171	BH3	01	7006	
171	BH3	02	7402A	
171	BH3	03	7211	
171	BH3	04	7218	
171	BH3	05	7416A	
171	BH3	06	7434	
171	BH3	07	7434T	
171	BH3	08	7434A	
Sign Type BH4 -IDENTIFICATION - OFFICE WITH NAME INSERT				
171	BH4	01	7002 (Name insert TBD)	
171	BH4	02	7004 (Name insert TBD)	
171	BH4	03	7402C (Name insert TBD)	
171	BH4	04	7206C (Name insert TBD)	
171	BH4	05	7206 (Name insert TBD)	
171	BH4	06	7402B (Name insert TBD)	
171	BH4	07	7406D (Name insert TBD)	
171	BH4	08	7406A (Name insert TBD)	
171	BH4	9	not used	
171	BH4	10	7406H (Name insert TBD)	
171	BH4	11	7406E (Name insert TBD)	
171	BH4	12	7406F (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
171	BH4	13	7406G (Name insert TBD)	
171	BH4	14	7406 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
171	BH4	15	7410 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
171	BH4	16	7410A (Name insert TBD)	XXXX
171	BH4	17	7410B (Name insert TBD)	XXXX
171	BH4	18	7410C (Name insert TBD)	XXXX
171	BH4	19	7220 (Name insert TBD)	XXXX
171	BH4	20	7220C (Name insert TBD)	XXXX
171	BH4	21	7220A (Name insert TBD)	
171	BH4	22	7220C (Name insert TBD)	XXXX
171	BH4	23	7410F (Name insert TBD)	XXXX
171	BH4	24	7410H (Name insert TBD)	XXXX
171	BH4	25	7410E (Name insert TBD)	XXXX
171	BH4	26	7410D (Name insert TBD)	XXXX
171	BH4	27	7420 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	XXXX
171	BH4	28	7416D (Name insert TBD)	XXXX
171	BH4	29	7416B (Name insert TBD)	XXXX
171	BH4	30	7416E (Name insert TBD)	XXXX

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
171	BH4	31	7416 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
171	BH4	32	7420A (Name insert TBD)	XXXX
171	BH4	33	7420B (Name insert TBD)	XXXX
171	BH4	34	7420C (Name insert TBD)	XXXX
171	BH4	35	7420D (Name insert TBD)	XXXX
171	BH4	36	7402 (Name insert TBD)	
171	BH4	37	7434K (Name insert TBD)	
171	BH4	38	7434H (Name insert TBD)	
171	BH4	39	7434G (Name insert TBD)	
171	BH4	40	7434L (Name insert TBD)	
171	BH4	41	7206B (Name insert TBD)	
171	BH4	42	7234A (Name insert TBD)	
171	BH4	43	7234B (Name insert TBD)	XXXX
171	BH4	44	7234C (Name insert TBD)	XXXX
171	BH4	45	7234D (Name insert TBD)	XXXX
171	BH4	46	7234 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
171	BH4	47	7238 (Name insert TBD) (Name insert TBD) (Name insert TBD) (Name insert TBD)	
171	BH4	48	7238B (Name insert TBD)	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
171	BH4	49	7238D (Name insert TBD)	XXXX
171	BH4	50	7238E (Name insert TBD)	XXXX
171	BH4	51	7238F (Name insert TBD)	XXXX
171	BH4	52	7238G (Name insert TBD)	XXXX
171	BH4	53	7238H (Name insert TBD)	XXXX
171	BH4	54	7434W (Name insert TBD)	XXXX
171	BH4	55	7434S (Name insert TBD)	
171	BH4	56	7434P (Name insert TBD)	
171	BH4	57	7434N (Name insert TBD)	
171	BH4	58	7434M (Name insert TBD)	
171	BH4	59	7416F (Name insert TBD)	XXXX
171	BH4	60	7416G (Name insert TBD)	XXXX
171	BH4	61	7416H (Name insert TBD)	XXXX
Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR				
171	BH5	01	not used	
171	BH5	02	not used	
171	BH5	03	not used	
171	BH5	04	not used	
Sign Type BH6 -IDENTIFICATION- RESTROOM				
171	BH6	01	7203 (symbol 5) RESTROOM	
171	BH6	02	**7205** (symbol 5) RESTROOM	
171	BH6	03	7208 (symbol 5) RESTROOM	

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
171	BH6	04	7210 (symbol 5) RESTROOM	
171	BH6	05	7407 (symbol 2,4) MEN	
171	BH6	06	**7409** (symbol 3,4) WOMEN	
Sign Type BH7 - IDENTIFICATION - STAIRWELL				
171	BH7	01	7010 **EAST EXIT STAIR #** 7th FLOOR	
171	BH7	02	7431 **WEST EXIT STAIR #** 7th FLOOR	
171	BH7	03	7433 **WEST EXIT STAIR #** 7th FLOOR	
171	BH7	04	7232 **WEST EXIT STAIR #** 7th FLOOR	
171	BH7	05	7225 **WEST EXIT STAIR #** 7th FLOOR	
Sign Type BH8 - IDENTIFICATION - COMMON SERVICES				
171	BH8	01	7020 ELEVATOR 2	
171	BH8	02	7016 ELEVATOR 1	
171	BH8	03	7227 ELEVATORS 5, 6	
171	BH8	04	7229 ELEVATOR 6	
171	BH8	05	7429 ELEVATOR 5	
171	BH8	06	7427 ELEVATORS 5, 6	
BJ				
Sign Type BJ1 REGULATORY - STAIR LEVEL / EXIT INSTRUCTIONS				
171	BJ1	01	EXIT STAIR # ROOF ACCESS FLOOR 7	*FLOOR 7 IS TACTILE AND IN BRAILLE*

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE ↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	REMARKS
171	BJ1	02	EXIT STAIR # ROOF ACCESS	
			FLOOR 7	*FLOOR 7 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	
171	BJ1	03	EXIT STAIR # ROOF ACCESS	
			FLOOR 7	*FLOOR 7 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	
171	BJ1	04	EXIT STAIR # ROOF ACCESS	
			FLOOR 7	*FLOOR 7 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	
171	BJ1	05	EXIT STAIR # ROOF ACCESS	
			FLOOR 7	*FLOOR 7 IS TACTILE AND IN BRAILLE*
			↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	

Sign Type BJ2 REGULATORY - ELEVATOR, IN CASE OF FIRE...

171	BJ2	01	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT ELEVATOR
171	BJ2	02	(symbol 17) IN CASE OF FIRE USE STAIRS DO NOT ELEVATOR
171	BJ2	03	not used

Sign Type BJ3 - MAXIMUM OCCUPANCY

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
171	BJ3	01	MAXIMUM OCCUPANCY ###	
Sign Type BJ4 - REGULATORY - MEDICAL TRANSIT ELEVATOR				
171	BJ4	01	(symbol 18)	mount on hoist way both sides above level number
Sign Type BJ5 - FIRE EXTINGUISHER				
171	BJ5	01 - 08	(symbol 21)	For estimate purpose, include 8. See note on dwgs.
Sign Type BJ6 - STAIR RE-ENTRY MESSAGE				
171	BJ6	01	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
171	BJ6	02	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
171	BJ6	03	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
171	BJ6	04	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
171	BJ6	05	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
BK				
Sign Type BK - LEED RECYCLE				
171	BK	01	RECYCLE	
BL				
Sign Type BL - EVACUATION MAP CASE				
171	BL	01 - 03	EVACUATION MAP (insert)	For estimate purpose, include 3. See note on dwgs. Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government
BM				
Sign Type BM - DIMENSIONAL LETTERS				
171	BM	01	not used	
SHEET W181 LEVEL ROOF				

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
BA				
Sign Type BA -BUILDING ENTRANCE IDENTIFICATION				
181	BA	00	not used	
BB				
Sign Type BB - VINYL DYE CUT COPY				
181	BB	01	not used	
BC				
Sign Type BC - LEED RECYCLE				
181	BC	01	not used	
BD				
Sign Type BD - WALL MOUNTED BUILDING DIRECTORY				
181	BD	01	not used	
BE				
Sign Type BE - WALL MOUNTED DIRECTIONAL				
181	BE	01	not used	
BF				
Sign Type BF - CONFERENCE IN / USE				
181	BF	01	not used	
BG				
Sign Type BG - LEED / INFORMATIONAL				
181	BG	01	not used	
BH				
Sign Type BH1 -IDENTIFICATION COMMON AREA - MECHANICAL / ELECTRICAL / COMMS / JANITOR				
181	BH1	01	8010A	
181	BHI	02	8206	
181	BHI	03	8429	
181	BHI	04	8035	
181	BHI	05	8208	
Sign Type BH2 - IDENTIFICATION - DEPARTMENT / TENANT				
181	BH2	01	not used	
Sign Type BH3 - IDENTIFICATION - OFFICE / GENERAL ROOMS				

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
181	BH3	01	not used	
Sign Type BH4 -IDENTIFICATION - OFFICE WITH NAME INSERT				
181	BH4	01	not used	
Sign Type BH5 - IDENTIFICATION - EXIT / ELEVATOR				
181	BH5	01	not used	
181	BH5	02	not used	
Sign Type BH6 -IDENTIFICATION- RESTROOM				
181	BH6	01	not used	
Sign Type BH7 - IDENTIFICATION - STAIRWELL				
181	BH7	01	8010 EAST EXIT STAIR 8th FLOOR	
181	BH7	02	8431 WEST EXIT STAIR 8th FLOOR	
181	BH7	03	8431 WEST EXIT STAIR 8th FLOOR	
Sign Type BH8 - IDENTIFICATION - COMMON SERVICES				
181	BH8	01	not used	
BJ				
Sign Type BJ1 REGULATORY - STAIR LEVEL / EXIT INSTRUCTIONS				
181	BJ1	01	EAST EXIT STAIR# ROOF ACCESS ROOF ↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	*ROOF IS TACTILE AND IN BRAILLE*
181	BJ1	02	WEST EXIT STAIR # ROOF ACCESS ROOF ↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	*ROOF IS TACTILE AND IN BRAILLE*
181	BJ1	03	WEST EXIT STAIR # ROOF ACCESS ROOF ↓ EXIT LEVEL 1 STAIR SERVES FLOORS 1 - ROOF	*ROOF IS TACTILE AND IN BRAILLE*

SHEET NO.	SIGN TYPE	SIGN NO.	← ROOM NUMBER AND MESSAGE	REMARKS
Sign Type BJ2 REGULATORY - ELEVATOR, IN CASE OF FIRE...				
181	BJ2	01	not used	
Sign Type BJ3 - MAXIMUM OCCUPANCY				
181	BJ3	01	not used	
Sign Type BJ4 - REGULATORY - MEDICAL TRANSIT ELEVATOR				
181	BJ4	01	not used	
Sign Type BJ5 - FIRE EXTINGUISHER				
181	BJ5	01 - 08	(symbol 21)	For estimate purposes, include 8. See note on dwgs.
Sign Type BJ6 - STAIR RE-ENTRY MESSAGE				
181	BJ6	01	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
181	BJ6	02	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
181	BJ6	03	RE-ENTRY DURING FIRE OR EMERGENCY *VERIFY ALL MESSAGE REQUIREMENTS*	ALTERNATE MESSAGE: THIS IS NOT A RE-ENTRY FLOOR. THE NEAREST RE-ENTRY FLOOR IS X OR LOBBY.
BK				
Sign Type BK - LEED RECYCLE				
181	BK	01	not used	
BL				
Sign Type BL - EVACUATION MAP CASE				
181	BL	01 - 03	EVACUATION MAP (insert)	For estimate purposes, include 3. See note on dwgs. Map graphic insert design and fabrication by fabricator Total quantity and locations to be determined by Government
BM				
Sign Type BM - DIMENSIONAL LETTERS				
181	BM	01	not used	

SECTION 10 21 13

TOILET COMPARTMENTS
01/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A336/A336M	(2010a) Standard Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts
ASTM A385/A385M	(2011) Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM B456	(2011; E 2011) Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2009) Accessible and Usable Buildings and Facilities

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60003	(Basic) Partitions, Toilet, Complete

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SYSTEM DESCRIPTION

Provide a complete and usable toilet partition system, including toilet enclosures, room entrance screens, urinal screens, system of panels,

hardware, and support components. and Affirmative Procurement guidelines. Furnish the partition system from a single manufacturer, with a standard product as shown in the most recent catalog data. Submit Fabrication Drawings for toilet partitions and urinal screens consisting of fabrication and assembly details to be performed in the factory. Submit manufacturer's Cleaning and Maintenance Instructions with Fabrication Drawings for review.

1.3.1 Sustainable Design Requirements

1.3.1.1 Local/Regional Materials Documentation

See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Toilet partition materials may be locally available. Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings
Installation Drawings; G

SD-03 Product Data

Toilet Compartments; G
Urinal Screens
Colors And Finishes
Anchoring Devices and Fasteners
Hardware and Fittings; G
Brackets; G

SD-04 Samples

Colors and Finishes; G

SD-07 Certificates

Warranty

1.5 REGULATORY REQUIREMENTS

Conform to ICC A117.1 code for access for the handicapped operation of toilet compartment door and hardware.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the manufacturer's original unopened packages with the brand, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated; free

from dust, water, other contaminants, and damage during delivery, storage, and construction.

1.7 WARRANTY

Provide certification or warranties that toilet partitions and urinal screens will be free of defects in materials, fabrication, finish, and installation and will remain so for a period of not less than 5 years after completion.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Anchoring Devices and Fasteners

Provide steel anchoring devices and fasteners hot-dipped galvanized after fabrication, in conformance with ASTM A385/A385M and ASTM A123/A123M. Conceal all galvanized anchoring devices.

2.1.2 Brackets

Wall brackets shall be heavy duty aluminum, bright dip anodized finish, two-ear panel brackets, T-style, 1-inch stock. Provide stirrup style panel-to-pilaster brackets.

2.1.3 Hardware and Fittings

2.1.3.1 General Requirements

Conform hardware for the toilet partition system to CID A-A-60003 for the specified type and style of partitions. Provide hardware finish highly resistant to alkalis, urine, and other common toilet room acids. Comply latching devices and hinges for handicap compartments with 36 CFR 1191; provide chrome-plated steel or stainless steel devices and hinges with door latches that operate without either tight grasping or twisting of the wrist of the operator. Submit three samples of each item, including anchoring devices and fasteners. Approved hardware samples may be installed in the work if properly identified.

Conform cold-rolled sheet steel to ASTM A336/A336M, commercial quality.

2.1.3.2 Finishes

Chrome plating shall conform to ASTM B456.

2.1.4 Door Hardware

2.1.4.1 Hinges

Hinges shall be adjustable to hold in-swinging doors open at any angle up to 90 degrees and outswinging doors to 10 degrees. Provide self-lubricating hinges with the indicated swing. Hinges shall have the following type of return movement:

Gravity return movement

2.1.4.2 Latch and Pull

Latch and pull shall be a combination rubber-faced door strike and keeper equipped with emergency access.

2.1.4.3 Coat Hooks

Coat hooks shall be combination units with hooks and rubber tipped pins.

2.2 PARTITION PANELS AND DOORS

Fabricate partition panels and doors not less than 1 inch thick with face sheets not less than 0.0396 inch thick.

2.2.1 Toilet Compartments

Product and Manufacturer - Basis of Design: Solid Plastic Toilet Compartments; Scranton Products .

Mounting: Ceiling hung.
Material: High density polyethylene (HDPE), fabricated from polymer resins compounded under high pressure, forming single thickness panel.
Panel Thickness: 1 inch.
Colors And Finishes: Refer to the Finish Legend.

Doors and Dividing Panels: 55 inches high, mounted 14 inches above finished floor, with aluminum heat-sinc fastened to bottom edges.

Pilasters: 94 inches high, fastened to pilaster sleeves with stainless steel tamper resistant Torx head sex bolts, with stainless steel angle attachment required for ceiling hung compartments.

Pilaster Sleeves: 4 inches high, 20 gage stainless steel, secured to pilaster with stainless steel tamper resistant Torx head sex bolt.

Brackets: Heavy duty aluminum, bright dip anodized finish; full height of panels; fasten to pilasters and panels with stainless steel tamper resistant Torx head sex bolts.

2.2.2 Urinal Screens

Product and Manufacturer - Basis of Design: Solid Plastic Urinal Screens; Scranton Products

Mounting: Wall hung.
Material: High density polyethylene (HDPE), fabricated from polymer resins compounded under high pressure, forming single thickness panel
Panel Thickness: 1 inch.
Colors And Finishes: Refer to the Finish Legend.

2.3 HARDWARE

Hinges: Scranton Products Regal hinge, or equal, fabricated from heavy-duty cast aluminum, wrap around flanges, adjustable on 30-degree increments, through bolted to doors and pilasters.

Door Strike and Keeper: 6 inches long, fabricate from heavy-duty extruded aluminum with bright dip anodized finish, with wrap-around flanges secured to pilasters with stainless steel tamper resistant Torx head sex bolts;

provide with extruded black vinyl bumper.

Latch and Housing: Heavy duty extruded aluminum latch with bright dip anodized finish latch housing. Provide with slide latch and paddle.

Coat Hook/Bumper: Type 316 stainless steel, #4 finish.

Door Pulls: Type 316 stainless steel, #4 finish.

PART 3 EXECUTION

3.1 PREPARATION

Take field measurements prior to the preparation of drawing and fabrication to ensure proper fits. Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work. Verify correct spacing of plumbing fixtures. Verify correct location of built in framing, anchorage, and bracing. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the work of this section. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

Install partitions rigid, straight, plumb, and level, with the panels centered between the fixtures. Provide a panel clearance of not more than 1/2 inch and secure the panels to walls and pilasters with brackets. Locate wall brackets so that holes for wall bolts occur in masonry or tile joints. Provide for adjustment due to minor floor variations. Locate head rail joints at pilaster center lines. Install adjacent components for consistency of line and plane. Equip each door with hinges, one door latch, and one coat hook and bumper. Align hardware to uniform clearance at vertical edges of doors.

a. Secure panels to stud framed walls with toggle bolts using not less than 1/4-20 screws of the length required for the wall thickness. Toggle bolts shall have a load-carrying strength of not less than 600 pounds per anchor.

b. Secure panels to ceramic tile on stud framed walls or hollow concrete-masonry walls with toggle bolts using not less than 1/4-20 screws of the length required for the wall thickness. Toggle bolts shall have a load-carrying strength of not less than 600 pounds per anchor.

c. Secure panels to solid masonry or concrete with lead or brass expansion shields designed for use with not less than 1/4-20 screws, with a shield length of not less than 1-1/2 inch. Expansion shields shall have a load-carrying strength of not less than 600 pounds per anchor.

d. Submit Installation Drawings for toilet partitions and urinal screens showing plans, elevations, details of construction, hardware, reinforcing and blocking, fittings, mountings and escutcheons. Indicate on drawings the type of partition, location, mounting height, cutouts, and reinforcement required for toilet-room accessories.

3.3 CEILING-HUNG PARTITIONS

Secure pilasters to the structural support above with the anchorage device specified. Make all leveling devices readily accessible for leveling, plumbing, and tightening the installation. Level the bottoms of doors with bottoms of pilasters when doors are in a closed position.

3.4 FINAL ADJUSTMENT

After completion of the installation, make final adjustments to the pilaster-leveling devices, door hardware, and other working parts of the partition assembly. Doors shall have a uniform vertical edge clearance of approximately 3/16 inch and shall rest open at approximately 30 degrees when unlatched.

3.5 CLEANING

Baked enamel finish shall be touched up with the same color of paint that was used for the finish. Clean all surfaces of the work, and adjacent surfaces soiled as a result of the work, in an approved manner compliant with the manufacturer's recommended cleaning and protection from damage procedures until accepted. Remove all equipment, tools, surplus materials, and work debris from the site.

-- End of Section --

SECTION 10 22 39

FOLDING PANEL PARTITIONS
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM E413	(2010) Rating Sound Insulation
ASTM E557	(2012) Installation of Operable Partitions
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2009) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code

1.2 SYSTEM DESCRIPTION

a. No less than 30 calendar days prior to the scheduled commencement of installation, submit the following to the Contracting Officer:

Manufacturer's Qualifications
Manufacturer's Sample Warranty
Statement of Code Compliance
Statement of Standards Conformity
Verification of Field Measurements

Fabrication Drawings
Installation Instructions

b. Supply and install manual operation, acoustical folding panel partitions, factory finished, supported from overhead track with floor guides, as shown on the drawings including all hardware, seals, track and rollers as needed to close the specified opening.

c. Submit drawings to demonstrate that the system has been coordinated and will properly function as a unit. Show layout of the work; track and jamb fastening methods; seal and installation details; and

equipment relationship to other parts of the work including clearances for maintenance and operation.

1.2.1 Manual Operation

The manual operation shall be a force no greater than 20 lbf to start movement at the rate of 3.33 ft/s (200 ft/min). Use a removable handle to extend and retract the bottom operable seals; vertical movement of seals shall be 2 inches. Closure to the lead wall shall be by use of a flexible bulb; accomplish final closing by means of a lever exerting pressure against the wall.

1.2.2 Performance Requirements

1.2.2.1 Fire Endurance

For partitions more than 60 square feet in area, provide covering and lining with flame spread rating of 25 or less, fuel contribution rating of 15 or less, smoke generation of 50 or less in accordance with NFPA 101 when tested in accordance with ASTM E84. Submit flame and smoke development tests reports. Provide door and partition finishes with a Class A rating when tested in accordance with ASTM E84.

1.2.2.2 Laboratory Acoustical Requirements

Provide partitions tested in accordance with ASTM E90, by a laboratory accredited by the U.S. Bureau of Standards, that have attained a sound transmission class (STC) of not less than 40 in a fully extended position, with a Noise Reduction Coefficient (NRC) of 0.25-0.30 for napped, tufted or looped fabric . Partition tested shall be of the same construction, materials, and model number as the partition to be provided and be fully operable. Test specimen shall be not less than 14 feet by 9 feet. Panel weight shall be a minimum of 5.5 psf for STC up to 40, 7.5 psf for STC up to 45, and 8.5 psf for STC up to 50, 10.0 psf for STC up to 53. Design panel thickness (4 inch nominal) and composition to provide the required STC rating in accordance with ASTM E90 and ASTM E413.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications
Manufacturer's Sample Warranty
Statement of Code Compliance
Statement of Standards Conformity
Verification of Field Measurements

SD-02 Shop Drawings

Installation; G
Layouts
Fabrication Drawings

SD-03 Product Data

Folding Panel Partitions; G
Installation Instructions
Maintenance Instructions

SD-04 Samples

Finish Color Samples; G

SD-06 Test Reports

Flame and Smoke Development Tests

SD-07 Certificates

Materials
Folding Panel Partitions

SD-10 Operation and Maintenance Data

Folding Panel Partitions

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the jobsite in the manufacturer's original, unopened, and undamaged packages with labels legible and intact. Provide labels to indicate the manufacturer, brand name, size, finish, and placement location. Store partitions and accessories in unopened packages in a manner that will prevent damage. Handle partition materials in accordance with manufacturer's instructions. Protect materials from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.5 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period. In addition, provide guarantee of the pantographs, trolleys and tracks for 10 years from date of acceptance for beneficial use.

PART 2 PRODUCTS

2.1 MATERIALS

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and essentially duplicate items that have been in satisfactory use for at least 2 year prior to bid opening. Submit Certificate attesting that the materials meet the requirements specified. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Provide heavy-duty type hardware standard with the manufacturer. Provide pulls and latches for all partitions. Provide partitions with magnetic contact latches . Provide anodized aluminum clear finish hardware.

2.2 FOLDING PANEL PARTITIONS

Model and Manufacturer - Basis of Design: Model 632 Operable Partition; Hufcor Inc., or equal.

STC Rating: 43
Panels: Top supported, center stacking, manually operated, hinged in pairs.

Seals:
Top: Continuous contact sweep seals.
Bottom: Manually operated mechanical seals.
Vertical Seals: Interlocking.

Trim: Lambs wool horizontal trim. Vertical trim - edge protection. Refer to the Room Finish Legned for trim color.

Jambs:

Stack End: Expandable jamb activated from either side wiht removable opearating lever.
Lead End: Buld seal jamb.

Carriers: Four high density polymer covered steel bal lbearing wheels.

Track: Type 40 clear anodized extruded aluminum.

Submit six complete copies of maintenance instructions explaining routine maintenance procedures including inspection, adjustments, lubrication, and cleaning.

Submit three finish color samples of specified surfaces and finishes to match those specified. Also submit certificate attesting that partitions have specified acoustical and flame retardant properties, as determined by test.

2.2.1 Panels

Provide panels of steel skin, laminated to appropriate structural acoustical backing, mounted in full perimeter protective frame. Steel for the panel frames shall be a minimum of 16 gauge thick steel with minimum 22 gauge thick face panels spot welded to the frame. Frame shall enclose and protect all edges of the surface material. Panels shall be not more than 4 feet wide, except for end closure panels, and be full height to track. Panels shall lock in place to form a stable, rigid partition; low profile hinges may not project more than 1/4 inch maximum from panel edge. Panel surfacing shall wrap around the vertical panel edges without vertical trim.

2.2.2 Folding Panel Partition Finish

Product and Manufacturer: Transformations Delight; Hytex Decorative Textiles Hytex Industries, Inc., or equal.

Color: Birch #48-02
Composition: 100% polyester yarsn
Finish: Dupont Teflon treated.
Flammability: Class A, ASTM E84
Tensile Strength: Exceeds minimum; ASTM D1682
Colorfastness to Light: Class 5, AATCC 16A

2.2.3 Track

Conform aluminum to ASTM B221. Provide track that is the manufacturer's standard product designed for the weight of the finished partition, including door. Provide track sections in the maximum lengths practicable, and not less than 6 feet long except for narrow doors and at ends of runs where short length is required. Provide suitable joint devices such as interlocking keys at each joint to provide permanent alignment of track.

2.2.4 Suspension System

Provide a suspension system consisting of heavy duty extruded aluminum track connected to the structural support by threaded rods, and trolleys designed to support the weight of the partition. Provide extruded aluminum track with minimum thickness of 1/8 inch.

2.3 ACCESSORIES

2.3.1 Doors

Provide non-fire rated, manually operated doors with vinyl sweep top seals which compress against the bottom of the top track.

2.4 SEALS AND SWEEPSTRIPS

Manufacturer's standard product, to achieve the sound transmission class specified and to pass the visual field test specified, without crack or craze when subjected to severe usage. Provide manufacturer's vertical seals between panels to ensure acoustical rating.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with the manufacturer's approved instructions.

3.1.1 Preparation Work

Verify dimensions and condition of openings scheduled to receive folding panel partitions. Install partitions in accordance with the approved partition layouts, manufacturer's directions, and ASTM E557. Provide structural support for the track support elements as indicated.

3.1.2 Adjustment

Adjust manually operated partitions to open and close from any position with a maximum horizontal force as specified in paragraph Manual Operation applied to pendant pull, box or handle.

3.2 FIELD TESTS

3.2.1 Operational Test

In the presence of the Contracting Officer's Representative, operate partition at least three times to demonstrate that partition is capable of being moved from the stored position to the fully extended position smoothly and quietly . Activate the emergency release mechanism and demonstrate proper operation of the partition in the manual mode . Adjust

partitions which do not operate properly and retest.

3.2.2 Visual Test

Conduct visual field tests for light leakage with all room lights turned on in the space on one side of the partition. Darken space on the other side of the partition. Light leakage from the lighted space to the darkened space is not acceptable. If light leakage does occur, adjust the partition to correct the problem and retest.

3.3 CLEANING

Clean any soiled parts of the partition in accordance with manufacturer's printed instructions.

-- End of Section --

SECTION 10 26 13

WALL AND CORNER GUARDS
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM D256	(2010) Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D543	(2006) Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D635	(2010) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM G21	(2009) Determining Resistance of Synthetic Polymeric Materials to Fungi
ASTM G22	Standard Practice for Determining Resistance of Plastics to Bacteria

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1545	(2005) Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Colored Trim

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval.When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Corner Guards; G
Protective Wall Covering; G

SD-03 Product Data

Corner Guards; G
Protective Wall Covering; G

SD-04 Samples

Finish; G

SD-06 Test Reports

Corner Guards
Protective Wall Covering

SD-07 Certificates

Corner Guards
Protective Wall Covering

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and trademarks intact. Keep materials dry, protected from weather and damage, and stored under cover. Materials shall be stored at approximately 70 degrees F for at least 48 hours prior to installation.

1.4 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

To the maximum extent possible, corner guards and wall covering shall be the standard products of a single manufacturer and shall be furnished as detailed. Drawings show general configuration of products required, and items differing in minor details from those shown will be acceptable.

2.1.1 Resilient Material

Provide resilient material consisting of high impact resistant extruded acrylic vinyl, polyvinyl chloride, or injection molded thermal plastic conforming to the following:

2.1.1.1 Minimum Impact Resistance

Minimum impact resistance shall be 18 ft-lbs/sq. inch when tested in accordance with ASTM D256, (Izod impact, ft-lbs per sq inch notched).

2.1.1.2 Fire Rating

Fire rating shall be Class 1 when tested in accordance with ASTM E84,

having a maximum flame spread of 25 and a smoke developed rating of 450 or less. Material shall be rated self extinguishing when tested in accordance with ASTM D635. Material shall be labeled and tested by an approved nationally known testing laboratory. Resilient material used for protection on fire rated doors and frames shall be listed by the testing laboratory performing the tests. Resilient material installed on fire rated wood/steel door and frame assemblies shall have been tested on similar type assemblies. Test results of material tested on any other combination of door/frame assembly will not be acceptable.

2.1.1.3 Integral Color

Colored components shall have integral color and shall be matched in accordance with SAE J1545 to within plus or minus 1.0 on the CIE-LCH scales.

2.1.1.4 Chemical and Stain Resistance

Materials shall be resistant to chemicals and stains reagents in accordance with ASTM D543.

2.1.1.5 Fungal and Bacterial Resistance

Materials shall be resistant to fungi and bacteria in accordance with ASTM G21, as applicable.

2.2 CORNER GUARDS

2.2.1 Stainless Steel Corner Guards

Stainless steel corner guards shall be fabricated of 16 gauge thick material conforming to ASTM A167, type 302 or 304. Corner guard shall be formed to dimensions shown.

2.3 PROTECTIVE WALL COVERING

2.3.1 Protective Wall Covering - Rigid Sheet

Product and Manufacturer: IPC Rigid Vinyl Sheet; InPro Corporation, or equal.

Description: Provide wall covering/panels consisting of high impact, chemical and stain resistant, polyvinyl chloride resilient material. No plasticizers shall be added. Submit fire rating and extinguishing test results for resilient material. Also submit statements attesting that the items comply with specified fire and safety code requirements.

Fire Performance Characteristics: UL Class 1; NFPA Class A; ASTM E84
Impact Strength: 30.4 ft-lbs/inch of thickness: ASTM D256
Chemical and Stain Resistance: Provide rigid vinyl sheet that show resistance to stain when tested in accordance with applicable provisions of ASTM D543.

Fungal and Bacterial Resistance: Provide rigid vinyl that does not support fungal or bacterial growth as tested in accordance with ASTM G21 and ASTM G22.

2.3.2 Protective Wall Covering - Stainless Steel

Material: Type 304 stainless steel.
Finish: NO. 4, satin finish.
Mounting: Adhesive mounted.
Joints: Overlapping.

2.4 TRIM, FASTENERS AND ANCHORS

Provide vinyl trim, fasteners and anchors for each specific installation as shown.

2.5 FINISH

Submit three samples indicating color and texture of materials requiring color and finish.

2.5.1 Resilient Material Finish

Finish for resilient material shall be embossed texture with colors in accordance with SAE J1545.

2.6 ADHESIVES

Adhesive for resilient material shall be in accordance with manufacturers recommendations.

2.7 COLOR

Color shall be as indicated on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Corner Guards

Material shall be mounted at location indicated in accordance with manufacturer's recommendations.

3.1.2 Protective Wall Covering

Surfaces to receive protection shall be clean, smooth, and free of obstructions. Protectors shall be installed after frames are in place, but prior to hanging of doors, in accordance with manufacturer's specific instructions. Adhesives shall be applied in controlled environment in accordance with manufacturer's recommendations.

-- End of Section --

SECTION 10 28 13

TOILET ACCESSORIES
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1036	(2010; E 2012) Standard Specification for Flat Glass

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Finishes; G
Accessory Items; G

SD-04 Samples

Finishes

SD-10 Operation and Maintenance Data

1.3 DELIVERY, STORAGE, AND HANDLING

Wrap toilet accessories for shipment and storage, then deliver to the jobsite in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism.

1.4 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

Provide toilet accessories where indicated in accordance with paragraph SCHEDULE. Porcelain type, tile-wall accessories are specified in Section 09 30 00 CERAMIC TILE QUARRY TILE, AND PAVER TILE. Provide each accessory item complete with the necessary mounting plates of sturdy construction with corrosion resistant surface.

2.1.1 Anchors and Fasteners

Provide anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide tamperproof design exposed fasteners with finish to match the accessory.

2.1.2 Finishes

Except where noted otherwise, provide the following finishes on metal:

Metal	Finish
Stainless steel	No. 4 satin finish

2.2 ACCESSORY ITEMS

Conform to the requirements for accessory items specified below. Submit fasteners proposed for use for each type of wall construction, mounting, operation, and cleaning instructions and one sample of each other accessory proposed for use. Incorporate approved samples into the finished work, provided they are identified and their locations noted. Submit certificate for each type of accessory specified, attesting that the items meet the specified requirements.

2.2.1 Grab Bar

Model and Manufacturer: B-6806 Series; Bobrick Washroom Accessories, Inc.or approved equal.

Provide an 18 gauge, 1-1/4 inch grab bar OD Type 304 stainless steel. Provide form and length for grab bar as indicated. Provide concealed mounting flange. Provide grab with satin finish . Furnish installed bars capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Allow 1-1/2 inch space between wall and grab bar.

2.2.2 Framed Mirror

Model and Manufacturer: B-290 Series; Bobrick Washroom Accessories, Inc. or approved equal. Sizes as shown on the drawings.

Mirror: Type I transparent flat type, Class 1-clear glass. Glazing Quality q1 1/4 inch thick conforming to ASTM C1036. Coat glass on one surface with silver coating, copper protective coating, and mirror backing paint. Provide highly adhesive pure silver coating of a thickness which provides reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, free of pinholes or other defects. Provide copper protective coating with pure bright reflective copper, homogeneous without sludge, pinholes or other defects, of proper thickness to prevent "adhesion pull" by mirror backing paint. Provide mirror backing paint with two coats of special scratch and abrasion-resistant paint and baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

Frame: 18-8 S, Type 304, heavy gauge stainless steel, 3/4-inch x 3/4-inch

angle with vertical grain satin finish. One-piece roll-formed construction with integral stiffener on all sides. Provide bevel on front of angle to hold frame tightly against mirror. Corners shall be welded, ground and polished smooth. Provide with galvanized steel back fastened to frame. Securely fasten mirror to wall frame.

Concealed Wall Hanger: Minimum 20-gauge galvanized steel.

2.2.3 Paper Towel Dispenser

Dispenser shall be surface-mounted, roll-paper-towel dispenser. The dispenser door and cabinet shall be stainless steel with all-welded construction with a satin finish. Door shall be secured to cabinet with a full-length stainless steel piano-hinge. Towel mechanism shall accommodate up to 8" (205mm) wide, 8" (205mm) diameter, non-perforated paper towel rolls and shall be compatible with Ecosoft 45800 paper towel rolls. The dispenser shall use a touch-free pull towel mechanism and dispenses at least an 8" length of towel paper per pull. The user only touches the paper in regular operation. The dispsenser shall include automatic transfer to accommodate a stub roll up to 3-1/2" (90mm) diameter before new roll is dispensed. The dispenser shall be equipped with paper towel feed wheel for use in filling the dispenser or for the user to advance paper should it become necessary to feed paper through dispenser. Paper towels are dispensed with pull force to operate 1.8 pounds (8.0 N) to comply with barrier-free accessibility guidelines. The dispenser shall be Bobrick model B-2860 or approved equal.

2.2.4 Sanitary Napkin Disposal - Surface Mounted

Model and Manufacturer: B-354; Bobrick Washroom Accessories, Inc. or approved equal.

Type 304 stainless steel with all-welded constuction; satin finish exposed surfaces. Provide full-length stainless steel piano-hinge and tumbler lock keyed like other washroom accessories. Provide international identifying graphic symbol. Provide with removable, leak-proof molded polyethylene receptacle having a capacity of 1.2 gallons.

2.2.5 Toilet Tissue Dispenser - Surface Mounted

Dispenser shall be surface mounted, double-roll dispenser. Dispenser shall be seamless stainless steel with satin finish, door and cabinet shall be stainless steel, 20-gauge minimum thickness. The dispenser shall be compatible with 2 ¼-inch or 3-inch roll cores and shall have a viewing slot to allow checking the supply from the outside. The dispenser shall be compatible with Ecosoft 10020 toilet paper rolls. The dispenser shall be Bobrick model B-2892 or approved equal.

2.2.6 Toilet Seat Cover Dispenser - Surface Mounted

Dispenser shall be compatible with Rochester Midland 250-count, half-fold toilet seat covers, Rest Assured, catalog no. 25177673. The dispenser shall be stainless steel with satin finish, all-welded construction. The dispenser shall be Bobrick model B-221 or approved equal.

2.2.7 Soap Dispenser - Surface Mounted

The dispenser shall be Model 34015, manufactured by Triple S or approved equal. The dispenser shall be a 800 ml bag-in-box soap dispenser system,

ADA compliant, and guaranteed for life. Coordinate the color for each location with the Contracting Officer.

2.2.8 Mop and Broom Holder with Shelf

Model and Manufacturer: B-224 x 36-inches; Bobrick Washroom Accessories, Inc. or approved equal.

Surface mounted utililty shelf with mop/broom holders and rag hooks; Type 304 stainless steel, satin finish. 18 gauge shelf with return edge; provide with 18 gauge mounting brackets.

PART 3 EXECUTION

3.1 INSTALLATION

Provide the same finish for the surfaces of fastening devices exposed after installation as the attached accessory. Provide oval exposed screw heads. Install accessories at the location and height indicated. Protect exposed surfaces of accessories with strippable plastic or by other means until the installation is accepted. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as their work progresses. After installation, thoroughly clean exposed surfaces and restore damaged work to its original condition or replace with new work.

3.1.1 Recessed Accessories

Fasten accessories with wood screws to studs, blocking or rough frame in wood construction. Set anchors in mortar in masonry construction. Fasten to metal studs or framing with sheet metal screws in metal construction.

3.1.2 Surface Mounted Accessories

Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with sheet metal screws or wood screws in lead-lined braided jute, PTFE or neoprene sleeves, or lead expansion shields, or with toggle bolts or other approved fasteners as required by the construction. Install backplates in the same manner, or provide with lugs or anchors set in mortar, as required by the construction. Fasten accessories mounted on gypsum board and plaster walls without solid backing into the metal or wood studs or to solid wood blocking secured between wood studs, or to metal backplates secured to metal studs.

3.2 CLEANING

Clean material in accordance with manufacturer's recommendations. Do mot use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

-- End of Section --

SECTION 10 44 16

FIRE EXTINGUISHERS
05/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 10	(2013) Standard for Portable Fire Extinguishers

UNDERWRITERS LABORATORIES (UL)

UL 299	(2012) Dry Chemical Fire Extinguishers

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval.When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Data

SD-02 Shop Drawings

Fire Extinguishers
Cabinets
Wall Brackets

SD-03 Product Data

Fire Extinguishers
Cabinets
Wall Brackets

SD-07 Certificates

Fire Extinguishers
Manufacturer's Warranty with Inspection Tag

1.3 DELIVERY, HANDLING, AND STORAGE

Protect materials from weather, soil, and damage during delivery, storage, and construction.

Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

1.4 WARRANTY

Guarantee that Fire Extinguishers are free of defects in materials, fabrication, finish, and installation and that they will remain so for a period of not less than 5 years after completion.

PART 2 PRODUCTS

Submit fabrication drawings consisting of fabrication and assembly details performed in the factory and product data for the following items: Fire Extinguishers; Accessories, Cabinets, Wall Brackets.

2.1 TYPES

Submit certificates that show Fire Extinguishers comply with local codes and regulations.

Provide Fire Extinguishers conforming to NFPA 10.

Provide dry chemical type fire extinguishers compliant with UL 299; UL Rating 4A-80BC.

Provide Ky class wet chemical at all kitchen/food service locations.

Submit Manufacturer's Data for each type of Fire Extinguisher required, detailing all related Cabinet, Wall Mounting and Accessories information, complete with Manufacturer's Warranty with Inspection Tag.

2.2 MATERIAL

Provide enameled steel extinguisher shell.

2.3 SIZE

10 pounds extinguishers.

2.4 ACCESSORIES

Forged brass valve

2.5 CABINETS

2.5.1 Model and Manufacturer

Basis of Design: Occult Series, AL 0-2409; Larsen's Manufacturing Company

Door Style: Solid door.
Lettering Color: Black
Lettering Stile: Horizontal
Hinge: Full-length piano hinge.

Fire Rated Cabinets: Provide fire rated cabinets if located in a fire rated wall assembly.

2.5.2 Material

Provide baked enameled steel cabinets with aluminum doors.

2.5.3 Type

Provide recessed type cabinets.

2.5.4 Size

Dimension cabinets to accommodate the specified fire extinguishers.

2.6 WALL BRACKETS

Provide spring-clip fire extinguisher wall brackets.

Provide wall bracket and accessories as approved.

PART 3 EXECUTION

3.1 INSTALLATION

Install Fire Extinguishers where indicated on the drawings. Verify exact locations prior to installation.

Comply with the manufacturer's recommendations for all installations.

Provide extinguishers which are fully charged and ready for operation upon installation. Provide extinguishers complete with Manufacturer's Warranty with Inspection Tag attached.

3.2 ACCEPTANCE PROVISIONS

3.2.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the Government.

Submit Replacement Parts list indicating specified items replacement part, replacement cost, and name, address and contact for replacement parts distributor.

3.2.2 Cleaning

Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

-- End of Section --

SECTION 10 51 13

METAL LOCKERS
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2012a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM B456	(2011; E 2011) Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS AA-L-00486	(Rev J) Lockers, Clothing, Steel

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Types
Location
Installation
Numbering system

SD-03 Product Data

Material; G
Locking Devices; G
Handles; G
Finish; G
Locker components; G

Assembly instructions; G

SD-04 Samples

Color chips; G

1.4 DELIVERY, HANDLING, AND STORAGE

Deliver lockers and associated materials in their original packages, containers, or bundles bearing the manufacturer's name and the name of the material. Protect from weather, soil, and damage during delivery, storage, and construction.

1.5 FIELD MEASUREMENTS

To ensure proper fits, make field measurements prior to the preparation of drawings and fabrication. Verify correct location

1.6 QUALITY ASSURANCE

1.6.1 Color Chips

Provide a minimum of three color chips, not less than 3 inches square, of each color selected.

Government may request performance-characteristic tests on assembled lockers. Tests and results must conform to FS AA-L-00486. Lockers not conforming will be rejected.

PART 2 PRODUCTS

2.1 TYPES

Locker must have the following type and size in the location and quantities indicated. Locker finish colors will be as scheduled.

2.1.1 Lockers

Description: Ventilated, triple tier, fully framed. Provide galvanized or galvaneal shelves and bottoms for all lockers, and fully galvanized or galvaneal lockers in locker space for kitchen staff. Provide full height door stiffeners.

2.2 MATERIAL

2.2.1 Galvanized Steel Sheet

ASTM A1008/A1008M, commercial quality, minimized spangle material. Prepare material surfaces for baked enamel finishing in accordance with FS AA-L-00486. Fabricate locker bodies from not less than 0.0239-inch thick steel sheet.

2.2.2 Chromium Coating

Nickel and chromium electrodeposited on the specified base metal. Conform to ASTM B456, SC-3, as applicable to the base metal.

2.2.3 Finish

Finish: Baked enamel or powder coat.

2.2.3.1 Color

As selected.

2.3 COMPONENTS

2.3.1 Built-In Locks

FS AA-L-00486. Provide locking devices as a padlock eye in the door latching mechanism.

2.3.2 Coat Hooks

FS AA-L-00486, chromium plated.

2.3.3 Door Handles

FS AA-L-00486. Provide zinc alloy or steel handles with a chromium coating.

2.3.4 Doors

FS AA-L-00486, not less than 0.0598 inch thick steel sheet.

2.3.4.1 Hinges

In addition to the requirements of FS AA-L-00486, provide 5-knuckle hinges, minimum 2 inches high. Fabricate knuckle hinges from not less than 0.0787 inch thick steel sheet. A full height piano hinge may be provided if standard with the manufacturer. Weld or bolt hinges to the door frame. Weld, bolt, or rivet hinges to the door.

2.3.4.2 Latching Mechanisms

FS AA-L-00486.

2.3.5 Latch Strikes

FS AA-L-00486. Fabricate from not less than 0.0787 inch thick steel sheet, except latch strike may be continuous from top to bottom and fabricated as part of the door framing.

2.3.6 Silencers

FS AA-L-00486.

2.3.7 Back and Side Panels, Tops, and Bottoms

FS AA-L-00486, not less than 0.0474 inch thick steel sheet.

2.3.8 Sloping Locker Tops

Where ceiling soffits are not provied provide sloping locker tops in addition to the locker-section flat tops. Sloping tops must be continuous in length. Provide fillers or closures at the exposed end of sloping

tops. Fabricate sloping tops from not less than 0.0478-inch thick steel sheet.

2.3.9 Shelves

FS AA-L-00486. Fabricate from not less than 0.0598 inch thick steel sheet.

2.3.10 Legs

Provide lockers without legs, as indicated.

2.3.11 Number Plates

FS AA-L-00486. Aluminum . Provide consecutive numbers.

2.3.12 Fastening Devices

Provide bolts, nuts, and rivets as specified in FS AA-L-00486.

PART 3 EXECUTION

3.1 ASSEMBLY AND INSTALLATION

Assemble lockers according to the locker manufacturer's assembly instructions. Align lockers horizontally and vertically. Secure lockers to wall with screws as indicated. Bolt adjacent lockers together. Adjust doors to operate freely without sticking or binding and to ensure they close tightly.

3.2 NUMBERING SYSTEM

Install number plates on lockers consecutively with odd numbers on top and even numbers on bottom.

3.3 FIELD QUALITY CONTROL

3.3.1 Testing

Government may request performance-characteristic tests on assembled lockers in accordance with FS AA-L-00486. Lockers not conforming will be rejected.

3.3.2 Repairing

Remove and replace damaged and unacceptable portions of completed work with new.

3.3.3 Cleaning

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work, in an approved manner. Remove equipment, surplus materials, and rubbish from the site.

-- End of Section --

SECTION 10 55 00

POSTAL SPECIALTIES

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Mailboxes
Include plans, elevations, sections, and attachment details.

SD-03 Product Data

Mailboxes; G
Mail/Parcel Drop
Rack Ladders and Trim

SD-04 Samples

Exposed finish; G

SD-07 Certificates

Sample warranty

1.2 DELIVERY, STORAGE, AND HANDLING

Furnish lock keys according to USPS requirements; with temporary identification for their respective locks, bagged, and securely taped inside the collection compartment for shipping.

1.3 WARRANTY

Special Warranty: Manufacturer agrees to repair or replace components of postal specialties that fail in materials or workmanship within specified warranty period.

Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MAILBOXES

2.1.1 Mailboxes

12 Door Rack Ladder P.O. Boxes: USPS approved.

Model and Manufacturer: 2212; Salsbury Industries, Mailboxes.com or approved equal.

a. Quantity: As shown on drawings (each unit contains 12 doors).

b. Loading: Rear loading.

c. Doors: Extruded aluminum; clear anodized finish.

d. Door Size: 3.5-inches x 5.5-inches

e. Compartment: Minimum 20 gauge steel with powder coated finish.

f. Lock: Coordinate with owner

2.1.2 Mailboxes

8 Door Rack Ladder P.O. Boxes:

Model and Manufacturer: 2208; Salsbury Industries, Mailboxes.com or approved equal.

a. Quantity: As shown on drawings (each unit contains 8 doors).

b. Loading: Rear loading.

c. Doors: Extruded aluminum; clear anodized finish.

d. Door Size: 5.5-inches x 5.5-inches

e. Compartment: Minimum 20 gauge steel with powder coated finish.

f. Lock: Coordinate with owner.

2.1.3 Mailboxes

4 Door Rack Ladder P.O. Boxes:

Model and Manufacturer: 2204; Salsbury Industries, Mailboxes.com or approved equal.

a. Quantity: As shown on drawings (each unit contains 4 doors).

b. Loading: Rear loading.

c. Doors: Extruded aluminum; clear anodized finish.

d. Door Size: 10-3/4 inches by 5.5 inches

e. Compartment: Minimum 20 gauge steel with powder coated finish.

f. Lock: Coordinate with owner.

2.1.4 Rack Ladders and Trim

Model and Manufacturer: 2200 and 2213; Salsbury Industries, Mailboxes.com or approved equal.

a. Quantity: As required.

2.1.5 Mail/Parcel Drop

Model and Manufacturer: N1006499 Mail Drop Compartment; Postal Products Unlimited, Inc. or approved equal.

a. Quantity: One.

2.2 FABRICATION

Form postal specialties to required shapes and sizes, with true lines and angles, square, rigid, and without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges and corners free of sharp edges and burrs and safe to touch. Fabricate doors of postal specialties to preclude binding, warping, or misalignment.

Preassemble postal specialties in shop to greatest extent possible to minimize field assembly.

Where dissimilar metals contact each other, protect against galvanic action by painting contact surfaces with bituminous coating or by applying other permanent separation as recommended by manufacturers of dissimilar metals.

PART 3 EXECUTION

3.1 INSTALLATION

Mail Receptacles: Install mail receptacles with center of tenant-door lock cylinders and bottom of compartments at the maximum and minimum heights above finished floor established by the USPS and manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

Arrange for USPS personnel to examine and test postal specialties served by the USPS after they have been installed according to USPS regulations.

-- End of Section --

SECTION 11 40 00

FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Supply, deliver, and install all food service equipment as listed within the following specification and indicated on the related drawings.

1.2 SCOPE OF WORK

A. Except as otherwise herein stated, the work of this Section consists of the furnishing of all materials, labor, fabrication, transportation, equipment and appliances required for the complete execution of all food service equipment as shown on the drawings, as specified, or both and as necessary to complete the work for Certificate of Occupancy and intended use by occupant. This shall include but not be limited to the following:

1. Stands and supports required for equipment, including backing plates.
2. Cutting of holes in equipment for pipes, drains, electric outlets, etc., indicated and those which are not indicated but which are required for this installation.

1.3 RELATED SECTIONS

A. Electric services, including wiring and final connections to the fixtures and equipment furnished under this Section and Government furnished equipment: Division 26 - Electrical.

B. Water, gas steam and waste services to the fixtures and equipment, except as otherwise specified in individual items: Division 22 - Plumbing.

C. Except exposed ducts specified as part of equipment, all ventilation duct work including final connections to hoods and ventilators: Division 23 - Mechanical.

1.4 RESPONSIBILITY

A. The work herein specified and/or shown on the Drawings shall be coordinated with the work of the other Subcontractors. It shall be the responsibility of the Contractor to maintain regular communication with the G.C. and project team members to assure coordination and cooperation with all other trades performing work on this project.

1.5 QUALIFICATIONS

A. Contractor shall submit satisfactory evidence that he is now, and has been for the past five (5) years, engaged in the food service equipment industry, installing projects of the type herein specified as his principal product. Contractor shall be engaged in the fabrication of stainless steel, food service equipment in his own plant, or he must submit to the Government the name of his fabricator for approval, prior to bidding. Contractor's fabricator must show evidence he can meet the requirements concerning qualifications. Contractor's fabricator submitted and approved must be subcontractor used.

1.6 QUALITY ASSURANCE

A. Requirements of regulatory agencies:

1. In addition to complying with other legal requirements, comply with:

a. NSF: National Sanitation Foundation Regulations
b. UL: Underwriters Laboratories

B. Reference specifications and standards:

1. NEMA: LP-3, Plastic Laminates.
2. ASTM: Designations specified.
3. ANSI: Z21.20, Automatic Gas Ignition Systems & Components.

1.7 SUBMITTALS

A. SD-02 Shop Drawings

1. Food Service Equipment Schedule; G

a. Submit in the same format as the equipment schedule on the drawings

2. Rough-in Drawings; G

a. The contractor shall submit 1/4 inch scale rough-in drawings for approval. Drawings shall be dimensioned, showing ventilation ducts, floor and wall sleeves, plumbing, gas, steam, and electrical lines, including those items purchased or supplied by the Government. Elevations and sections of special work shall be prepared for use of the respective trades.
b. The following shall each be drawn on separate sheets and/or plans; Plumbing; Electrical, and Ventilation. In addition, a plan indication slab recesses, wall blocking, Refrigeration, and Beverage Chase locations shall be provided.
c. Utilities shall be stubbed out of walls wherever possible.

d. Contractor shall field verify mechanical, electrical, and ventilating rough-in and sleeve locations before floor slabs are poured.

3. Detail Drawings; G

a. Indicate dimensions, details or construction, installation, relation to adjoining and related work where cutting or close fitting is required.
Verify at job site, all dimensions, mechanical, electrical and ventilation rough-in, and sleeve locations before fabrication.

b. Indicate all reinforcements, anchorages and other work required by other trades for complete installation of all items.

c. Include on shop drawings all items furnished by the Government. Government shall provide Contractor with product data and other information required for detailing.

B. SD-03 Product Data

1. Food service equipment; G

a. Manufacturer's detailed literature, catalog cuts, and specifications. Submit for each manufactured item. Include rough-in and service information and details.

C. SD-10 Operation and Maintenance Data

1. Operation and Maintenance Manuals: Include the following.

a. System description.
b. Wiring diagrams.
c. Operating sequence.
d. Manufacturer's data.
e. Preventative maintenance.
f. Trouble shooting.
g. Warranties.
h. Directory.
i. Valve directory with tag schedule showing location of each valve, type, number and manufacturer.

2. Compile required operating maintenance data stipulated into individual packages for each item of equipment. Identify each package with equipment name and item number corresponding to name and number in schedule. All data shall be incorporated in hardback, (3) ring binders. Include a complete list of service agencies for all equipment. Provide a total of (2) operation and maintenance manuals.

1.8 (Not Used)

1.9 WARRANTY

A. Guarantee all equipment furnished under this Section for a period of one year from the date of substantial completion, covering defective materials, design and workmanship. Upon receipt of notice of failure of any part of the warranted equipment during the warranty period, the affected part or parts shall be replaced promptly and at the expense of the Contractor.

1. Until the time replacement equipment is installed, the Contractor shall have full use of the defective equipment.2. Warranty shall include installation, start-up and one year free service for all self-contained refrigeration equipment with evidence of manufacturer's one year Warranty on the entire cabinet and additional four year Warranty on sealed compressor motor assembly except for labor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless steel: ASTM A240, U.S. Standard gauges, 18-8 type 302 or 304, not over 0.12% maximum carbon. Provide No. 4 finish unless otherwise specified.

B. Galvanized steel: Arco, gauges as specified or indicated on Drawings.

C. Sink wastes: All custom fabricated and die-drawn sinks: Rotary type waste outlet with one-piece connected overflow assembly and stainless steel removable basket strainer manufactured by Component Hardware Group as "Drain Master" Model DSS-8000 or approved equal..

D. Legs: 1-5/8 inch diameter 16 gauge stainless steel tubular legs with bullet type feet, Model A10-0881 as manufactured by Component Hardware Group (or approved equal), unless specified or detailed otherwise.

E. Hardware: Except where specified otherwise, all hardware shall be solid material, and where exposed, chrome plated or stainless steel.

1. Provide locking type hardware.
2. Identify hardware with manufacturer's name and number so that broken or worn parts may be ordered and replaced.
3. Unless specified otherwise, provide Kason No. 171C magnetic latches with No. 218 self closing hinges (or approved equal) for under counter refrigerator doors.
4. Unless otherwise specified, provide stainless steel recessed flush pulls, Klein Hardware, Model #12000, and Klein Model #242, solid brass, satin finish door catches (or approved equal) for refrigerated drawers, side sliding doors, access panels and hinged doors.

5. Locks and keys: Equip all doors and drawers on all equipment with stainless steel hasps for padlocks.
6. Faucets and Pre-Rinse Spray Units: "Encore" as manufactured by Component Hardware Group(or approved equal). Model numbers as shown on Drawings.
7. Drawers: Model S90-0020 manufactured by Component Hardware Group (or approved equal)
8. Sound Deadening Material: Q75-2500 "Multiflec Sound Deadener" as manufactured by Component Hardware Group (or approved equal). Color Grey.

F. Inset type sinks: 16 gauge or heavier polished stainless steel (installed in tops as an integral part of the fixture).

G. Casters: Double ball bearing, rubber tire, heavy duty, 1 inch tread width, cadmium plated, as manufactured by Jarvis and Jarvis, Inc., except that the manufacturer's standard casters shall be accepted on non-custom fabricated equipment items.

H. Plumbing Products: All plumbing products shall utilize "lead free" castings and comply with NSF Standard 61, Section 9 (11 micrograms or less of lead when normalized to one liter).

2.2 FABRICATION

A. All custom fabricated equipment shall be provided by approved fabricator.

B. Drawings:

1. Food Service drawings indicate general arrangement of the piping and location of equipment. Should it be necessary to deviate from the arrangement indicated in order to meet structural conditions, such deviations, as approved, shall be made without additional expense to the Government.

C. General:

1. Provide all fabrication in accord with NSF Standards.
2. Verify size and location of all duct connections required for ventilators, including Government furnished ventilators, prior to fabrication.
3. Provide concealed galvanized steel frame for all equipment indicated with fully-welded construction.
4. Provide casters on all wheeled equipment.

D. Welding:

1. Make all shop and field welds continuous and hidden or ground smooth.
2. Polish exposed welds in stainless steel to original finish after grinding, with no visible welds, line or buckles.
3. Grind galvanized steel so no visible welds, lines or buckles show, and touch up with galvanizing stick, where galvanizing has been removed.

E. Manufacturer's instructions: Follow manufacturer's directions in all cases where the manufacturer of items used in this work furnish directions or prints covering points not indicated or specified.

F. Metal tops:

1. Fabricate all tops from 14 gauge No. 4 finish stainless steel unless specified otherwise. Provide one piece welded construction reinforced on the underside with 14 gauge stainless steel channels.
2. Provide cross braces not more than 30 inch O.C.
3. Coat underside of all tops with a minimum of 1/8 inch thick approved hard drying, sound deadening mastic material dried smoothly without dirt catching crevices.

G. Enclosed cabinet type bases:

1. Made of formed sheets reinforced to create a rigid structure. All unexposed sections, upright partitions and back shall be 18 gauge galvanized steel or heavier, except as specified otherwise.
2. Exposed body facings, partitions, stiles and aprons shall be 18 gauge stainless steel No. 4 finish unless otherwise specified.
3. Shop weld all seams and joints where possible. Ground welds smooth and polish welds to match original finish. Faces to be all flush welded.
4. Finish ends of all fixtures, back splashes, shelves, etc., flush to walls or adjoining fixtures.
5. Provide access holes in panels in the equipment to allow plumbing and electrical trades to make their respective connections.

6. Coved corners:

   a. Provide all dish tables, drain tables, work tops, splash backs and turned up edges with radius bends on all inside horizontal and vertical corners, and coves at intersections.
   b. Provide all shelves, under shelves, elevated shelves, port shelves, etc., with turned-up edges and radius bends on all inside horizontal corners.
   c. Unless specified otherwise in individual items, provide rounded and coved corners or radius ends of 3/4 inch radius or larger.

7. Fabricate equipment legs and cross rails from 1-5/8 inch diameter 16 gauge stainless steel tubing unless otherwise noted. Grind smooth and polish all welds at cross-rails. Fit bottom of each leg at floor with a sanitary stainless steel bullet type foot with not less than 2 inch adjustment. Fasten legs to equipment as follows:

a. To sinks by means of cylinder gussets: Provide stainless steel gussets reinforced with bushing, and set screw for securing legs. (United Show Case No. LC-158 or Approved Equal)
b. To metal top tables and dish tables: Provide cylinder gussets or equivalent, welded to 14 gauge or heavier channel. Weld bracing to underside to tops.
c. Closed gussets shall be a minimum 3 inch diameter on top continuously welded to frame members of sink bottoms.

H. Sinks:

1. Provide fabricated sink compartments with fully coved vertical and horizontal interior corners. All coves 3/4" RAD.
2. Where one or more sink compartments are adjacent, provide double thickness partitions, continuously welded at top. Fronts of multiple compartment sinks continuous on the exterior.
3. Crease bottoms of each sink compartment to insure complete drainage to waste opening.
4. Install inset type sinks in tops as an integral part of the fixture.

I. Drawers: Model S90-0020 manufactured by Component Hardware Group or approved equal, or custom fabricated to following standards:

1. Fabricated die stamped 18 gauge stainless steel with stainless steel fronts. Fabricate support slides so that drawers may be pulled out a minimum of two-thirds or its length and still support heavy loads without deflection.
2. Fabricate to allow easy removal without the use of tools. Provide with built-in flush type pulls. All drawers mounted on open tables shall have enclosure on sides and rear and shall be self-closing.
3. Mount drawers in refrigerated sections on large ball bearings surface in flat tracks.
4. Wheels and bearings shall be corrosion resistant, long wearing material, grease packed before assembly.
5. Provide a means of locking all drawers. This may include an integral hasp for use with an Government supplied lock.

J. Doors:

1. All doors shall be double pan type, outer pans cased, with welded corners.

a. Sliding doors: Removable double pan type, reinforced and stiffened with closed hat sections, and mounted on ball bearing quiet rollers in overhead tracks.
b. Hinged doors: Flush type mounted on heavy duty stainless steel piano hinges. Fill inside core of doors with sound deadening material. Provide built-in flush type pulls as detailed.

K. Shelves:

1. Overhead shelves: Constructed of #16 gauge stainless steel not less than 12" wide, unless otherwise specified. The shelves shall be polished on all surfaces (top and bottom). Each shelf shall be made in one (1) piece or butt welded, ground and polished smooth. Shelves shall be made as shown, welded, ground, and polished. Where shelves adjoin walls, gauge stainless steel wall brackets, triangular shaped, spaced not more than 48 inches on center, welded to stainless steel 1-1/4" diameter, #16 gauge stanchions mounted through table backsplash unless otherwise specified for particular item.
2. Under shelves: At open tables constructed of #16 gauge polished stainless steel, having edges turned down 1-1/2" and under 3/4" except at walls turned up 2"; with all corners welded, ground and polished; where required shelves suitable reinforced with stainless steel channels running the full length. Shelves connected to legs by means of notching and continuous welding. All cabinet bottoms shall be #16 gauge stainless steel reinforced as required and shown on the contract drawing, completely integrally flush welded to cabinet face. Provide ferruled openings in bottom shelves top entry of service where required.

2.3 UNDERCOUNTER REFRIGERATORS

A. See Item Specification.

2.4 HEATING EQUIPMENT

A. Provide gas, electric or steam heating equipment or thermostat control for such equipment, and of materials, sizes or ratings specified within the equipment items or details.

1. All such equipment shall be of nature and so installed as to be readily cleanable or made easily removable for cleaning.

B. Electrical appliances or heating element circuits of 120 volts shall not exceed 1650 watts.

2.5 GAS-FIRED EQUIPMENT

A. Burners for gas heated equipment shall be equipped with AGA approved automatic lighters.

B. Oven burners and other concealed burners shall have automatic safety pilots to conform to AGA requirements.

C. No extra charge shall be paid for furnishing items required by the regulations, but not specified or indicated.

D. The Contractor shall confirm gas type and pressure requirements, providing any required regulator or gas connection attachment as required for a complete installation.

E. The Contractor shall provide and install Hosemaster Mfg. "Super-Swivel" or approved equal (multi-axis) quick disconnects with strain relief cable attachment for all gas fired equipment. Equipment that could present a tipping hazard if moved shall not be provided with quick-disconnect hoses.

2.6 SWITCHES AND CONTROLS

A. Provide on each motor driven appliance or electrical heating unit a suitable control switch or starter of proper type in accord with UL requirements.

B. Provide all internal wiring for fabricated equipment items, including all devices, wiring controls, switches, electrical boxes, receptacles, stainless steel face plates, conduit and wiring, etc., built into or forming an integral part of these items, in factory or at the job site, with all items completed to a junction box for final connection to the building services.

1. Fixture internal wiring shall conform to UL standards.

C. Provide standard 3-prong plug to fit "U" slot grounding type receptacles, similar to Hubbell No. 5262 (or equal) for all equipment items noted as powered by plug connection into 110-120 volts, single phase A.C. Provide suitable length 3-wire cord for all such equipment.

2.7 CONNECTION TERMINALS

A. Provide equipment complete with connection terminals as standardized by equipment manufacturers except where specified otherwise, for other trades to make plumbing, gas, steam, electrical, ventilation and refrigeration connections.

B. Provide equipment including refrigerated drawer section and ice bins, and all indirect wastes or other special applications, with 1 inch minimum copper drain tubing of sufficient length to extend to floor sinks.

1. Wrap drain tubing with 1/4 inch thick foamed plastic insulation to prevent condensation.

2.8 TRIMMING AND SEALING EQUIPMENT

A. Seal spaces between all units at walls, ceilings, floors and adjoining non-portable units with enclosed bodies against entrance of food particles or vermin by means of stainless steel trim, strips, welding, soldering or commercial joint materials as suited to the nature of the equipment. Use General Electric silicone or approved equal sealants where applicable.

B. Close ends of all hollow sections.

C. Fixtures resting on concrete bases shall be set into sealant bed to eliminate crevices between fixture and base, and caulked after installation has been completed.

2.9 EXHAUST VENTILATORS

A. Ventilators shall meet the latest NFPA standard No. 96 as Underwriter's Laboratories, listed "Grease Extractors for Exhaust Ducts" and conform to National Sanitation Foundation requirements and bear its seal. All models shall be ETL Listed and comply with UL705 (electrical) and UL762 Standards and CSA Std C22.2, No 113. Fan shall bear the AMCA certified ratings seal for sound and air performance.

B. Exhaust ventilators shall include an EMS (Energy Management System) or Demand Ventilation System designed to automatically reduce exhaust and supply airflow quantities, while ensuring hood performance is maintained. The EMS shall use Variable Frequency Drives (VFD) and temperature sensors in the exhaust ducts to modulate the fans speed during cooking operation and maximize energy savings. The EMS LCD screen interface shall provide fan(s) control, system configuration, and diagnostic information.

The EMS includes:
- A smart Controller
- LCD Screen Interface
- Duct Temperature Sensor(s)
- Room Temperature Sensor
- Variable Frequency Drive(s)

Controls will be listed by ETL to UL standard 508A.
The system shall include a LCD screen interface for fan(s) and hood lights control, wash control (if applicable), gas valve reset, programmable schedule, Max Air Override function, Preparation Time mode, Cool Down mode, and diagnostics including VFD status. The LCD screen shows descriptive plain text explaining the functions or values. The LCD screen interface will be installed on the face of the hood, on the face of the utility cabinet or on the face of a wall mounted control enclosure.

Control enclosure will be NEMA 1 rated and listed for installation inside of the exhaust hood utility cabinet. Control enclosure may be constructed of stainless steel or painted steel. The smart controller will constantly monitor the exhaust air temperature through the riser mounted temperature sensor and modulate the fan speeds accordingly. A room temperature sensor will also be provided for field installation in the kitchen space in order to start the fan(s) based on the temperature differential between the room and the exhaust air in the duct rather than fixed set-points.

A Preparation Time Mode shall be available for morning operation: dedicated make-up air will be locked out only allowing the use of transfer air during this mode. Exhaust fan(s) will run at low CFM while maintaining a balanced kitchen pressure.

A Cool Down Mode shall be provided for equipment cool-down period at the end of the daily cooking operations: similarly to Preparation Time mode, dedicated make-up air will be locked out only allowing the use of transfer air during this mode. Exhaust fan(s) will run at low CFM while maintaining a balanced kitchen pressure.

Fan maximum/ minimum speeds shall be adjustable for proper kitchen balance. Fan direction change is also available from the smart controller configuration menu without need for rewiring. Duct Temperature Sensor(s) shall be mounted in the exhaust hood riser(s). Temperature probe will be constructed of Stainless Steel. System will be factory pre-set to modulate fan speed within a range of45°F for 600°F and 700°F cooking applications and a range of 5°F for 400°F cooking applications. Set points shall be fully adjustable through the touch screen interface based on application needs

The Max Air Override shall have an adjustable timeout value
The panels shall include color-coded wiring with as-built wiring diagrams and spare terminals controlled by the fire system micro switch. The panel shall be factory pre-wired to shut supply fans down in a fire condition. Options to turn ON the exhaust fans or turn off the hood lights in a fire condition shall be configurable through the smart controller, but only through a password protected menu to prevent any changes after a fire inspection has been performed

Sequence of Operation:

Under normal conditions, the operator shall turn hoods on with the switch provided at the face of the hood when cooking starts. The Energy Management System will monitor heat quantity and modulate as needed. When cooking is complete for day operator turns fans off and water wash automatically starts. Water will be sprayed during the total duration of the cycle. The surfactant is injected for 1 second every 1 minute of wash time. Factory default is a 3 minute wash. Hood is ready to be turned on again once cooking starts. Heat sensors are provided to override switch in off position if appliances are turned on and heat is detected.

Under fire condition, the exhaust fans turns on if off, the supply fan turns off if on, a signal is sent to shunt trip breaker to turn any electrical under hood off, the gas valve is closed, and a signal to building alarm is sent.

During a Launch Mishap condition, the red kill switch on face of hood shall be manually activated causing the exhaust and supply fans to shut off, the gas valve to close, and a signal shall be sent to shunt trip breaker(s) to shut off all electrical power to cooking appliances located under the exhaust hood.

C. Fans shall be a spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator.

The fan windband shall be constructed of heavy gauge spun aluminum with consistent dimensions. Horizontal and vertical internal supports shall be used to securely fasten the windband to the discharge apron. The discharge apron shall have a rolled bead.

The base shall be constructed of galvanized steel. Base corners shall be welded and leakage-free.

The fan wheel shall be centrifugal backward inclined and non-overloading. Wheels shall be balanced in two planes and done in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans. The wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency and reduce noise. The wheel blades shall be welded to the wheel inlet cone. In the event that balancing weights are required they shall be riveted to the blades or wheel. The wheel inlet shall overlap the fan base inlet for maximum performance and efficiency. The wheel shall be firmly attached to the motor shaft with no fewer than two set screws.

Motors shall be heavy duty ball bearing type, mounted out of the airstream and furnished at the specified voltage, phase and enclosure. Motor mounting plate shall be constructed of 14 gauge galvanized steel and isolated from the fan structure with vibration isolators. The motor compartment shall be cooled by outside air. The motor compartment shall be of a two-piece construction to provide access to the motor compartment.

Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for and individually tested specifically for use in air handling applications.

Belts shall be oil and heat resistant, non-static type. Drives shall be cast type, precision machined and keyed and secured attached to the fan and motor shafts. Drives shall be sized for a minimum of 150% of the installed motor horsepower. Fan operating speed shall be factory set using fixed pitch motor pulleys; motors over 2 HP will come standard with double groove pulleys. Adjustable pitch pulleys are not allowed. Contractor shall re-sheave fan based upon final recommendation of TAB contractor during startup and commissioning phase of project.

A grease spout made of aluminum tubing shall be welded to the fan housing. The weld shall be factory tested to ensure it will not leak.

To provide a tight seal all fasteners in the fan housing shall be backed with nylon washers.

A safety disconnect switch shall be standard on all NCA-FA units with open drip proof motors. Switches shall be installed in a

NEMA3R enclosure and mounted to exterior of fan housing for code-required access.

D. All piping within the ventilator to be factory pre-piped with all exposed piping, fittings and nozzles chrome plated or chrome sleeved. Ventilator shall be equipped with by-pass test valve for testing of the system.

E. Contractor shall provide factory authorized start-up supervision and inspection with written confirmation of same issued to Architect within 48 hours of start-up. Confirmation letter should include names of Government's representative(s), Contractor's representative(s), and factory service representative present at time of start-up. Units must comply with all applicable codes and be of type 304 s/s construction.

2.10 MAKE-UP AIR UNITS

Fan shall be G90 galvanized steel, roof mounted, belt drive or direct drive, forward curved, filtered supply fan. Fan shall be listed by ETL and conforms to UL705 and CSA Std. C22.2, No. 113 standards.

Fan shall be constructed of 16 gauge G90 galvanized steel. Doors shall be removable to facilitate access to interior components. Weather hood shall include 2" washable filters and inlet screen to prevent large debris from clogging filters.

The base shall be constructed of 16 gauge galvanized steel. Base shall be structurally reinforced to accommodate the blower assembly.

The blower wheel shall be forward curved centrifugal, constructed G-90 galvanized steel. Wheels shall be balanced in two planes and done in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans. The wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency and reduce noise. The wheel blades shall be securely attached to the wheel inlet ring. The wheel shall be firmly attached to the fan shaft with set screws and keys. The blower assembly shall be isolated from the fan structure with vibration isolators.

The coil shall be chilled water. Coil shall be standard duty with 1 coil per bank. Finns shall be .0075 aluminum and tubes shall be .02 copper. Housing shall be 16 gauge galvanized steel.

Motors shall be heavy duty ball bearing type. Motor mounting plate shall be constructed of 14 gauge galvanized steel and shall be designed to provide easy adjustment of belt tension (belt drive units only).

Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for, and individually tested specifically for use in air handling applications.

Belts shall be oil and heat resistant, non-static type. Drives shall be cast type, precision machined and keyed and secured attached to the fan and motor shafts. Drives shall be sized for a minimum of 150% of the installed motor horsepower. Fan operating speed shall be factory set using fixed pitch motor pulleys; motors over 3 HP will come standard with double groove pulleys. Adjustable pitch pulleys are not allowed. Contractor shall re-sheave fan based upon final recommendation of TAB contractor during startup and commissioning phase of project.

2.11 WALK IN REFRIGERATORS

A. See Item Specification.

B. Acceptable Manufacturers: MasterBilt, Kolpack or approved equal

2.12 REFRIGERANT SYSTEMS

A. See Item Specification.

B. General Note: Center mount evaporator coils may not be used.

C. The Contractor shall confirm HP requirements for all units submitted. Design shall be submitted by factory shop drawings and shall reflect, field dimensions, building temp/humidity, use, and configuration of compartments.

2.13 POLLUTION CONTROL UNIT (PCU)

The PCU housing is to be constructed of 430 SS of polish 2B or better. All metal in contact with the air-stream is to be constructed of 430SS. Ceramic based gasket shall provide resistance to 1500°F and must be in place for all internal seams exposed to airflow. High-temperature weatherproofing gasket must be used on all exterior seams.

Base shall be constructed of 14 gauge galvanized steel and shall be structurally reinforced to accommodate filter assembly.

Pre-filter section shall include two (2) inch deep steel washable permanent filters. Filter frames shall be constructed of 16 gauge steel. Disposable filters placed upstream of the permanent filters shall be provided. Filters shall be arranged in a v-bank configuration to increase filter area and reduce static pressure. All filters shall be removable without the use of tools through side access. Filters shall be washable with soapy water.

The phase-two filters shall consist of four (4) inch deep rigid cell extended surface filters. Filter cell sides shall be constructed of 16 gauge steel frame with downstream mesh.

Beverage board filter sides shall not be permitted. Filters shall be arranged in a v-bank configuration. Filters shall be removable without use of tools through side access doors. Filters shall be rated MERV14 minimum in accordance with ASHRAE standard 52.2 and have a minimum average arrestance of 98% in accordance with ASHRAE 52.1-1992. High efficiency module must be installed downstream of pre-filter module.

The phase two filters shall consist of four (4) inch deep rigid cell extended surface filters. Filter cell sides shall be constructed of metallic frame with downstream mesh for durability. Beverage board filter sides shall not be permitted. Filters shall be arranged in a v-bank configuration to increase filter area and reduce static pressure. Filters shall be removable without use of tools through side access doors. High efficiency module must be installed downstream of pre-filter module.

Filter Monitoring includes a module that provides the necessary precision pressure measurements for accurate monitoring of the complete system. Based on the measurements the AFM will initiate suitable actions via the electric control package in case of a fault. Direct access to the operating conditions is also provided through the use of a HMI (Human Machine Interface), which is conveniently located on the PCU.

2.14 Food Service Equipment Schedule - ITEM SPECIFICATION AND SCHEDULE OF FOOD SERVICE EQUIPMENT

Note: All items listed on the contract drawings under the heading "Foodservice Equipment Schedule" shall be furnished in accordance with the Master project specifications and the following detailed item specifications.

2.14.1 Provide rough-in drawings required for equipment utility connections to equipment in accordance with requirements specified and in accordance with the physical dimensions, capacities, manufacturer's instructions, and other requirements of the equipment indicated.

2.14.2 Provide detail drawings including utility requirements for equipment indicated.

2.14.3 Provide operation and maintenance data and include in the operation and maintenance manuals for equipment indicated.

ITEM NO. 1 - AIR CURTAIN
Qty (2) Mars Air Doors Model No. 36C, or approved equal, air curtain, unheated, with corrosion resistant painted metal housing, field adjustable intake and discharge louvers. Motor and fan assembly to be easily accessible for maintenance. Unit to be approximately 36"-long, and suitable for insect control on doors up to 10-feet high. Motor(s) shall be provided with sealed lifetime pre-lubricated ball bearings and protected by an automatic reset thermal overload switch. Provide door mounted micro switch for door. Manufacturer to provide five year guarantee on all parts.
Electrical Characteristics: 120 Volts

ITEM NO. 2 - SPARE NUMBER

ITEM NO. 3 - CHEMICAL STORAGE SHELVING
Qty (1) MetroMax, or approved alternate, 4 tier synthetic shelving unit, 18X48 shelving size per plan, no "S" hooks, 64" posts, adj. NSF feet

ITEM NO. 4 - SPARE NUMBER

ITEM NO. 5 - WATER FILTER
Qty (1) Everpure Model AR4000 or approved equal, dual wall mounted graded density carbon block water filter to provide pre-filter, dirt and rust sediment reduction to 1 micron, 40,000 gal capacity, 80 grams scale inhibitor, taste and odor reduction with filter change auto shut-off and pressure release valve. Provide with (4) additional replacement water filter cartridges. Three year warranty.

ITEM No. 6 - ICE MACHINE
Qty (1) Manitowoc model ID-1803W ice machine, water-cooled, 1800 lb production in 24 hrs, 7/8" square cube size. Ice machine to have self-diagnostic capability with easily visible electronic display, acoustical ice sensing probe, programmable ice production capability, and easily cleaned ice production areas. Exterior shall be stainless steel or synthetic panels. Provide with "LuminIce" option.
Unit to be provided with Manitowoc model F-1325 storage ice bin, 1320 lb storage capacity.
Electrical: 208v 3PH 14A
Approved Alternate Mfgrs: Hoshizaki or equal as approved by contracting officer

ITEM NO. 7 - FLOOR TROUGH
Qty (1) IMC Teddy model CFT-1860, or approved equal, 4" deep coved base interior 14 gauge s/s floor trough with s/s bee hive strainer and 4" OD tailpiece, all joints TIG welded and exposed surfaces having a brushed satin finish. Overall size 18" x 60" x 4" deep, and provided with a DuraDeck, or approved equal, removable subway style fiber grate

ITEM NO. 8 - HAND SINK
Qty (10) Advance Tabco model 7-PS-50, or approved equal, hand sink, wall-mounted, all type 304 s/s construction with die formed countertop edge with no-drip offset, deep drawn sink bowl, s/s basket drain with 1 ½" tailpiece, with cut outs for 4" OC splash and lever drain. Faucet shall be T&S model B-1146, or approved equal, wall mounted ½" supply goose-neck faucet with wrist blades and Component Hardware, or approved equal, "Quick-Wash control mounted on faucet outlet.
Soap and paper towel dispenser by Government.

ITEM NO. 9 THRU 12 - SPARE NUMBERS

ITEM NO. 13 - CONDENSATE HOOD
Qty (1) CaptiveAire model 4224VHB, or approved equal, condensate hood, all welded type 304 s/s construction, 42" x 42" x 24" high with 1 ½" gutter along bottom perimeter with 3/8" drain at rear. Provide s/s closure panels to ceiling.

ITEM NO. 14 - PRE-RINSE SPRAY
Qty (1) T&S model B-0133, or approved equal, wall mount pre-rinse spray with 44" flex house with 18" rigid riser and overhead spring and spray valve assembly. Spray valve to be rated at 1.42 gal per minute. Faucet to have ½" NPT female inlets at 8" OC with color coded lever handles and spring check cartridges. Overall height 34"

ITEM NO. 15 - DISHWASHER, HIGH TEMP
Qty (1) Hobart model AM15, or approved equal, corner model dishwasher, single rack door type high temp sanitizing with integral 70 degree F. rise booster and single point electrical connection. Provide with pressure regulator valve and corner splash shield. Standard features shall include .74 gallons per rack final rinse water, 58, racks per hour, NSF pot and pan listed for two, four, and 6 min. cycles, solid-state integrated controls with digital status indicators, self draining high-efficiency stainless steel pump and stainless steel impeller. Construction shall include stainless steel drawn tank, tank shall, chamber trim panels, frame and feet. Construction shall include revolving, interchangeable upper and lower anti-clogging wash arms and a slanted, self locating, one piece scrap screen and basket system. Unit shall also include the following features: automatic fill, door actuated start, automatic drain closure, exhaust vent fan control, external booster activation, delime cycle, service diagnostics, and NAFEM Data Protocol capable. Provide with splash shield for corner installation.
Electrical: 208V 3PH 46A

ITEM NO. 16 - SOILED DISHTABLE
Qty (1) Custom fabricated soiled dish table, NSF 84" long, L to R operation.
Top shall be 14 Ga. type 304 stainless with 1/4" radiused horizontal and vertical inside corners. Work surfaces shall be turned up 3" and terminate in a 1 1/2" dia. roll along working edges, and turned up into a min. of 8" splash, with the upper 2" angled up to the wall surface. Intersecting rolled edges shall be shaped and welded to form a smooth "ball" corner.
Legs shall be 1 5/8" dia. type 304 stainless steel tubing with NSF adjustable s/s bullet feet.
Rails shall be 1 1/4" dia. type 304 stainless steel tubing. All intersections of rails and legs shall be fully welded and finished smooth.
Leg sockets shall be 2" O.D. stainless steel with set screw to secure leg to socket, and welded to 14 Ga transverse top support channels.
Pre-rinse sink shall be fitted with rack guides and removable s/s perforated basket for collection of food waste.
Wall Mtd. Rack Shelf: Qty (1) Custom fabricated wall shelf, 54" long approx 16" front-to-back, slanted design to accommodate std. dishwasher racks for glassware racking. Fabricate of 1 5/8" 16 Ga. type 304 stainless steel tubing running horizontally between s/s double end panels, with all joints fully welded, ground smooth and polished. Secure to wall with 1/4" x 20 s/steel roundhead bolts and s/steel lock washers. Method of attachment (anchors or toggle bolts) shall be appropriate for the type of wall construction.
KEC shall provide complete shop drawings of all custom fabricated s/s equipment to Contractor for approval prior to fabrication.
Custom Fabricator must be reviewed and approved by contracting officer prior to bidding.

ITEM NO. 17 - CLEAN DISHTABLE
Qty (1) Custom fabricated clean dish table, NSF, "L" shape, L to R operation, see plan for dimensions

Top shall be 14 Ga. type 304 stainless with 1/4" radius horizontal and vertical inside corners. Work surfaces shall be turned up 3" and terminate in a 1 1/2" dia. roll along working edges, and turned up into a min. of 8" splash, with the upper 2" angled up to the wall surface. Intersecting rolled edges shall be shaped and welded to form a smooth "ball" corner. See drawing detail for landing shelf offset.
Legs shall be 1 5/8" dia. type 304 stainless steel tubing with NSF adjustable s/s bullet feet.
Rails shall be 1 1/4" dia. type 304 stainless steel tubing. All intersections of rails and legs shall be fully welded and finished smooth.
Leg sockets shall be 2" O.D. stainless steel with set screw to secure leg to socket, and welded to 14 Ga transverse top support channels.
Rack storage shall be provided, either through multiple sets of s/steel angles for "flat" storage of empty racks, or by tubular cross rails for storage of racks on edge.
Custom Fabricator must be reviewed and approved by contracting officer prior to bidding.

ITEM NO. 18-20 SPARE NUMBERS

ITEM NO. 21- WALK-IN COOLER/FREEZER
Qty. (1) KOLPAK, or approved equal, Cooler/Freezer room assembly shall be constructed with modular pre-fabricated precision formed, metal-clad insulated panels to conform with drawings. Height 8"-6" and exterior dimensions of 29'-9" x 20'-9" as indicated on plans.

Manufacturer shall conform to the following:

1. National Sanitary Foundation (NSF) Standard 7 construction.
2. Underwriters' Laboratories (UL) approval of door electrical circuit assembly.
3. Compliance with fire hazard classification ASTM-E84 (UL 723)

II. PANEL CONSTRUCTION

All panel sections shall be precisely shaped with metal pans processed through roll forming equipment and steel dies. Urethane insulation shall be injected (poured-in-place) to bond with the inner and outer metal pans when confined within temperature controlled fixtures or molds. Finished panels shall be insulated with 100% urethane without internal wood, wood fiber, steel perimeter or substructure except for cam locking devices.

All panels shall be 4" thick in widths of 11-5/8", 23-1/4", 34-7/8" and 46-1/2" as selected to conform with drawings. Corner panels shall be 11-5/8" x 11-5/8", 90 deg. angled with interior and exterior radius.

All wall and ceiling lengths shall be provided with a DOUBLE 90 deg. formed edge (17/32" initial flange, 11/32 return) to provide maximum panel rigidity and strength.
All panel edges shall have a formed urethane tongue or groove configuration with factory foamed-in-place compression gaskets on interior and exterior of all male edges. Urethane insulation shall be poured-in-place to a minimum density of 2.2 pounds per cubic foot (yielding compression strength of 30 PSI). NO FREON 12 SHALL BE USED AS AN EXPANDING AGENT IN THE MANUFACTURING PROCESS. Established thermal conductivity factor ("K") is 0.118 BTU/hr./sq.ft./degree (F) /inch. The overall coefficient of heat transfer

("U" Factor) is .0295 resulting "R" value, or assigned insulation efficiency rating is 33.9

Panels shall be equipped with steel cam locking devices foamed-in-place at exact matching location within tongue and groove perimeters. All locks shall have integral rear flanges to permanently anchor their position without use of temperature conductive strapping. Male and female locks shall be precisely situated to secure all panels and uniformly compress perimeter gaskets. Access to lock assembly must be provided on interior of panels allowing erection of structure within confined areas. Lock access ports shall have closure snap-in caps of colored PVC to match interior panel finish.

III. FINISH

A. Panel surface finish has been selected of standard material best suited to location and/or application of structure. A combination of materials (interior versus exterior) has been selected to satisfy aesthetic and economic design requirements.

1. Walls - exterior in the following: 20 gauge type 304 stainless steel with a number 4 finish. ALL MATERIAL TO BE OF DOMESTIC ORIGIN.
2. Interior and ceilings: finish in 18 gauge smooth aluminum with a baked-on white acrylic enamel finish. Exterior edge caps to match adjacent walls
3. Floors - interior surface shall be mud set quarry tile (By Contractor) to match kitchen floor, placed over 4" board insulation provided by Contractor or walk-in manufacturer. Metal clad 4 1/2" insulated screeds to be provided by cooler manufacturer. Screeds to be clad in 22 gauge S/S. Foam screed to have female top configuration and pins to accept all bottom, corner, and wall male locks.

IV. ENTRANCE DOOR AND SECTION

A. Hinged entrance doors with swing and net opening size of 34" x 78" shall be provided in either 46-1/2" or 69-3/4" wide sections.

1. Entrance door shall be flush-mounted, infitting type with full 4" thickness insulated by poured-in-place urethane as specified for panels. Interior and exterior finish shall be 20 gauge type 304 stainless steel with a number 4 finish.
2. Each door shall be provided with cam-lift, non-sag, strap-type hinges (minimum 9" leaf) and spring activated positive closure device. Handle assembly shall incorporate latch and keeper system, with padlocking facility and an interior push-rod safety release. All hardware must be attached with stainless steel machine screws. Screws shall be fastened into minimum 14 gauge tap plates foamed into door panel. Standard hardware finish to be tumbled grey "Durakeil" with chrome plated solid brass handle.
3. A bellows-type thermoplastic gasket with magnetic core shall be provided at top and strike side of interior door flange with cushion core on hinge side to prevent binding. The gasket retainer - an integral part of door assembly - shall allow easy replacement of gasket in the event of damage through misuse.

A flexible double blade "sweep" wiper gasket shall be provided at the bottom of door. All gasket material is resistant to sunlight, water, mild cleaning soap, oil and fat.

All hardware, pull handles, cylinder lock handles and dead bolt locking hardware shall be provided in polished stainless steel or chrome finish.

B. Door section shall be constructed with an opening framed by a non-conductive heavy duty extrusion. Insulation of this section shall be as described for all panels. Jamb members (non-conductive extrusion) shall be foamed-in-place without screws or other visible fasteners within door section assembly.
The door face of jamb shall contain an anti-condensate heater circuit concealed behind a highly polished, magnet attracting, stainless steel channel to insure a positive frost-free seal. A heavy gauge stainless steel sill plate shall be provided for all hinged doors.
Heater circuit shall trace multiple runs beneath sill to prevent frost or moisture accumulation and profile design shall insure contact by both blades of door wiper gasket.

1. The exterior "strike" side of each door section shall be provided with a flush-mounted toggle switch and pilot light indicator. The cover plate shall be chrome plated. An incandescent vapor-proof light fixture shall be supplied and mounted on interior of section over opening. All wiring shall be accomplished at the factory by material and performance guidelines approved by Underwriters' Laboratories (UL).

2. A 3-1/2" diameter, flush-mounted dial thermometer shall be supplied on one entrance door section for each refrigerated room or compartment. The thermometer shall have a highly visible "safety range" color code on dial, be equipped with recalibration device, have both Fahrenheit and Centigrade scales in 2 degree increments and have a nickel-plated capillary/bulb assembly to prevent reactive toxicity. Mounting flange and ring shall be chrome plated.

VI. PARTITIONS

A. Wall, floor and screed sections used in location of partition walls for multi-compartment structures shall be supplied with a fully coved "T" configuration to provide a thermal break between various temperature rooms. Floor cove to-wall and perimeter wall-to-partition shall be 1/2" radius. Ceiling panel shall have a foamed-in thermal break (not coved). No attaching angles are allowed to effect construction of partitions.

VII. SPECIAL OBLIGATORY CONSIDERATIONS

A. Installation guidelines must accompany all panel structures in the form of complete panel assembly and erection instructions. Accepted construction procedure and special techniques must be described. All necessary working drawings with dimensional detail shall be supplied to illustrate exact location of specific panels. Drawings must clearly indicate inside and outside

diagonal dimensions to facilitate "square" layout of all regular shaped structures.

WARRANTY shall certify that their foamed-in-place panels shall be free of defects in material and workmanship when those panels are installed properly and used in normal service for a period of ten (10) years.

Parts and hardware not manufactured by walk-in manufacturer (door hardware, electric components and various optional accessories listed below) shall be guaranteed against defects in material and workmanship under normal use and service for a period of three years.

The manufacturer of the walk-in assembly shall replace any panel or part they accept as defective under these guidelines.

VIII. ACCESSORIES AND OPTIONAL EQUIPMENT

A. Door Sections, Special Accessories

1. Two-Way, Heated Pressure/Vacuum Relief Ports must be provided on all low temperature structures. These assemblies shall be constructed of stainless steel with screening to prevent vermin and insect transit.
   A minimum of one (1) vent assembly shall be provided for each 2500 cubic feet of interior structure volume. Initial vent shall be installed and pre-wired (where applicable) at factory. Additional vents (if required) shall be installed at factory with vapor-proof junction box mounted to facilitate field connection.
2. Audio/Visual Alarms shall be supplied at entrance for both compartments. Mfg. by EJS Limited, Stanford Texas, or equal as approved by contracting officer. Unit to monitor temperatures of all walk-in coolers/freezers, providing audible and visual alarms at pre-set limits, and shall provide NO contacts for connection to building central monitoring system. Provide flush mounted stainless steel enclosure, 24 hr battery back-up
   Electrical Characteristics: 120V 1PH 2A
3. Interior lighting: In addition to light provided over door, both compartments to have (1) 48" dual tube fluorescent fixture. Freezer compartment fixture to be suitable for low temperature application. Fixture shall be located in center of ceiling to offer a minimum of 25 foot-candles of illumination in uniformly distributed square foot areas (specific requirements as directed by local sanitation codes). Fixtures shall be field installed.

4. Panel Protection: Entrance doors involved in traffic situations shall be provided with 30" high "abuse plates" on interior and exterior. Material shall be selected for strength and finish complementary to adjacent panel surface (stainless steel).
   Wall surfaces potentially exposed to damage by mobile carts or shelving shall be protected by "bumper rails" installed at appropriate height.
   Rails to be extruded aluminum channel with vinyl insert applied after channel attachment to wall surface. Note: Rails must be sealed to wall with silicone and ends closed by welded or inserted caps. Provide Curtron Mfg. (or approved equal) strip curtain at exterior door.

ITEM NO. 22 - MED. TEMP EVAPORATOR COIL
Qty (2) wall mounted medium temperature 11,500 BTU evaporator coil sized to provide 35 degree F. holding in compartments indicated. Unit shall be low-profile type to maximize the available storage space inside the compartment. Exterior housing shall be of corrosion resistant material. Electrical requirements: 120 V
Manufacturer and model as approved by contracting officer

ITEM NO. 23 - REMOTE CONDENSER, MED TEMP
Qty (1) Remote condenser, med. Temp, 11,500 BTU, water cooled, provided with s/s wall mount support or s/s stand. The condensing unit supplied shall be guaranteed to be free of defects in normal service for a period of (1) one year from the date of installation with an additional warranty covering parts & labor for the motor compressor for an extended (4) four year period.
Electrical: 208V 1PH 11A
Manufacturer and model as approved by contracting officer

ITEM NO. 24 - LOW TEMP EVAPORATOR COIL
Qty (2) wall mounted low temperature evaporator coil, electric defrost, minimum of 15,100 BTU sized to provide -10 degree F. holding in freezer compartment indicated. Unit shall be low-profile type to maximize the available storage space inside the compartment. Exterior housing shall be of corrosion resistant material.
Manufacturer and model as approved by contracting officer

ITEM NO. 25 - REMOTE CONDENSER, LOW TEMP
Qty (1) Remote condenser, low temp water cooled, 15,100 BTU min. provided with s/s wall mount support or s/s stand. The condensing unit supplied shall be guaranteed to be free of defects in normal service for a period of (1) one year from the date of installation with an additional warranty covering parts & labor for the motor compressor for an extended (4) four year period.
Electrical: 208V 1PH 11A
Manufacturer and model as approved by contracting officer

GENERAL INFORMATION
Contractor shall verify all dimensions and shall prepare the platform, curbed openings, and weatherproof the unit after installation.

All copper tubing to be refrigerant grade. A.C.R. or Type "L". Welding shall be used for all refrigerant piping. Silver solder or soft solder is not acceptable. All piping to be pressure tested with nitrogen at 300 PSI. After the condensing unit and coil have been connected, the balance shall be tested with valves open at 200 PSI.
The complete system shall be evacuated with a vacuum pump. Each unit shall be charged, tested and adjusted to assure operation.
Refrigeration contractor should provide and install the drain line heater in the low temperature compartments.

Electrical contractor shall provide power for refrigeration package and connect control and defrost system as called for in the wiring diagram provided with the system.
Provide 7-wire color coded service from the time clock at the refrigeration package to the blower coil in fixture when electric defrost is used, either cooler or freezer.

Provide A.C.R. or Type "L" copper drain-lines for walk-in refrigerator and freezers, pitched 4" per foot of run. Trap drain-line outside of refrigerated space to prevent entrance of warm moist air.
Provide individual drain-line for each evaporator

ITEM NO. 26 - SPARE NUMBER

ITEM NO. 27 - SPARE NUMBER

ITEM NO. 28 - STAINLESS STEEL WALL COVERING
Qty (1) lot custom fabricated stainless steel wall panels, seam covers and end caps, type 304 s/s 22 gauge minimum thickness, shall cover wall area under hood to top of tile cove base, approx. 20' x 78"
Custom Fabricator must be reviewed and approved by contracting officer prior to bidding.

ITEM NO. 29-31 SPARE NUMBERS

ITEM NO. 32 - HOOD FIRE PULL STATION
Qty (3) Exhaust hood fire suppression system remote activation station. Provided as part of wet chemical fire suppression system for hoods #35 and #50 See specification section 21 23 00.00 98

ITEM NO. 33 - TILTING KETTLE
Qty (1) Cleveland model KET-12-T, or approved alternate, a 2/3 steam jacketed manual tilting electric kettle, 12 gallon, cold water faucet, removable s/s cooking basket, and lift-off s/s cover. Features shall include: steam jacket filled with treated water, solid-state temperature controls, operating temperature range from 145°F to 260°F, LED indicator for heat cycle and low water, water resistant controls, reinforced rolled rim on top of kettle, welded in place heating elements, type 304 stainless steel with a number four finish on kettle and all exterior surfaces, rear mounted pressure gauge and pressure release valve, 50 psi steam jacket rating, solid-state water level control, self locking Marine type tilting mechanism. Provide with stainless steel equipment stand with drain drawer and splash shield. Tell liner to be 316 stainless steel for high acid food products.
Electrical: 208V 3PH 27A
Note: Provided by KSC Exchange or Vendor - Bid as "Option A-6"

ITEM NO. 34 - POT WASH SINK
Qty (1) Custom fabricated three compartment sink, 11'-6" x 30" front-to-back, all-welded 14 gauge type 304 s/s with L & R drain boards, 11" rear and R side splash, deep drawn 20" wide x 24" x 12" deep sink compartments with 3" radius corners. Provide with T&S, or approved equal, wall mounted swing arm faucets with ½" supply and Component Hardware Mfg. Or approved equal, lever waste drain assemblies with removable stainless steel basket wastes and copper manifold connection to a single air-gap dump as indicated on plumbing rough-in drawings.
Custom Fabricator must be reviewed and approved by contracting officer prior to bidding.

ITEM NO. 35 - EXHAUST HOOD
Qty (1) CaptiveAire wall mount exhaust hood, 20'0" total length, 60" deep, and supplied with a MUA plenum. This exhaust hood shall be an exhaust only canopy hood rated for all types of cooking equipment. The hood shall have the size, shape and performance specified on the food service equipment plan drawings.

Construction shall be type 100 % 430 stainless steel with a #3 or #4 polish. Construction shall be dependent on the structural application to minimize distortion and other defects. All seams, joints and penetrations of the hood enclosure to the lower outermost perimeter that directs and captures grease-laden vapor and exhaust gases shall have a liquid-tight continuous external weld in accordance with NFPA 96. Hood shall be wall type with a minimum of four connections for hanger rods. Corner hanging angles have a 5/8" x 1-1/2" slot pre-punched at the factory, allowing hanging rods to be used for quick and safe installation.

Ventilator shall be furnished with U.L. classified high efficiency stainless steel filters, supplied in size and quantity as required by ventilator. The filters shall extend the full length of the hood and the filler panels shall not be more than 6" in width.The hood manufacturer shall supply complete computer generated submittal drawings including hood sections view(s) and hood plan view(s). These drawings must be available to the engineer, architect and owner for their use in construction, operation and maintenance.

Exhaust duct collar to be 4" high with 1" flange. Duct sizes, CFM and static pressure requirements shall be as shown on drawings. Static pressure requirements shall be precise and accurate; air velocity and volume information shall be accurate within 1-ft increments along the length of the ventilator.

U.L. incandescent light fixtures and globes shall be installed and pre-wired to a junction box. The light fixtures shall be installed with a maximum of 4'0" spacing on center and allow up to a 100 watt standard light bulb.

The hood shall have:

- A double wall insulated front to eliminate condensation and increase rigidity. The insulation shall have a flexural modulus of 475 EI, meet UL 181 requirements and be in accordance with NFPA 90A and 90B.
- An integral front baffle to direct grease laden vapors toward the exhaust filter bank.
- A built-in wiring chase provided for outlets and electrical controls on the hood face and shall not penetrate the capture area or require an external chaseway.

The hood shall be ETL Listed as "Exhaust Hood Without Exhaust Damper", ETL Sanitation Listed and built in accordance with NFPA 96. The hood shall be listed for 450°F cooking surfaces at 150 CFM/ft, 600°F cooking surfaces at 200 CFM/ft, and 700°F cooking surfaces at 250 CFM/ft. The hood shall be ETL Listed as "Exhaust Hood Without Exhaust Damper".

The hood shall be a Type I exhaust hood with factory installed spray and manifold assembly. Assemblies shall be ETL Sanitation listed and ETL listed to conform to UL710, ULC710, and UL508A.

The hood shall be constructed of 100% Stainless steel, either 304 or 430. All welds in the plenum shall be dye-penetrate tested for leaks. High efficiency baffle filters shall be installed in hood, and the sprayers located inside the plenum will clean the back of the filters. All plumbing shall be standard brass pipefitting except for penetrations, which shall be stainless steel. All nozzles shall be wide-angle, full-cone with internal strainer and pressure sensitive check valve.

The water inlet shall be a 3/4" NPT pipefitting. Drains shall consist of one 1 1/2" NPT pipe, unless exhaust hood is over 10' long or 30" tall, in which case two drains shall be installed. A ball valve shall be installed with the manifold for servicing the self cleaning system. All surfactant injection shall be done after a vacuum breaker backflow prevention valve. Timers shall be factory set for a three minute wash cycle with a one second surfactant injection before a delay of one minute.

The exhaust hood shall be supplied with an integral wet chemical fire suppression system. See specification section 21 23 00.00 98

Note that all roof top exhaust fans, supply fans, and pollution control units shall be by same manufacturer as exhaust hood.
Approved Manufacturers: CaptiveAire, Gaylord, Halton, Ventmaster, Caddy, Greenheck, and Carroll Manufacturing

ITEM NO. 36 - FRYER BATTERY
Qty (2) Frymaster, or approved equal, fryer battery consisting of (2) 16" wide, 50# capacity, gas-fired fryers with an attached dump station with IR strip heat lamp, and integral filtration system. Cabinets shall be, all welded type 304 s/s construction. Note (1) shall have dump station on R side, (1) on L side. Verify gas type, provide with Dormont SuperSwivel flexible gas disconnect.
Note: Provided by KSC Exchange or Vendor - Bid as "Option A-6"

ITEM NO. 37 - TILT SKILLET
Qty (1) Cleveland, model SGL-30-T1, or approved alternate, 30 gallon, gas-fired (verify gas type)open base tilt skillet with cold water swing arm faucet. Features shall include 5/8 inch stainless steel being blasted cooking surface, 12 gauge type 304 stainless steel pan construction, 35 inch rim height, splash proof controls, 120 V cord and plug, manual and tilt with enclosed permanently lubricated gearbox, gallon markings and vented spring assist cover, 2 inch tangent draw off valve, ability to tilt unit up to 10° without power being turned off, adjustable electronic thermostat with range from 100°F to 450°F, and electronic spark ignition system.
Electrical: 120V C&P
Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 38 - COMBI OVEN
Qty (1) Cleveland model OGS-6.20, or approved equal, dual compartment gas-fired boiler-less combi oven with s/s legs Capacity of (7) 18x26 x 1" full-size sheet pans per compartment. Features shall include: fully insulated cooking compartment, polished cooking compartment with coved corners for easy cleaning, a quantity of 4 26x20 inch wire shelves, hinged fan guard and hinged removable pan racks, to speed auto reversing convection fan, antibacterial door handle, door latch with safety event position, vented double glass door with integrated door stop and self draining condensate drip tray, multipoint core temperature probe, digital controls for temperature time Amcor probe settings, self-diagnostic system with full text message display, a programmable one step recipe buttons, ability to store up to 250 recipe programs, flexible, hand shower for compartment cleaning, injection system for steam, hands-free automatic compartment washing system, stainless steel equipment stand without casters. Provide with air-fry baskets, clean and rinse solution, universal pan rack system, and Kleensteam II, or approved equal, water filter. Verify gas type, provide with Dormont SuperSwivel, or approved equal, flexible gas disconnect.

Electrical: 120V 12A
Gas: ¾" NPT 136 MBTU
Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 39 - CONVECTION OVEN
Qty (1) Garland model MCO-GD-20S, or approved alternate, double stacked, deep depth, gas-fired convection oven Features shall include: solid-state temperature control with 150°F to 500°F temperature range and electro mechanical timer, electronic spark ignition with safety shutoff, to speed fan control with, three-quarter horsepower fan motor, 60,000 BTU per oven cavity, stainless steel front sides, top and legs, 60/40. Dependent door design with double pane thermal window in both doors, interior lighting, porcelain enamel of interior with coved corners, 24 inch cooking cavity height with six chrome plated oven racks on 13 position rack guides, two-year limited parts and one year labor warranty.

Verify gas type, provide with Dormont SuperSwivel, were approved equal, flexible gas disconnect.
Electrical: 120V 12A

Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 40 - RANGE
Qty (1) Garland model G36-6R, or approved alternate, a 36" wide gas range with (6) open burners, standard oven base, high s/s riser with overshelf, casters. Features shall include cast iron top ring grates, 38,000 BTU oven burner, snap action modulating oven thermostat with a maximum temperature range of 500°F, nickel plated oven rack in three position removable oven rack guide, porcelain oven interior sized to accept standard sheet pans in both directions, stainless steel front and sides, stainless steel, 5 inch plate rail, 12 inch sectioned stamped drip trays, 6 inch heavy-duty casters.
Verify gas type, provide with Dormont SuperSwivel, or approved alternate, flexible gas disconnect.
Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 41 - SPARE NUMBER

ITEM NO. 42 - FLOOR TROUGH
Qty (2) IMC Teddy model CFT-1224 or approved equal, 4" deep coved base interior 14 gauge s/s floor trough with s/s bee hive strainer and 4" OD tailpiece, all joints TIG welded and exposed surfaces having a brushed satin finish. Overall size 12" x 24" x 4" deep, and provided with a DuraDeck, or approved equal, removable subway style fiber grate

ITEM NO. 43- SPARE NUMBER

ITEM NO. 44 - SPARE NUMBER

ITEM NO. 45 - PREP SINK TABLE
Qty (1) Custom fabricated prep sink table, all welded type 304 s/s, 7' - 0" long x 30" front-to-back as indicated on equipment plan drawings, 34" high. 14 ga top with rear 8" splash, open base with shelves supported on NSF adj legs. Counter shall be provided with (2) sink bowls approx. 16" x 22" x 8" deep, with a T&S swing arm faucet mounted on an 8" high backsplash. Sink to be provided with level waste drain assembly, directed to air gap to a floor sink.

Custom Fabricator must be reviewed and approved by contracting officer prior to bidding.

ITEM NO. 46 - WALL SHELF
Qty (1) Custom fabricated wall shelf, all welded type 304 s/s, 7' - 0" long x 12" front-to-back as indicated on equipment plan drawings, 16 gauge top with rear 1" turn up.
Custom Fabricator must be reviewed and approved by contracting officer prior to bidding.

ITEM NO. 47-49 SPARE NUMBERS

ITEM NO. 50 - EXHAUST HOOD
Qty (1) Exhaust Hood, wall mount, 13'-0" total length, two sections, 54" deep, and supplied with a MUA plenum. This exhaust hood shall be an exhaust only canopy hood rated for all types of cooking equipment. The hood shall have the size, shape and performance specified on the food service equipment plan drawings.

Construction shall be type 100 % 430 stainless steel with a #3 or #4 polish. Construction shall be dependent on the structural application to minimize distortion and other defects. All seams, joints and penetrations of the hood enclosure to the lower outermost perimeter that directs and captures grease-laden vapor and exhaust gases shall have a liquid-tight continuous external weld in accordance with NFPA 96. **Internal seams shall be filled with NSF approved, non-hardening sealer to facilitate ease of cleaning.** Hood shall be wall type with a minimum of four connections for hanger rods. Corner hanging angles have a 5/8" x 1-1/2" slot pre-punched at the factory, allowing hanging rods to be used for quick and safe installation.

Ventilator shall be furnished with U.L. classified high efficiency stainless steel filters, supplied in size and quantity as required by ventilator. The filters shall extend the full length of the hood and the filler panels shall not be more than 6" in width.

The hood manufacturer shall supply complete computer generated submittal drawings including hood sections view(s) and hood plan view(s). These drawings must be available to the engineer, architect and owner for their use in construction, operation and maintenance.

Exhaust duct collar to be 4" high with 1" flange. Duct sizes, CFM and static pressure requirements shall be as shown on drawings. Static pressure requirements shall be precise and accurate; air velocity and volume information shall be accurate within 1-ft increments along the length of the ventilator.

U.L. incandescent light fixtures and globes shall be installed and pre-wired to a junction box. The light fixtures shall be installed with a maximum of 4'0" spacing on center and allow up to a 100 watt standard light bulb.

The hood shall have:

- A double wall insulated front to eliminate condensation and increase rigidity. The insulation shall have a flexural modulus of 475 EI, meet UL 181 requirements and be in accordance with NFPA 90A and 90B.
- An integral front baffle to direct grease laden vapors toward the

exhaust filter bank.

- A built-in wiring chase provided for outlets and electrical controls on the hood face and shall not penetrate the capture area or require an external chaseway.

The hood shall be ETL Listed as "Exhaust Hood Without Exhaust Damper", ETL Sanitation Listed and built in accordance with NFPA 96. The hood shall be listed for 450°F cooking surfaces at 150 CFM/ft, 600°F cooking surfaces at 200 CFM/ft, and 700°F cooking surfaces at 250 CFM/ft. The hood shall be ETL Listed as "Exhaust Hood Without Exhaust Damper".

The hood shall be a Type I exhaust hood with factory installed spray and manifold assembly. Assemblies shall be ETL Sanitation listed and ETL listed to conform to UL710, ULC710, and UL508A.

The hood shall be constructed of 100% Stainless steel, either 304 or 430. All welds in the plenum shall be dye-penetrate tested for leaks. High efficiency baffle filters shall be installed in hood, and the sprayers located inside the plenum will clean the back of the filters. All plumbing shall be standard brass pipefitting except for penetrations, which shall be stainless steel. All nozzles shall be wide-angle, full-cone with internal strainer and pressure sensitive check valve.

MAKE-UP AIR: The Perforated Supply Plenum (PSP) shall provide make-up air through perforated stainless steel panels. All seams shall be welded and have stainless steel on exposed surfaces. Unexposed surfaces shall be constructed of aluminized steel. Perforated diffuser plates shall be included in the design and to provide even air distribution and the plenum shall be insulated to prevent condensation.

LIGHTS: Incandescent light fixtures, spaced at a maximim of 60" O.C., suitable for use with restaurant cooking equipment and are installed and prewired according to the National Electrical Code.

The water inlet shall be a 3/4" NPT pipefitting. Drains shall consist of one 1 1/2" NPT pipe, unless exhaust hood is over 10' long or 30" tall, in which case two drains shall be installed. A ball valve shall be installed with the manifold for servicing the self cleaning system. All surfactant injection shall be done after a vacuum breaker backflow prevention valve. Timers shall be factory set for a three minute wash cycle with a one second surfactant injection before a delay of one minute.

The exhaust hood shall be supplied with an integral wet chemical fire suppression system. (See specification section 21 23 00.00 98)

Note that all roof top exhaust fans, supply fans, and pollution control units shall be by same manufacturer as exhaust hood.

Approved Manufacturers: CaptiveAire, Gaylord, Halton, Ventmaster, Caddy, Greenheck, and Carroll Manufacturing

ITEM NO. 51 - SPARE NUMBER

ITEM NO. 52 - REFRIGERATED DRAWER BASE
Qty (1) Delfield model F2987C, or approved equal, self-contained, low-profile refrigerated equipment stand, 87 1/4 inch wide Marine edge, stainless steel top. Unit shall be 20" high, with (4) drawers, s/s front, top, back, and sides. Features shall include: heavy duty stainless steel top with full perimeter Marine edge, high-density polyurethane foam insulation, snap in drawer gaskets, 6" casters, 8 foot cord and plug, refrigerated base cabinets section to maintain 36°F to 40°F meeting NSF7 requirements, full extension, all stainless steel drawer support system, HFC-404A refrigeration, one-year parts and 90 day labor warranty
Electrical: 120V 10 amps, 1/4 HP
Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 53 - CHARBROILER, 36"
Qty (1) MagiKitch'n model APM-RMB-648 or approved equal, gas-fired, low-profile radiant charbroiler, cast-iron top grids, 10" cutting board, safety pilot. Verify gas type, provide with Dormont SuperSwivel, or approved equal flexible gas disconnect.
Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 54 - GRIDDLE, 48"
Qty (1) MagiKitch'n model MKG-36, were approved equal gas-fired, low-profile griddle with matchless electronic ignition system with solid state thermostat griddle plate with front grease trough, 10" cutting board with pan cutout
Verify gas type, provide with Dormont SuperSwivel, or approved equal, flexible gas disconnect.
Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 55 - REFRIG PREP TABLE, MOBILE
Qty (1) Delfield model D4460N-12, or approved equal, self-contained salad top refrigerated counter, 4 drawers, 12 pan capacity with dual covers. Features shall include: stainless steel, size, top and front, ABS or stainless steel interior1/6 size pans and adapter bars to fill top openings, to a level pan brackets to allow the pans to be lowered an additional inch in the unit without tools to provide additional pan temperature holding performance, 10 inch wide polyethylene cutting board, R404A refrigerant, high-density foamed in place, polyurethane insulation, 5 inch casters, 6 foot cord and plug, three-year parts and labor warranty, additional two-year compressor parts warranty, door lock, and exterior thermometer.
Electrical: 120V 1/2HP 12A
Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 56 - THREE COMPARTMENT SINK
Qty (1) Custom fabricated three compartment sink, NSF compliant 9'-0" x 30" front-to-back, all-welded 14gauge type 304 s/s with L & R drain boards, 11 inch high rear splash, 20" wide x 24" x 12" deep sink compartments with three-inch coved corners. Provide with T&S, were approved alternate, swing arm faucets and Component Hardware Mfg., were approved alternate, lever waste drain assemblies with stainless steel basket wastes and copper manifold connection to a single air-gap dump as indicated on plumbing rough-in drawings.
Custom Fabricator must be reviewed and approved by contracting officer prior to bidding.

ITEM NO. 57-59 SPARE NUMBERS

ITEM NO. 60- WALK-IN COOLER
Qty. (1) KOLPAK, or approved alternate, walk-in cooler room assembly constructed with modular pre-fabricated precision formed, metal-clad insulated panels. Height 8"-6" and exterior dimensions of 15'-8" x 5'-8" as indicated on plans. See Item #21 for detailed specifications.
Approved Alternate: Manufacturer and model as approved by contracting officer

ITEM NO. 60 - MED TEMP EVAPORATOR COIL
Qty (1) wall mounted medium temperature evaporator coil sized to provide 35 degree F. holding in compartments indicated. Unit shall be low-profile type to maximize the available storage space inside the compartment. Exterior housing shall be of corrosion resistant material.
Electrical requirements: 120 V
Manufacturer and model as approved by contracting officer

ITEM NO. 62 - REMOTE CONDENSER, MED TEMP
Qty (1) Remote condenser, med. temp water cooled, provide with s/s wall mount support or s/s stand. The condensing unit supplied shall be guaranteed to be free of defects in normal service for a period of (1) one year from the date of installation with an additional warranty covering parts & labor for the motor compressor for an extended (4) four year period.
Manufacturer and model as approved by contracting officer

ITEM NO. 63 - SPARE NUMBER

ITEM NO. 64 - SPARE NUMBER

ITEM NO. 65 - ICE AND BEVERAGE DISPENSER
Qty (2) Servend model M-250, or approved equal, ice, and beverage dispenser with (8) fast-flow valves, 250 lb ice capacity. Features shall include one piece ABS base, multiport flex manifold to allow flexibility to serve both carbonated and noncarbonated beverages, Flowmatic 464, or approved equal, beverage, valves with sanitary lever design. Provide with required hoses, connectors, fittings, valves, pumps, pressure valves, carbonators, and all other required components for a fully operational dispensing system for up to eight individual beverages. Provide adapter kit for top mounted ice machine.
Electrical: 120V 15 amps
Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 66 - ICE MAKER
Qty (2) Manitowoc model IY-0606A, or approved alternate, self-contained ice maker, 600 lb/24hr production, provide with required adapter plate to mount on dispenser #65. Features shall include: energy Star rating, diagnostic capability, ice sensing probe, front mounted display to communicate operating status and cleaning reminders, programmable ice production, easily cleaned food zone, stainless steel exterior, and "Luminice" or approved alternate bacteria growth control system. Ice cube size Shelby 7/8 of an inch by 7/8 of an inch by 7/8 of an inch.
Electrical: 208v 1ph 11 amps
Note: Provided by KSC Exchange or Vendor - Bid as part of "Option A-6"

ITEM NO. 67 - SKELETON WALL
Qty (1) Duke Mfg, Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 68 - DISPLAY BREAD CABINET
Qty (1) Lockwood mfg. Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 69 - COLD PAN UNIT, 48"
Qty (2) Duke Mfg. or approved alternate, self-contained refrigeration, drop-in design, NSF compliant, stainless steel construction. Electrical specification: 120 V
Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 70 - HOT FOOD TOASTING STATION
Qty (1) Duke Mfg. Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 71 - FRONT COUNTER CASH UNIT
Qty (1) Duke Mfg. Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 72 - COOKIE DISPLAY CASE
Qty (1) Mfgr: Advance Displays in Plastic. Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 73 - SAFE, UNDER COUNTER
Qty (1) C.S.S./Tidel under counter drop safe. Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 74 - POS REGISTER
Qty (2) SUBSHOP 2000 POS by Micros Systems Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 75 - MENU BOARD
Qty (4) VGS/Translite Sonoma soffit mounted menu board. Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 76 - DISPLAY REFRIGERATOR
Qty (1) True Mfg model GDM 23, or approved alternate, Part of Subway build-out package. Features shall include a self-contained bottom mount refrigeration system, capable of holding 33°F to 38° fair within interior of cabinet, exterior Shelby stainless steel, interior shall be NSF approved white aluminum interior liner with stainless steel floor, self-closing door with double pane thermal insulated glass and integrated door light. Cabinet lighting shall have electronic ballast and T-8 bulbs, (4) heavy duty PVC coated wire shelves,
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 77 - BACK COUNTER HAND SINK UNIT
Qty (1) Duke Mfg. Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 78 - BACK COUNTER, REFRIGERATED 60"
Qty (1) refrigerated counter unit, Duke Mfg. Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 79 - RAPID COOK OVEN
Qty (1) Merry Chef or Turbo Chef rapid cook oven. Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 80 - COMBI BREAD CABINET
Qty (1) Lockwood/Nu-Vu or approved alternate Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 81 - BREAD OVEN
Qty (1) Duke Mfg. Nu-Vu, modelUB-5/10 oven-proofer, or approved equal, combination oven and proofer. Features shall include: top mounted moving air oven with stainless steel interior, five full-size pan capacity in oven, bottom mount proofer compartment with capacity for 10 full-size sheet pans with a manual Phil humidity system. Standard features shall include all stainless steel construction, magnetic door latches, heavy duty casters, tempered glass doors, high-temperature silicone rubber door gaskets, stainless steel hinges, overflow drain pan, separate heat and humidity controls or proof compartment, solid-state controls, and indicator lights for thermostats. Electrical requirements 208V 3PH 32A
Part of Subway build-out package
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 82 - THREE COMPARTMENT SINK
Qty (1) Custom fabricated three compartment sink, 10'-6" x 30" front-to-back, all-welded 14gauge type 304 s/s with L & R drain boards, 11 inch high rear splash, 20" wide x 24" x 12" deep sink compartments. Provide with T&S, or approved alternate, swing arm faucets and Component Hardware Mfg. or approved alternate, lever waste drain assemblies with basket wastes and copper manifold connection to a single air-gap dump as indicated on plumbing rough-in drawings.
Custom Fabricator must be reviewed and approved by contracting officer prior to bidding.

ITEM NO. 83 - HAND SINK
Qty (2) Advance Tabco model 7-PS-50, or approved equal, hand sink, wall-mounted, all type 304 s/s construction with die formed countertop edge with no-drip offset, deep drawn sink bowl, s/s basket drain with 1 ½" tailpiece, with cut outs for 4" OC splash and lever drain. Faucet shall be T&S model B-1146, or approved equal, wall mounted ½" supply goose-neck faucet with wrist blades and Component Hardware, or approved equal, "Quick-Wash control mounted on faucet outlet.
Soap and paper towel dispenser provided by Government.

ITEM NO. 84- BAG IN BOX RACK
Qty (2) stainless steel, floor mounted, shelving unit designed to accommodate bag-in-box containers of syrup and provide mounting location for syrup pumps. Design of shelving unit shall be specifically for this purpose with slope shelves sized appropriately for product. The minimum width of this shelf unit shall be 36 inches.
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 85 - CARBONATOR
Qty (2) Cornelius model 1624 or approved equal large reserve soda system carbonator, 120V with cord & plug.
Note: Not In Contract - BY SUBWAY VENDOR

ITEM NO. 86 - CO2 TANK
Qty (3)
Note: Not In Contract - BY SUBWAY VENDOR

PART 3 - EXECUTION

3.1 GENERAL:

A. Review all drawings pertaining to the food facilities and food facilities areas, including the utility load information. Provide all equipment in accordance with the requirements of these documents (i.e., voltage characteristics, kw loads, special valves, etc.).

B. Notify the Consulting Officer of any discrepancies between plans and specifications and actual conditions on the job before fabrication of equipment.

C. Contractor is responsible for assuring that all door openings, passageways, elevators, etc., to be sure that the equipment can be conveyed to its proper location within the building and shall coordinate wall erection, placement of doorjambs, windows, etc., for the purpose of moving the equipment to its proper location. Any removal and rebuilding of walls, partitions, doorjambs, etc., necessary to place the equipment shall be done at the expense of the Contractor.

D. Contractor shall review drawings and physically check the location and utility size of all "rough-ins" at the job site for compatibility with the equipment being installed before finished floors, walls, and/or ceilings are in place.

E. Provide all necessary appurtenances to accommodate plumbing, electrical, and refrigeration, etc.

F. Where portions of an item pass through masonry, walls, or partitions, provide complete installation of the item, including trim, field welding, dimensions, and coordinate all other work being performed relative to the item being installed.

G. All equipment, such as pass-through refrigerators and warmers, which pass through a wall where one side is exposed to public view shall be provided and installed with the operating controls located on the kitchen or working side of the wall. All equipment such as coffee urns, which are located on or in a counter having a pick-up side and a working side, shall be provided and installed with the operating controls facing the working side of the counter.

3.2 DELIVERY:

A. All food service equipment shall be delivered to the job site protected from weather, vandalism and/or loss, and placed within the building. Surfaces shall be protected from damage by the use of cardboard, plastic or similar materials.

3.3 CLEANING:

A. Cleaning shall be in accordance with Section 01 74 10 - General Cleaning, Article 3.4.A.9

3.4 COMMISSIONING:

A. Manufacturer training shall occur minimally within 2 week period prior to Substantial Completion.

B. Refer to Commissioning Section 01 91 13.

---END OF SECTION ---

SECTION 11 72 13

MISCELLANEOUS EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B241/B241M	(2012) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM FP 1001	Guide Specifiations for Design of Metal Flagpoles

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fall Protection System Installation Drawings

Shop drawings to be reviewed by a professional engineer, registered in the state of Florida, and upon request, complete with test reports.

Flagpole Installation Drawings

Shop drawings to be reviewed by a professional engineer, registered in the state of Florida and complete with test reports.

SD-03 Product Data

Fall Protection Tie Back Anchors

Include construction details, material descriptions, and dimensions of individual components for each product indicated. Include manufacturer's installation instructions and recommendations.

Aluminum Flagpoles

Flagpole Beacon

Flag

SD-10 Operation and Maintenance Data

Fall Protection System

Submit one copy of system Equipment Manual & Inspection Log Book, with Initial Inspection - Certification for Use and Inspection Sign-Off forms completed.

1.3 DESIGN REQUIREMENTS

Locate anchorages as indicated to suit suspension equipment that will be used on the building with respect to items such as reach, rigging, spacing, roof edge condition, and similar items.

Ensure all anchor components conform to proper engineering principles and have been designed by a Professional Engineer, registered in the state of Florida, and who is qualified in the design of fall protection safety equipment, its application and safety requirements.

1.3.1 DRAWINGS

Fall protection system installation drawings shall include complete layout and configuration including all components and accessories.

Include record drawings indicating locations of safety anchors. Provide two copies of a reduced plastic laminated as-built shop drawing showing equipment locations and details.

Flagpole installation drawings.

1.4 QUALIFICATIONS

Manufacturer: Work of this Section to be executed by manufacturer specializing in the design, fabrication and installation of fall restraint equipment having a minimum of 5 years documented experience.

Loading and Safety Assurance: Work of this Section to meet the requirements of governing codes and jurisdiction and to comply with properly engineered loading and safety criteria for the intended use.

Welding Certification: Welding to be executed by certified welders in accordance with AWS requirements.

PART 2 PRODUCTS

2.1 FALL PROTECTION SYSTEM

Fall Protection Tie Back Anchors: Model and Manufacturer: Roof Anchor Model PBE74-00A4; PRO-BEL ENTERPRISES LTD. or as approved otherwise by the Contracting Officer's Representative.

Type: Case in place.

U-Bar Safety Anchor: Stainless steel.

Steel Pier: Galvanized steel.

Working Load: 1000 pounds in any direction.

Design of Safety Anchor: Typical Maximum Fall Arrest Force: 1800 pounds when wearing a body harness, with a factory of safety of 2 without any permanent deformation and to 5000 pounds against fracture or detachment.

Height: As indicated.

Spacing: As recommended by the manufacturer's anchor spacing chart.

Anchors and Attachments:

Provide stainless steel anchors and attachments required for a complete installation.

2.2 ALUMINUM FLAGPOLES

Flagpole Model and Manufacturer - Basis of Design: Illuminator Model ECH30 Hurricane Series; The Flagpole Warehouse, or equal.

Structural Performance: Provide flagpole assemblies, including anchorages and supports, capable of withstanding the effects of wind loads, determined according to NAAMM FP 1001 for specified ground speed.

Material: Extruded aluminum alloy 6063T6 ASTM B241/B241M.

Finish: Directional sanded pole finish #4 satin finish; fine, directional, medium satin polish; buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

Halyard System: External; manually operated halyard; ball-bearing, nonfouling, revolving truck assembly; finish exposed metal surfaces to match flagpole.

Flashing Collar: Aluminum; finish to match flagpole.
Foundation Sleeve: Minimum 16 gauge hot dipped galvanized steel; provide with steel centering wedges; 1/4-inch thick steel base plate and 1/4-inch thick steel support plate welded to grounding spike.

Exposed Height: 30 feet; fabricate in one piece if possible. If more than one piece is necessary, comply with the following.

1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

Flagpole Beacon:

Product and Manufacturer - Basis of Design: The Flagpole Beacon Illuminator Flagpole Series; The Flag Company, Inc., or equal.

Type: Internal halyard beacon (359 degree revolution); provide with wiring, transformer, 8-inch Flagpole Beacon; LED Bulb.

Flag:

Construction and Material: Heavy duty 2-ply polyester (spun polyester)

Thimbles: Galvanized steel.
Seaming: Color-matched, lock-stitched seams.
Headings: Nylon rope-reinforced.
Flag Size: Maxiumum size 5 feet by 8 feet.

PART 3 EXECUTION

3.1 EXAMINATION

Examine surfaces and areas upon which the work of this section is to be installed. Report in writing, defects of work prepared by other trades and other unsatisfactory site conditions that would cause defective installation of products, or cause latent defects in workmanship and function.

Commencement of work will imply acceptance of prepared work.

3.2 INSTALLATION

Install equipment in accordance with approved shop drawings and manufacturer's recommendations.

Co-ordinate installation with work of related trades.

3.3 FINAL ADJUSTING AND INSPECTION

Adjust and leave equipment in proper working order.

3.4 TESTING

Acceptance Testing: Perform acceptance testing in accordance with manufacturer's recommendations.

-- End of Section --

SECTION 12 24 13

ROLLER WINDOW SHADES
08/10

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

Provide roller window shades, complete with necessary brackets, fittings, and hardware as located in the drawings. Mount and operate equipment in accordance with manufacturer's instructions. Windows to receive a shade shall be completely covered.

a. Submit drawings showing plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work. Include the use of same room designations as indicated on the drawings.

b. Provide manufacturer's data composed of catalog cuts, brochures, product information, and operating and maintenance instructions on each product to be used. Include styles, profiles and features.

c. Furnish samples of each type and color of roller shade fabric and roller shade channel. Shade material shall be minimum6 by 6 inch in size. Mark face of material to indicate interior faces.

d. Mock up: Install shade in area designated by Contracting Officer. Do not proceed with remaining work until the Contracting Officer approves workmanship and operation. Re-work mock-up as required to produce acceptable work. The approved shade can be used in installation.

e. Submit fire resistance data, flame spread and smoke contribution data.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM G21	(2009) Determining Resistance of Synthetic Polymeric Materials to Fungi

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2010) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

UNDERWRITERS LABORATORIES (UL)

UL 325	(2002; Reprint Jun 2013) Door, Drapery, Gate, Louver, and Window Operators and Systems

1.3 SUSTAINABILITY REQUIREMENTS

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 LEED DOCUMENTATION for project LEED NC, requirements.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES

SD-02 Shop Drawings

Installation; G

SD-03 Product Data

Window Shades; G

SD-04 Samples

Window Shades; G

SD-06 Test Reports

Window Shades

SD-08 Manufacturer's Instructions

Window Shades

SD-10 Operation and Maintenance Data

Window Shades

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

1.5.1.1 Manufacturer's Qualifications

Obtain motor-controlled roller shades through one source from a single manufacturer with a minimum of twenty years experience and minimum of three projects of similar scope and size in manufacturing products comparable to those specified in this section.

1.5.1.2 Installer's Qualifications

Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in

this section.

1.5.2 Flammability Requirements

Passes in accordance with NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

1.5.3 Electrical Requirements

NFPA Article 100 listed and labeled in accordance with UL 325 or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will no be acceptable in lieu of system testing.

1.5.4 Anti-Microbial Requirements

'No Growth' per ASTM G21 results for fungi ATCC9642, ATCC 9644, ATCC9645.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver components to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated and free from dust, water, or other contaminants and has easy access for inspection and handling. Store materials flat in a clean dry area with temperature maintained above 50 degrees F. Do not open containers until needed for installation unless verification inspection is required.

1.7 WARRANTY

Provide 10 year minimum limited warranty.

PART 2 PRODUCTS

2.1 WINDOW SHADES

Roller tube shall operate smoothly and be of sufficient diameter and thickness to prevent excessive deflection. Provide brackets that are appropriate for outside mount. The shade cloth shall meet the performance described in NFPA 701, small scale test. Treat steel features for corrosion resistance.

Type RA-01: Roller Shade Manually Operated

Model and Manufacturer - Basis of Design: Mecho/5 Standard Bracket with Fascia; Ceiling mount; Light filtering shade; MechoSystems, or equal.

Type RA-02: Roller Double Shade Manually and Motor Operated

Model and Manufacturer - Basis of Design: ElectroShade Electro/1, Double Shade #13 Bracket with No-Cost Pocket with Closure; Top mount; Light filtering shade (manually operated); MechoSystems, or equal.

Type RA-03: Roller Shade Motor Operated - Room Darkening Shades Only

Model and Manufacturer - Basis of Design: ElectroShade Electro/3 Standard Bracket with Fascia; Ceiling mount; Room darkening shade;

MechoSystems, or equal.

Type RA-04: Roller Shade Manually Operated

Model and Manufacturer - Basis of Design: Mecho/5 Standard Bracket with Fascia; Ceiling mount; Room darkening shade; MechoSystems, or equal.

Type RA-05: Roller Shade Manually Operated

Model and Manufacturer - Basis of Design: Mecho/5 Extended Bracket with Fascia; Ceiling mount; Light filtering shade; MechoSystems, or equal.

2.1.1 Light Filtering Shades

Product and Manufacturer: ThermoVeil Dense Vertical Weave 1000 series Shadecloth Collection; MechoSystem

Color: To be selected by the Contracting Officer's Representative from manufacturer's full line.

Content: 75% PVC (coating), 25% polyester (yarn)
Openness Factor: 2-3%
Test Reports: Passes NFPA 701

Provide light filtering window shades to conform with the following:

a. Roller tube shall be extruded aluminum or steel. Diameter, wall thickness, and material to be selected by the manufacturer to accommodate the shade size. Provide roller idler assembly of molded nylon and zinc-plated steel pin. Sliding pin shall allow easy installation and removal of roller. Fabric shall be connected to the roller tube with double sided adhesive specifically developed to attach coated textiles to metal to eliminate horizontal impressions in fabric or attached with a spline lock system.

b. Fascia shall be L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands.

c. End caps shall be stamped steel with universal design suitable for mounting to window mullions. Provide size compatible with roller size. End cap covers shall match fascia/headbox finish.

d. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without requiring removal of brackets and end or center supports. Provide hardware system that allows for operation of multiple shade bands by a single operator. Connectors shall be offset to assure alignment from the first to the last shade band. Provide shade hardware constructed of minimum 1/8 inch thick plated steel or heavier as required to support 150 percent of the full weight of each shade.

e. Manual Operated Chain Drive Hardware shall provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change. Provide positive

mechanical engagement of drive mechanism to shade roller tube. The drive bracket shall be fully integrated with all accessories. Drive chain shall be #10 stainless steel chain rated to 90 lb. minimum breaking strength.

2.1.2 Room Darkening Shades

Provide a second shade (room darkening shade) as indicated on the Drawings.

Product and Manufacturer: Classic Blackout 0700 series Shadecloth Collection; MechoSystem

Content: 75% vinyl (coating); 25% fiberglass (yarn)
Openess Factor: 0%
Test Reports: Passes NFPA 701

Provide room darkening (black-out) window shades designed to eliminate all visible light gaps when shades are fully closed, and conform with the following:

a. Roller tube shall be aluminum. Provide shop fabricated light traps, consisting of a head box to house the shade roller, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.

b. Provide light trap made of sheet steel having a minimum thickness of 22 gauge or anodized, extruded, aluminum. The legs of the channels shall be not less than 1-3/4 inches long and separated by the minimum distance that will permit free operation of the shade. Edges of light trap coming into contact with the shade cloth shall be smooth pile light seal. The exposed face of the head box shall be hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap shall have a finish coat of flat black enamel. The exposed portions of the light trap shall have a factory-applied priming coat of gray paint.

c. Cloth shall be of type for blackout purposes. Make the shade from a single piece of . When not finished with a selvage, the vertical edges of the shade shall be bound or hemmed using a high-grade thread. Make needle holes lightproof by applying a suitable filler.

d. Fit the bottom edge of the shade with a steel operating bar. Shades will engage positively with bottom rail through operating bar or chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 175 pounds breaking strength.

Motors shall be hard-wired, wired into the building electrical system. The position of the motor and electrical connection shall be left or right side of roller, based on the hand of the user facing the shade from inside, unless otherwise indicated on drawings.

Activation Controls of Shades: Wall mounted controls: switches are able to electronically set and reconfigure shade open and close limits, shade preset positions, system groups and system subgroups at the control without rewiring and without access to the Electronic Drive Unit.

PART 3 EXECUTION

3.1 FIELD MEASUREMENTS

After becoming familiar with details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Perform installation in accordance with the approved detail drawings and manufacturer's installation instructions. Install units level, plumb, secure, and at proper height and location relative to window units. Provide and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Do not start installation until completion of room painting and finishing operations.

3.3 CLEAN-UP

Upon completion of the installation, clean window treatments and adjust them for form and appearance and proper operating condition. Repair or replace damaged units as directed by the Contracting Officer. Isolate metal parts from direct contact with concrete, mortar, or dissimilar metals. Ensure shades installed in recessed pockets can be removed without disturbing the pocket. The entire shade, when retracted, shall be contained inside the pocket. For shades installed outside the jambs and mullions, overlap each jamb and mullion 0.75 inch or more when the jamb and mullion sizes permit. Include all hardware, brackets, anchors, fasteners, and accessories necessary for a complete, finished installation.

-- End of Section --

SECTION 12 48 13.13

ENTRANCE FLOOR MATS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC 134	(2011) Electrostatic Propensity of Carpets
AATCC 138	Cleaning: Washing of Textile Floor Coverings
AATCC 174	(2011) Antimicrobial Activity Assessment of Carpets

ASTM INTERNATIONAL (ASTM)

ASTM D5793	(2005) Binding Sites Per Unit Length or Width of Pile Yarn Floor Coverings
ASTM E648	(2010; E 2011) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E662	(2013) Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Entrance Carpet Tile; G

SD-04 Samples

Entrance Carpet Tile

PART 2 PRODUCTS

2.1 TYPE OF MATS

2.1.1 Entrance Carpet Tile

Product and Manufacturer: Refer to the Room Finish Legend.

Physical Characteristics:

Carpet Type: Tile

Carpet Construction: Tufted textured loop.

Size: 19.69 inches by 19.69 inches.

Antimicrobial Treatment: AATCC 138 Washed; AATCC 174 Parts 2 & 3; Intersept

Indoor Air Quality: Green Label Plus Certified #GLP:0820.

Radiant Panel: Class 1; ASTM E648

Smoke Density: Less than or equal to 450; ASTM E662

Static: Less than 3.0 KV; AATCC 134

Tufted yarn weight: 28 oz./sq. yd.

Machine Gauge: Minimum 1/12th inch in accordance with ASTM D5793.

Stitches: Minimum 8 per square inch.

Pile Height: 0.22 inch.

Pile Thickness: 0.15 inch

Pile Density: 6720.

Dye Method: Solution dyed.

Backing Materials: Provide primary backing materials like ethylene vinyl. Provide secondary backing to suit project requirements of post-consumer and post-industrial vinyl. Backing system shall contain a minimum of 20 percent post-consumer recycled content, or minimum 30 percent post-industrial recycled content. See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Carpet backing may contain post-consumer or post-industrial recycled content.

Recycle Efforts: Use of nylon carpet with backing containing recovered carpet and use of nylon fiber with 25 per cent minimum recycled content.

PART 3 EXECUTION

3.1 DELIVERY OF MATERIALS

Deliver materials to the project site in their original packages or containers bearing labels clearly identifying the manufacturer, brand name, and quality or grade.

Store materials in their original unbroken packages or containers in the area in which they will be installed. Unwrap, inspect, and place mats at indicated location.

Remove and dispose all excess packing materials.

3.2 EXAMINATION

Comply with manufacture's requirements of substrates and floor conditions for location, sizes, and other conditions affecting installation of floor mats and frames.

3.3 INSTALLATION

Install only in satisfactory conditions. Comply with manufacturer's written printed instructions for recessed mat frames. Set mat tops at height recommended by manufacturer for most effective cleaning action. Coordinate top of mat surfaces with bottom of doors that swing across mats to provide clearance between doors and mat.

Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level. Install surface-type units to comply with manufacturer's written printed instructions at locations indicated. Coordinate with other trades, entrance locations and traffic patterns.

-- End of Section --

SECTION 12 50 00

FURNITURE SYSTEMS, DESKING, SEATING, CASEGOODS AND STORAGE
02/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2009; Errata 2010) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C1048	(2012; E 2012) Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
ASTM C423	(2009a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM E290	(2013) Bend Testing of Material for Ductility
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2009) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

BIFMA INTERNATIONAL (BIFMA)

ANSI/BIFMA X5.5	(2008) Desk Products
ANSI/BIFMA X5.6	(2010) Panel Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WD 1	(1999; R 2005; R 2010) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2012) Wiring Devices Dimensions Specifications

GREENGUARD ENVIRONMENTAL INSTITUTE (GEI)

GEI	Greenguard Standards for Low Emitting Products

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code
NFPA 265	(2011) Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Coverings on Full Height Panels and Walls
NFPA 70	(2014) National Electrical Code

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	Scientific Certification Systems (SCS)Indoor Advantage

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-569	(2012c; Addendum 1 2013; Errata 2013) Commercial Building Standard for Telecommunications Pathways and Spaces

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

UNDERWRITERS LABORATORIES (UL)

UL 1286	(2008; Reprint Sep 2011) Office Furnishings
UL 723	(2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements. Under Product Data and Closeout submittals, furnish documentation relative to each material credit in accordance with the LEED GBDC.

1.3 SYSTEM DESCRIPTION

1.3.1 Workstations

This specification establishes the minimum requirements for the acquisition and installation of a complete and usable system of workstations composed of panels, stacking panel-frames, freestanding work surfaces or base units, supporting components, electrical hardware, communications, special electrical features, and accessories. Workstation requirements and configurations shall be in accordance with the furniture layout and typical workstation types shown in drawings and specified herein. Provide components and hardware from a single manufacturer; they

shall be standard products as shown in the most recent published price lists or amendments; submit complete listing of part/model numbers for all components to be provided, including names and codes of components referenced on updated drawings. Electrical components shall be products of a single manufacturer to the extent practicable (different types of components may be of different manufacturers, but all units of a given component shall be from a single source). The completed installation shall comply with NFPA 70 and NFPA 101. Coordinate the work of this section with that to be performed under other sections. This specification may include items which are not manufactured by the furniture manufacturer; provide any such items under this section. Submit two complete sets of certificates attesting that the proposed workstation meets specified requirements. The certificate shall be dated after the award of contract, shall name the project, and shall list specific requirements being certified.

1.3.2 Desking, seating, casegoods and storage

This specification establishes the minimum requirements for the acquisition and installation for all desking, seating, casegoods & storage components as described in this specification. Desking configurations and placement of seating, casegoods and storage shall be in accordance with the furniture layout shown in the drawings and specified herein. Provide components and hardware from a single manufacturer; they shall be standard products shown in the most recent published price lists or amendments; submit complete listing of part/model numbers for all components to be provided, including names and codes of components referenced on updated drawings. Submit two complete sets of certificates attesting that the proposed desking, seating, casegoods and storage meets specified requirements. The certificate shall be dated after the award of contact, shall name the project, and shall list specific requirements being certified.

1.3.3 Samples

Submit samples as required to obtain final approval after award of bid. The Government reserves the right to reject any finish samples that do not satisfy the construction or color requirements. Work shall not proceed without sample approval in writing from the Contracting Officer. Submit four sets of the finish samples listed below:

a. Panel and fabric. Minimum 6 by 6 inches with label designating the manufacturer, color, fiber content, fabric weight, fire rating, and use (panel and/or tackboard).

b. Panel, center wall, work surface, modesty panel, and component finish. Minimum 2-1/2 by 3 inches with label designating the manufacturer, material composition, thickness, color, and finish.

c. Task lights.

d. Panel and center wall glazing. Glazing samples with label designating the material and safety ratings.

e. Desking work surface and component finish. Minimum 2-1/2 by 3 inches with label designating the manufacturer, material composition, thickness, color and finish.

f. Seating upholstery. Minimum 6 by 6 inches with label designating the

manufacturer, color, fiber content, fabric weight, and fire rating.

g. Seating arm and base finish. Minimum 2-1/2 by 3 inches with label designating the manufacturer, material composition, color and finish.

h. Casegoods and storage finish. Minimum 2-1/2 by 3 inches with label designating the manufacturer, material composition, color and finish.

1.3.4 Mock-up

Submit a Mock-up of an actual workstation. Reflecting approved finishes and fabrics in the workstation mock-up . Locate the mock-up installation at approved off-site location. Do not order furniture systems for the project until the mock-up has been approved; submit manufacturer's product and construction specifications which provide technical data for furniture system and components specified, including task lighting and illumination performance information. Literature shall include adequate information to verify that the proposed product meets the specification. Review of the mock-up may result in adjustments to the product, layout and finishes. The approved mock-up can be used in installation.

1.3.5 ALTERNATE DESIGN

Manufacturers who are unable to provide workstations that conform exactly to the furniture layouts and typical workstation types shown in the contract drawings, may submit alternate designs for consideration by the Contracting Officer. Alternate designs shall meet or exceed the following criteria. Alternate designs that are submitted but do not meet these criteria will be rejected. The alternate design shall provide workstations and components of the same basic size and configuration shown, with only the sizes of the individual components within the workstation changed to meet the standard product of the manufacturer or site conditions.

1.3.5.1 Component Requirements

The types of components or elements utilized shall be as shown on the drawings and as specified in PART 2 PRODUCTS of this specification. The storage capacity, number of workstations, desking, office and public seating, casegoods and storage accommodated, width of aisles, or workstation and desking configurations shall not be reduced.

1.3.5.2 Wiring Configuration

Alternate configurations shall support the circuiting and connection capabilities identified under the provisions pertaining to power distribution of paragraph POWER AND COMMUNICATIONS. Generally any alternate will be acceptable which involves only a variation in size or quantity that exceeds the specified configuration.

1.3.6 Sustainable Design

1.3.6.1 Low Emitting Furniture-Systems Furniture and Seating Certification

Product shall be third party certified by GEI GREENGUARD Certification Program, SCS Scientific Certification Systems Indoor Advantage or equal. Certification shall be performed annually and shall be current. In addition, furniture to be certified under ANSI/BIFMA e3-2011e Furniture Sustainibility Standards.

1.3.7 Performance Requirements

Panels, center walls, frames and frame covers, connection system, work surfaces, pedestals, shelf units, overhead door cabinets, lateral files, locks, accessories, and miscellaneous hardware shall meet testing as specified. ISO 9001 certified manufacturers may perform inhouse testing. Manufacturers not ISO 9001 qualified will be required to produce testing by an independent testing laboratory. Component specific requirements are listed in appropriate paragraphs. Storage units must meet or exceed the ANSI/SOHO S6.50 Racking Resistance Test.

1.3.7.1 Selected Components

Workstations shall conform to the requirements of ANSI/BIFMA X5.5 and ANSI/BIFMA X5.6 with the following exceptions: Panel supported components shall be tested and pass in accordance with the requirements of ANSI/BIFMA X5.6 and representative items shall be selected for testing based on worst case situations (i.e., the deepest and widest work surface or shelf). Perform the keyboard drawer or shelf test applying a 50 lb load to the center of the keyboard shelf for a period of 5 minutes. Any loosening of attachments, permanent deflection or damage to the operation of the drawer or shelf will be cause for rejection.

1.3.7.2 Panel Acoustics

Provide acoustical panels with a minimum noise reduction coefficient (NRC) of 0.55 when tested in accordance with ASTM C423 and a minimum sound transfer coefficient (STC) of 7 when tested in accordance with ASTM E90 and ASTM E290. Conduct the test on the entire assembled panel, full face area (the complete core, adhesive, decorative fabric, frame and joining components).

1.3.7.3 Panel Glazing

Tempered glass shall conform to ASTM C1048, Kind FT, Condition A, Type I, Class 1 Transparent Class and 3 - Light reducing, tinted or translucent.

1.3.8 Pattern and Color

Pattern and color of finishes and fabrics for panels, seating, casegoods, storage units, components, and trim shall be as shown in furniture package specifications.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings
Installation; G

SD-03 Product Data

Furniture Systems; G
Certification; G
Desking; G
Office and public seating; G
Casegoods; G
Storage; G
Warranty; G
Workstations; G
Materials; (LEED NC); G
Environmental data
Fabric; G

SD-04 Samples

Workstations; G
Mock-up; G

SD-06 Test Reports

Selected Components
Panel Acoustics
Fire Safety
Electrical System
Emissions

SD-07 Certificates

Workstations
Desking
Office and public seating
Casegoods
Storage

SD-08 Manufacturer's Instructions

Material Safety Data Sheets

SD-10 Operation and Maintenance Data

Assembly Manuals
Maintenance Manuals
Cleaning
Electrical System
Maintenance Service

SD-11 Closeout Submittals

Composite Wood and Fiberboard

1.5 QUALITY ASSURANCE

1.5.1 General Safety

Provide all furniture products free of rough or sharp edges. Workstation panel and center wall supported components shall have a positive, integral locking device which secures components without the use of additional screws or clamps to prevent the components from being accidentally pulled or knocked off the panels. Desk-based workstation components shall have the option for a positive, integral locking device that secures components

to the base units.

1.5.2 Fire Safety

Components shall meet requirements for flame spread and smoke development as specified by NFPA 101 except as follows. Testing shall have been conducted in accordance with either ASTM E84 or UL 723 on the entire assembled panel and each different combination of fabric and interior construction. In addition, fabric shall meet the requirements of NFPA 265. Panel flame spread shall not exceed 25 for Class A 75 for Class B 200 for Class C and panel smoke development shall not exceed 450 for Class A, B and C.

1.5.3 Electrical System

Task lights shall be UL approved and shall meet the requirements of NFPA 70. The electrical system shall meet the requirements of UL 1286 and panel wiring must meet or exceed UL 183 manufactured wiring systems tests. Submit three sets of electrical system manuals describing the functions, configuration, and maintenance of the electrical system (power, communications , data). This material may be included in the above manuals at the Contractor's option.

1.5.4 Detail Drawings

Submit detail drawings showing communications, electronic data processing (EDP) and local area network (LAN); locations may be provided as a separate submittal from remaining workstation drawings. Drawing requirements, which are the furniture manufacturer's responsibility, shall be provided as a single submittal. Provide electronic drawings to the user for future re-configuration in the software package requested by the user. The electronic drawings shall include all modifications made during installation. As a minimum, submit the following:

a. Overall reference drawings: Drawings showing workstation, desking, seating, casegoods and storage locations and overall plan view within each floor. The scale shall be 1/8 inch = 1 foot. Layouts shall reflect field verified conditions.

b. Installation drawings: Drawings showing desking, workstations, panels, components, and plan view within each floor. Workstations and desking shall be identified by workstation and desking type; submit drawings showing the proposed workstation and desking installation at a scale of 1/4 inch = 1 foot, unless otherwise specified. Scale of other drawings shall be identical to Architectural plans. Installation drawings shall reflect field verified conditions.

c. Workstation elevations: Dimensioned workstation elevations showing each type of workstation with panel frame configurations and all components identified with manufacturer's catalog numbers. Elevations shall be drawn at 1/2 inch = 1 foot scale.

d. Panel drawings: Panel drawings showing panel locations and critical dimensions from finished face of walls, columns, panels, including clearances and aisle widths. Assemblies shall be keyed to a legend which shall include width, height, configuration and composition of frame covers finishes and fabrics (if different selections exist within a project), power or nonpower, connectors and wall mount hardware. Panel placement shall be coordinated with location of

electrical, voice/date LAN, mechanical and fire protection fixtures. Drawings shall reflect field verified conditions.

e. Electrical drawings: Drawings showing power provisions including type and location of feeder components (service entry poles, base or ceiling feeds), activated power receptacles and other electrical components. Wiring configuration (circuiting, switching, internal and external connections) shall be identified and a legend provided as applicable.

f. Wire management capacity drawings.

g. Communication drawings showing telephone provisions: Drawings indicating the type and location of feeder components and communications jacks with wiring configuration identified where applicable.

h. Communication drawings showing electronic data processing provisions: Drawings indicating the type and location of feeder components, communications jacks, or accessories with wiring configuration identified where applicable.

i. Communication drawings showing local area network provisions: Drawings indicating the type and location of feeder components and data jacks with extra ports for future expansion with wiring configuration identified where applicable.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver components to the jobsite in the manufacturer's original packaging with the brand, item identification, and project reference clearly marked thereon. Remove furniture system components from packaging and store in an unoccupied, dry location that is ventilated. Storage shall be free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling. Inspect workstations, desking, seating, casegoods and storage units upon delivery for damage. Minor damages may be repaired, provided finish items are equal to new work and acceptable to Architect. Remove and replace damaged items as directed.

1.7 WARRANTY

Manufacturer must offer a lifetime warranty that product (workstations desking and seating) shall be free from defects in materials and workmanship (includes shipping, parts and labor for the repair or replacement of defective item.) The following lifetime warranty exceptions shall be allowed: textiles, laminates, wood veneers and modular power components shall have a minimum 12 year warranty. Paint color fastness shall have a minimum 5 year warranty and markerboards shall have a minimum 3 year warranty. Manufacturer shall provide a five year warranty on power supply and a twelve year warranty on light fixtures. Warranties shall be signed by the authorized representative of the manufacturer. Present warranties, accompanied by document authenticating the signer as an authorized representative of the guarantor, to the Contracting Officer upon the completion of the project. Guarantee that the workstation products and installation are free from any defects in material and workmanship from the date of delivery.Submit two copies of the warranty. Lounge chairs and lounge tables to have at minimum (10) ten year warranty against defects in material and workmanship. Fabrics are warranted to be free from defects in materials and workmanship for (1) one

year or the extent of the manufacturer of fabric will warrant further, whichever is greater. Conference tables to have a manufacturer warranty that product will be free from defects in materials and workmanship for a period of (10) ten years.

1.8 MAINTENANCE SERVICE

Collect information from the dealer about maintenance agreement options, and submit to Contracting Officer. Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Manufacturer shall agree to pay for all labor associated with warranty repairs. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse. Services shall reclaim materials for recycling and/or reuse. Services shall not landfill or burn reclaimed materials. When such a service is not available, local recyclers should be sought after to reclaim the materials.

PART 2 PRODUCTS

2.1 MATERIALS

a. Must comply with EPA requirements in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION. Submit environmental data sheets to include environmental attributes and recycled content summary.

2.1.1 Composite Wood and Fiberboard

Provide documentation that composite wood and agrifiber products are third-party certified as meeting ANSI standard requirements for formaldehyde emissions. Submit manufacturer's product data indicating VOC and formaldehyde content contain no added urea-formaldehyde resins. Submit one complete set of test reports for the proposed system.

2.1.2 Fabric

Submit Material Safety Data Sheets for fabrics.

2.2 PANEL SYSTEM

2.2.1 Panel System

Accessories and appurtenances for a completely finished panel assembly shall be supplied complete with the system. Provide a system capable of structurally supporting cantilevered work surfaces, shelves, files, overhead cabinets, and other components in the configurations shown on the drawings plus more than one fully loaded component per panel per side. All panels shall be tackablecapable of accommodating fabric covered tackboards, markerboard, acoustical, stackable, segmented as designated on the drawings and panel skins shall be field removable from both sides of the panel. The panel system shall be available in a variety of nominal widths and heights as designated on the drawings. Heights shall be measured from the finished floor to the top of the panel. Return wing panels shall match or exceed the width of the worksurfaces. Worksurfaces shall be able to install on return panels without the need for counterbalancing to assure that the structural integrity of the work station will not be compromised. Panels must allow up-mounted upper storage. In-line 180 degree, L, T and X 90 degree panel connections must be accommodated. Connectors shall be able to connect panels of differing

heights. Connectors shall be made of steel to withstand the weight of loaded components and the stress of movement under loaded conditions. Connector system shall allow continuation of electrical and communications wiring within a workstation and from workstation to workstation. All vertical and horizontal panel trim components offer matching finishes. Lay-in cable routing must be accommodated in the base area and in the top cap. Powered and nonpowered panels shall be compatible in height. Coordinate panel heights with the HVAC and electrical designs. System shall have 100% off-modular capability with no defacement of any element caused by components when used in an off-modular application. Off modular connections shall not require a unique panel frame. Submit three sets of Assembly Manuals describing assembly and reconfiguration procedures.

2.2.2 Administration Workstation

Worksurface and countertop shall be constructed of medium density particleboard. Adjoining core units shall butt tightly to one another to provide a continuous and level work surface without gaps. Edge banding for work surface must be provided and finished with a durable plastic with at minimum ½ inch thick. Large cord or cable connectors routing behind the worksurface shall be accommodated through removable, snap-in-place plastic covers in the rear corners. Grommets shall be provided in the work surface. Keyboard trays shall be provided and must be adjustable. Back panels shall be full height and width to cover the entire back of an exposed storage unit. A continuous open space shall provide a channel for dropping cords and cables between worksurface and back panel.

2.2.3 Finishes

a. The panels shall be available in the following options: Wide range of skin types including: fabric covered, tackable acoustical skins, wood skins, laminate skins, glass window segments-tempered safety glass offered in clear and frosted, markerboard skins (with steel substrate for ability to use with magnets with flexible white surface for dry erase markers). Skins shall be available both monolithic and segmented in a variety of surface materials and sizes. Skins shall be replaceable in the field and can be added or removed without tools at any time to allow access to internal power, telecommunications and data cabling within the open panel frame. Removal of skins does not require tearing down a panel run.. Exposed panel trim shall have a wood, finish. Filler trim shall either match the panel trim or be fabric covered to match the panel fabric. Each fabric-faced panel shall have a seamless width of fabric stretched over the entire face of the panel and the color of each fabric utilized shall be consistent throughout the installation and is edge glued with hot melt adhesive. The fabric shall be attached securely and continuously along the entire perimeter of the panel and shall allow for easy removal and replacement in the field. Fabric shall be factory installed.

2.2.4 Raceways

Raceways shall be an integral part of the panel. Provide panels whether powered or nonpowered, with a raceway cover. Magnet and plastic held base covers will not be accepted. Raceway shall have the ability to be located in any location on the panel.

2.2.5 Panel Base Trims

Panel base trims to match all panel widths, refer to panel elevations in

drawings for height. Must be steel fabricated with knockouts for both power and communication terminations with a filler piece available to close off unused openings. Multiple finish options must be provided to match panel trim color.

2.2.6 Leveling Glides

The system shall provide precise alignment of adjacent panels and shall include leveling glides to compensate for uneven floors. On panel-to-panel products, each panel shall have 2 leveling glides. On panel-to-post products each connector shall contain a leveling glide. On stacking panel frames each vertical panel assembly shall have two leveling guides. A minimum 3/4 inch adjustment range is required for all systems.

2.2.7 Connection System

The system shall have connectors which accommodate a variety of configurations as shown on the drawings. A straight line connection of 2 panels (180 degrees), corner connection of 2 panels (90 degrees), T connection of 3 panels (90 degrees), cross connection of 4 panels (all 90 degrees), and a connection of 2 panels for setting the panels at any angle. The connector system shall provide tight connections with continuous visual and acoustical internal seals. All two-way and T connections shall have steel or wood veneer finish to match system. The connector system shall allow removal of a single panel within a typical workstation configuration, without requiring disassembly of the workstation or removal of adjacent panels. The connector system shall provide for connection of similar or dissimilar heights. Provide dissimilar height panel assemblies with trim pieces to finish the exposed edge. Right angle (90 degree) connections between panels shall not interfere with the capability to hang work surfaces and other components on any adjacent panel. The connector system shall provide, as required, for the continuation of electrical and communications wiring within workstations and from workstation to workstation. Filler posts shall be level with the top rail. Connectors shall be made of steel for added structural integrity.

2.2.8 Wall Mounted Panels

Use wall-mount accessories when it is necessary to attach panels or vertical panel-frame assemblies to the building walls. Wall panels shall have structural support as required.

2.2.9 Glazed Panel Inserts

Glazed panel inserts shall be comprised of tempered glass in accordance with ANSI Z97.1. Acrylic glazing will not be accepted. Glass panel - factory-installed or tempered glass with clear and frosted glass. Refer to Architectural drawings for locations

2.2.10 Custom Fabrications

Workstation top panel to be custom fabricated by Manufacturer's preferred millwork vendor. Dimensions and locations are to be as shown on drawings. Finish to match workstation panel trim. One (1) top panel to be test fit and obtain government approval before production on all top panels.

2.3 WORK SURFACES

2.3.1 General Requirements

Construct work surfaces to prevent warpage. Work surfaces shall be either fully supported from the panels or supported jointly by the panels and supplemental legs, pedestals, or furniture end panels. Supplemental end supports shall be used only under work surfaces when the work station configuration does not permit full support by the panels. Use metal support brackets to support work surfaces from the panels, provide metal-to-metal fitting to the vertical uprights of the panels, vertically adjustable, to lock the work surfaces in place without panel modifications. Work surfaces shall be fully floor supported with legs, pedestals, or furniture end panels. Work surfaces must be capable of being suspended from similar width standard panel system modules or supports. Abutting work surfaces shall mate closely and be at equal heights when used in side-by-side configurations in order to provide a continuous and level work surface. Grommets shall be provided in the work surface. Keyboard trays shall be provided and must be adjustable. Work surfaces shall either have pre-drilled holes to accommodate storage components, pedestals and additional supports, or holes shall be able to be drilled at the job site to accommodate these items. Work surfaces shall be provided in sizes and configurations shown on the drawings. Work surfaces shall be available in nominal depths of 18 inches, and 24 inches, and 30 inches; nominal lengths from 24 to 72 inches, and a nominal thickness from 1 inch to 1-3/4 inches. Work surfaces shall be height adjustable in 1 to 1 1/2 inch increments from 25 to 41 inches above the finished floor. Work surfaces abutting at equal heights shall provide a continuous and level work surface. Corner work surfaces, peninsula work surfaces, and counter/transaction work surfaces shall be provided as shown on the drawings and shall include all hardware necessary to provide firm and rigid support. Work surfaces shall have 100% off-modular capability with no defacement of any element caused by components when used in an off-modular application.

2.3.2 Finishes

The work surfaces shall have a finished top surface of high pressure plastic laminate or veneer and shall have a smoothly finished underside. The work surface shall not be affected by ordinary household solvents, acids, alcohols, or salt solutions, and shall be capable of being cleaned with ordinary household cleaning solutions. Metal support brackets shall match the color and finish of trim. Edges shall be post formed or vinyl molding or solid wood to match work surface.

2.4 Desking

Pedestals must fit easily under most core units and do not support the freestanding work surface, to be able to be moved without affecting the core unit. Adjoining core units shall butt tightly to one another to provide a continuous and level work surface without gaps. Worksurface shall feature a wood veneer or phenolic decorative laminate. Desk to be constructed of medium density fiberboard with a backing, balanced construction with wood veneer or phenolic decorative laminate finish. Edge banding for work surface must be provided and finished with a durable plastic with at minimum ½ inch thick. Large cord or cable connectors routing behind the worksurface shall be accommodated through removable, snap-in-place plastic covers in the rear corners. Grommets shall be provided in the work surface. Keyboard trays shall be provided and must be

adjustable. Back panels shall be full height and width to cover the entire back of an exposed storage unit. A continuous open space shall provide a channel for dropping cords and cables between worksurface and back panel. Modesty panels shall be available in full-height and partial-height as well as flush and inset versions and equal to the work surface width. End panels must support work surfaces without modesty or back panels. Where work surface is to span more than 60 inches without pedestals, a support leg is to be placed in center of work surface for stability. All exposed end panel sides and edges shall be finished. Refer to furniture package specifications for locations.

2.5 Office and Public Seating

2.5.1 Task chairs

Task chairs must be adjustable including a height adjustment range. Seat construction to be flexible molded plastic with steel rods and springs. Seat shall have a pneumatic cylinder to adjust seat height with pneumatic control located on the side. Seat edge to have angle to allow front edge of seat to flex and shall not have hard edges. Back frame construction to be structural molded plastic perimeter support. Variable back stop to be available which allows user to set the back rest at multiple positions. Chair must offer back support over the entire backrest via a method other than suspension material (i.e. mesh). Width of the back shall provide adequate support for the curvature of the user's back without causing localized pressure points. Chair base to have a five-star base with multiple finish options available. Base to be constructed of plastic with aluminum option available. Standard hard caster wheels shall be constructed of durable nylon for smooth and quiet rolling with a soft wheel caster option available. Range of standard upholstery and finish options to be available including knit mesh or approved equal.

2.5.2 Typical Side Chair

Frame to be black powder coated cold rolled steel wire construction, sled base. Outer seat and back to be constructed of molded polypropylene with inner construction to be molded plywood. Seat and back foam to be at minimum ½ inch thick. Arms to be molded polyurethane. Glides to be constructed of high impact modified nylon or approved equal.

2.5.3 Executive Side Chair

Exterior cantilevered frame to be cold rolled steel, rectilinear tubing. Frame to be powder coated with multiple color selections available. Seat frame formed with furniture grade curved plywood covered with high resiliency molded foam. The interior back frame is formed with furniture grade curved plywood covered with high resiliency molded foam. A welded steel J- bar holds the seat and back together to maximize durability. Upholstery to feature French stitch in seat and back or approved equal.

2.6 Public Seating

2.6.1 Modular Lounge Chair

Interior frame and arms to be constructed of engineered hardwood. Interior frame components are to be CNC machined to maintain accuracy of part dimensions and also to ensure that all connection joints are engineered to interlink with the other hardwood components. All joints are glued and further secured with adhesive staples and/or wood screws. The corner

sections of the frame are reinforced with corner braces that are glued and screwed into position. Seat position utilizes rows of serpentine springs that are affixed to the machined frame. The seat cushion to be comprised of the highest grade of high resistant polyurethane foam used within office furniture. Seat back utilizes rows of serpentine springs that provide the contour of the inside back as well as the comfort of the back. The legs are made of steel tubing that is affixed to the frame using bolts and finished with epoxy powdercoat or approved equal.

2.6.2 Lounge Chair

Upper frame to be plywood construction, leather upholstery. Lower frame and legs to be solid maple carved wood with standard tap in glides. Seat and back to be fully upholstered, semi-attached cushions with a welt perimeter or similar. All other seams are topstitched or similar. Arms to be fully upholstered or approved equal.

2.6.3 Café Chair

Frame to be constructed solid steel for strength and durability. Seat and back constructed of single high strength polymer shell. High impact nylon glides must be available. Provide arms with polypropylene arm caps or approved equal.

2.7 Casegoods

2.7.1 Lounge Table

Panels are constructed of engineered hardwood, finished with solid surface. The engineered hardwood plywood meets and exceeds CARB compliance for hardwood components. All panel components are CNC machined to maintain accuracy of part dimensions and also to ensure that all connection joints are engineered to interlink with the other hardwood components. All joints are glued and further secured with adhesive staples and wood screws. The corner sections of the frame are reinforced with corner braces that are glued and screwed into position. The legs and apron are machined from solid lumber to shape. The table is sanded to a smooth, consistent feel. All joints are cleaned of excess glue.

2.7.2 Coffee Table

1-1/4 inch 3-ply top with mitered side panels that form an apron on two sides. Wood veneer runs lengthwise along the surface and continues down the sides and underside of the table. Table base is constructed of 1-1/4 inch wide by 3/8 inch thick stainless steel with a brushed finish and a protective clear coat. Table is shipped fully assembled. Wood veneer is quarter cut, slip matched.

2.7.3 Cafe Table

Disc base constructed of die cast aluminum or steel with extruded aluminum or steel leg. Steel mounting plate. Injection molded polypropylene glides with no height adjustment. Top surface core to be constructed of particleboard, medium density. Tables shall have a backer sheet to balance the construction. Tables shall have phenolic decorative laminate. Table top to have PVC edge or approved equal.

2.7.4 Conference Tables

Table tops shall be at minimum 1-1/4 inches thick, balanced by 3-ply construction consisting of flake core with veneer applied to the top and a composite backer material applied to the underside. Flake core to be medium density, AWI 200-G compliant. Top edge band shall be constructed of hardwood. Table top shall be wood veneer and laminate; refer to Architectural drawings for locations. Top shall be available with reverse bevel and self edge profiles. Table bases shall be panel base and round metal disc. Panel base shall have flake core, veneer surface, glue and dowel construction. Round metal disc base shall be metal tube and plates, powder coat paint, welded construction. Bases are mounted to tops utilizing a metal plate with black powder coat paint with fasteners. Power location options to be available in the center and ends of table tops and must be fed in from table base. Power coves with data and power to be located on table tops with multiple finish options available or approved equal.

2.8 Storage

2.8.1 Lateral Files

Cabinet shall have steel construction with finished back. Base shall be integral to the cabinet. Base shall feature adjustable glides in each corner. Steel drawer and door fronts to be steel and shall feature a flush front with full-width integral pull or front with handle pulls. Cabinet components to allow for complete, full depth access to drawer and roll-out shelf contents. Must have rubber bumpers cushion drawer opening and closing for quiet operation. Must have safety interlock to prevent tipping. One hanging folder bar for accommodating side-to-side filing of letter, A4 international, and legal size hanging folders must be included with each drawer, or approved equal. Mount lateral file cabinets 4-drawer high or higher to the wall with steel brackets and securely fastened to the wall.

2.9 Bookcase

2.9.1 Laminate Bookcase

Shelves shall be designed to support a proof load of 150 pounds, at minimum. Shall feature a fixed bottom finished shelf, a fixed finished mid shelf and three adjustable shelves. Constructed of medium density particleboard core as defined by ANSI/NPA A208.1 with laminate on the faces and assembled using hidden fasteners. All visible faces shall be covered with laminate. Shelves must be constructed of medium density particle board, at minimum ¾ inch nominal thickness. All visible faces of shelf must be finished with laminate, or approved equal.

2.9.2 Wood Veneer Bookcase

Shelves shall be designed to support a proof load of 150 pounds, at minimum. Shall feature a fixed bottom finished shelf, a fixed finished mid shelf and three adjustable shelves. Constructed of medium density particleboard core as defined by ANSI/NPA A208.1 with laminate on the faces and assembled using hidden fasteners. All visible faces shall be covered with laminate. Shelves must be constructed of medium density particle board, at minimum ¾ inch nominal thickness. All visible faces of shelf must be finished with laminate, or approved equal.

2.10 Outdoor Furniture

Table and seat to be constructed of heavy gauge perforated steel with a thermoplastic or similar coating. Frame to be galvanized tubular steel with a powder coat finish for rust-prevention. Table and seat corners are to be beveled for safety. Mounting tabs must be specified to allow anchoring to floor for security and stability. Table top to have 2 inch diameter opening to accept umbrella with a pole of up to 1- 1/2 inch diameter, or approved equal.

2.11 PEDESTALS

Drawer configurations and pedestal height shall be as shown on the drawings. The deepest possible pedestal shall be provided for each work surface size specified.

2.11.1 Construction

Pedestals and drawers shall be of steel construction. Drawer faces shall be securely attached to the drawer front. Cabinet shall be of steel construction with welded steel rear horizontal braces and vertical steel upright braces to minimize racking and misalignment. Pedestal back to be finished with an integral cabinet base. Cabinet drawer fronts to be steel and feature a flush front with full-width integral pull or front with interchangeable handle pulls. Standard pedestals to be formed steel with full height back and sides with heavy duty steel suspensions to allow complete, full depth access to drawer contents. Cabinet to have rubber bumpers to cushion drawer opening and closing for quiet operation. Pedestals used with wood desk system, wood drawer fronts to be constructed of medium density fiberboard with a backing, balanced construction with wood veneer applied to the faces and plastic edge banding to finish all exposed edges.

2.11.2 Finishes

The finish of steel surfaces shall be a factory baked enamel finish or powder coated. Drawer fronts shall be steel or veneer. Cabinet and top must be available in multiple paint finishes, in both smooth and metallic finishes. Wood veneer finishes to be available to match wood veneer desk based system for monolithic aesthetic. Drawer pulls to be available in more than one metal finish. Refer to furniture package specifications for furniture finishes.

2.11.3 Drawer Requirements

Pedestals shall be field interchangeable from left to right, and right to left, and shall retain the pedestal locking system capability. Pedestals shall be free standing; as shown. Drawers shall stay securely closed when in the closed position and each drawer shall contain a safety catch to prevent accidental removal when fully open. File drawers shall have either a cradle type or full extension ball bearing suspension with hanging folder frames or compressor dividers. File drawers shall be +/- 12 inches high. Box drawers shall be provided with one pencil tray and divider. Each 12 inch high file drawer must be provided with one hanging folder bar for accommodating side-to-side filing of letter, A4 international and legal size hanging folders. Box drawers to be 6 inches high and each must be provided with a pencil tray. Box and file drawers shall be available as box-box-file or file-file drawers in all fixed pedestals.

2.12 STORAGE CAPACITY

Provide Storage Units in the sizes and configurations shown on the drawings. Overhead cabinets and shelf units shall accommodate task lighting and shall have a depth to accommodate a standard three ring binder.

2.12.1 Shelf Unit Construction

The shelf pan shall be of metal construction with formed edges. Shelf supporting end panels shall be constructed of steel. Shelf units shall accommodate relocatable shelf dividers.

2.12.2 Overhead Cabinet Construction

Provide metal construction overhead cabinets. Units shall remain securely fastened when in the locked position. Doors shall utilize a suspension system. Overhead cabinet door shall retract over the top of the cabinet and shall be curved.

2.12.2.1 Metal Overhead Cabinets

Case shall be constructed of welded steel components for durability and security. Cabinet shall feature a fully enclosed back to support freestanding applications and prevent contents from damaging the surface of panels or walls.

2.12.2.2 Laminate and Wood Veneer Overhead Cabinets

Interior depth of case shall be able to accommodate 3-ring binders. Clearance between the cabinet and worksurface shall be at a height to not conflict with computer monitors. Cabinet shall be constructed of welded steel components for durability and security. Cabinet shall feature a fully enclosed back to support freestanding applications and prevent contents from damaging the surface of panels or walls.

2.12.2.3 Metal Shelf

Shelf depth shall be at minimum 14 inches. Shelf to be constructed of steel components. Shelf shall allow enough depth for open space for storage.

2.12.3 Lateral File, Pedestal and Book Case Construction

Units shall be of steel construction and file fronts, top and end panels shall be of metal construction. File drawers shall have full extension ball bearing drawer slides. File drawers shall have hanging folder frames or rails and shall be capable of hanging side-to-side or front-to-back.

2.12.4 Finish

Shelves, dividers and top dust cover shall have a factory baked enamel or epoxy powder coat finish. Shelf supporting end panels shall have a factory baked enamel, epoxy powder coat finish. Shelf bottom shall match end panel color. Metal doors shall have an exterior finish of epoxy powder coat or factory baked enamel and an interior finish of factory baked enamel or epoxy powder coat. Metal drawers shall have a factory baked enamel finish or an epoxy powder coat finish. Overhead cabinet

doors shall have an epoxy powder coat finish.

2.13 ACCESSORIES

2.13.1 Keyboard Tray

Work surfaces shall be capable of accepting an articulating keyboard in locations as shown on the drawings. The keyboard tray shall have the capability to be fully recessed under the work surface and extend to give the user full access to the keyboard. Side travel rotation shall be a 180-degree swing. The keyboard tray shall have tilting capability and shall contain a wrist support. The keyboard tray shall include a mouse pad at the same level as the keyboard tray and accommodate either right or left-handed users.

2.13.2 Erasable Marker Boards

Marker boards shall have a white writing surface which can be easily written on and erased and shall be unaffected by common marker board cleaning/conditioning agents and shall contain a storage tray. Size and location shall be as shown on the drawings. All marker boards to be magnetic.

2.13.3 Signage

Signage shall be panel mounted. Signage shall be composed, at a minimum, of aluminum frame, back panel, clear plastic cover, and D-screw mount option. Signage shall be approximately 6 inches high x 8 inches long and capable of receiving standard white paper insert. Text type shall match Helvetica Medium, HMC.. Signage shall be provided with name of occupant for each workstation. Names to be provided by customer prior to installation. Software for creating text in PC computers for owner production of paper inserts after project completion shall be provided. Refer to signage detail drawings.

2.14 MISCELLANEOUS HARDWARE

Provide brackets, supports, hangers, clips, panel supported legs, connectors, adjustable feet, cover plates, stabilizers, and other miscellaneous hardware.

2.15 LOCKS AND KEYING

Provide drawers, overhead cabinets, pedestals and lateral files with keyed locks, unless otherwise noted. Provide field changeable lock cylinders with a minimum of 100 different key options. Each workstation shall be individually keyed, and locks within a workstation shall be keyed alike. Drawers within a pedestal shall be lockable either by a central lock that controls all pedestals under one work surface or an individual keyed lock in each pedestal. Central file and storage units which are grouped together but are not a part of a workstation shall be keyed alike unless otherwise specified. Two keys shall be provided for each lock or 2 keys per workstation when keyed alike, and 4 master keys shall be provided per area as shown on the contract drawings. Keys and lock cylinders shall be numbered for ease of replacement. Locks shall be clearly labeled with a key number, except for those manufacturers who have removal format locks.

2.16 POWER AND COMMUNICATIONS

Provide both powered and nonpowered panels with base raceways capable of distributing power circuits, communication cables and data lines. Nonpowered bases shall be capable of easy field conversion to powered base without requiring the panel to be dismantled or removed from the workstation. The label or listing of Underwriter's Laboratories, Inc. will be accepted as evidence that the material or equipment conforms to the applicable standards of that agency. In lieu of this label or listing, submit a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures of UL and that the materials and equipment comply with contract requirements. Electrical work not addressed in this section shall conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.16.1 Panel Raceways

Panels shall have removable covers that permit easy access to the raceway when required but are securely mounted and cannot be accidentally dislodged under normal conditions. The raceway shall not extend past panel face by more than 1/2 inch. Provide steel covers which attach securely to the raceway as required and match the finish and color of the panel trim. Raceways in full size panels over 24 inches shall have a minimum of 2 knockouts (doors) per side for power receptacles and communications jacks. Other raceways shall be flush with panel face.

2.16.2 Power Distribution

The panels shall have an internal power and communications raceway. The communications receiving raceway shall have capacity for at least twelve 4-pair category 5 cables. Power and communications wiring may share a common wireway if a metal divider is included to ensure electrical isolation. Doors or access openings shall be included for entry of communications cable.

2.16.2.1 Receptacles

Provide power receptacles in the powered panels. Place devices at the locations indicated on the plans. Unless otherwise indicated, receptacles shall be 15 amp (NEMA 5-15R) commercial grade conforming to NEMA WD 1 and NEMA WD 6. Receptacles shall be of the duplex configuration. Coordinate the color of receptacle bodies with the color of the panel trim. Field applied identification shall be permanent; stick-on or non-setting adhesives shall not be used. Each workstation shall require at minimum 2 receptacles.

2.16.3 Electrical Connections

2.16.3.1 Internal Connections

Panels and receptacles shall be field wired to provide the powered configurations shown on the drawings. Internal wiring shall conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Internal wiring shall conform to Section 26 20 00 INTERIOR DISTRIBUTION

2.16.3.2 Connections to Building Services

Supply external power and communications services to the panels via direct-wired base entry modules.Wiring from building services shall be extended to the entry modules or panel bases in metal conduit or tubing or in flexible liquidtight conduit 6 foot maximum. Cord and plug assemblies shall not be used for any portion of external links. Base feed modules shall plug into the end or either side of the raceway at receptacle doors. External wiring shall conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.16.4 Wire Management

Provide wire management capability at all workstations. Actual wire management capacity shall accommodate all cable types specified, including the applicable manufacturer required bending radius at corners. Raceways and interfaces to the raceways shall be designed to accommodate the bend radius as shown in TIA-569 for Category 6A/6B and fiber optic cables communication wiring . The capability may be accomplished by cable access cutouts (1 minimum per work surface), covered wire management troughs in vertical end panels, horizontal wiring troughs, internal midpanel (beltline) raceways, or rear gaps (between the back edge of the work surface and the facing support panel). Grommet kits or another suitable finish arrangement shall be provided for all cable cutouts. Accessories for an externally mounted vertical and horizontal wire management and concealment system shall be provided as recommended by the manufacturer. Horizontal wire managers shall be supplied for mounting under all work surfaces. The wire managers shall be attached either to the underside of the work surface or to the vertical panel without damaging the face. Exposed or loose wiring will not be acceptable. Wire managers shall be prefinished and shall secure, conceal, and accommodate outlet cords as well as electrical and communications wiring. Wire channels shall attach by means of clip-on attachment, and shall conceal wires routed vertically. Power wiring shall be separated from communication wiring by use of separate raceways or by placement of channels in joint use troughs or wireways.

2.16.5 Field Wiring

The workstations shall be field-wired as shown on the drawings. Connections shall be made to the building electrical distribution system as shown on the contract drawings and in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.16.6 Task Lighting

Provide under-shelf task lights. Task light size and placement shall be provided as indicated on the contract drawings. Such lights shall be a standard component of the manufacturer's workstation products. The ends of the task light length shall not extend beyond the edges of the overhead cabinet. Task lights shall have structurally sound panel bracket mounting devices which will prevent accidental displacement, but will allow easy removal and replacement when necessary. Task light frame to be painted to match system paint. Luminaires shall be UL approved for use in the configurations indicated on the drawings.

2.16.6.1 Luminaire Configuration

Luminaires and lamps shall be as specified in Section 26 51 00.00 40

INTERIOR LIGHTING and as modified herein. Luminaires shall be LED type and shall have prismatic lenses, baffles, or other shielding device configured to minimize glare by shielding the lamp from the view of a seated user. Provide a built-in reflector. Task lights for each workstation shall provide a minimum of 75 foot candles of light (horizontally measured), without veiling reflections, on the work surface directly below and a maximum of 20 inches from the luminaire. All diffusers, grilles or other coverings shall be easily removable to permit cleaning and relamping. Each luminaire shall have an easily accessible on-off switch and one ballast. A variable intensity control is acceptable if the low setting is equivalent to "off" with zero energy consumption. Multiple switching is also acceptable. Ganged luminaires or shared ballasts shall not be used.

2.16.6.2 Wiring

Each luminaire shall have a 6 foot minimum, factory installed, heavy duty electrical cordset with a grounded plug for luminaries that are mounted on the same wall as the receptacle. Luminaires mounted on non-powered wall shall have a 9 foot minimum, factory installed heavy duty electrical cordset with a grounded plug. Direct or hard wire connections are not acceptable. Unless otherwise indicated, cords shall be concealed. Cord concealment shall be built-in within panels or shall utilize field installed, manufacturer approved accessories. Cords may be extended through dedicated channels located at any point within panels or may be placed in vertical slots or in the space between panels if held in place by retainers and concealed by a cover plate. Vertical wire managers shall be prefinished and cut to size and shall extend from the task light level down to the top of the work surface below the task light. Each manager shall be attached to a panel vertical edge or connector strip without damage to the surfaces.

2.16.7 Communications

Communications wiring shall be extended to, and installed in, the electrified panels as shown on the plans. Communications jacks shall be field installed at designated locations. Communications work may be performed in conjunction with the installation of workstations or may be separately executed at the Contractor's option; however, equipment, materials, and installation shall conform to the requirements of Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM and all interfaces shall be properly coordinated.

PART 3 EXECUTION

3.1 INSTALLATION

Install the workstations using certified installers in accordance with manufacturer's recommended installation instructions. Workstation components shall be installed level, plumb, square, and with proper alignment with adjoining furniture. The components shall be securely interconnected and securely attached to the building where required. Provide three sets of special tools and equipment necessary for the relocation of panels and other components. Verify that equipment is properly installed, connected, and adjusted.

3.2 CLEANING

As specified in Section 01 78 00 CLOSEOUT SUBMITTALS. Upon completion of

installation, all products shall be cleaned and polished and the area shall be left in a clean and neat condition. Any defects in material and installation shall be repaired, and damaged products that cannot be satisfactorily repaired shall be replaced. Submit three sets of Maintenance Manuals describing proper cleaning and minor repair procedures.

3.3 WASTE MANAGEMENT

Collect information from manufacturer regarding maintenance agreement take-back program and provide to Contracting Officer. Separate corrugated cardboard and packing materials in accordance with the Waste Management Plan and reuse or recycle.

-- End of Section --

SECTION 13 49 00

RADIATION PROTECTION
02/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1371	Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Radio Frequency Attenuation Barrier

SD-04 Samples

Radio Frequency Attenuation Barrier

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the original containers bearing the name of the manufacturer and brand name. Store materials off the ground under watertight cover. Handle materials preventing damage. Remove damaged materials from the premises.

PART 2 PRODUCTS

2.1 RADIO FREQUENCY ATTENUATION BARRIER

Product and Manufacturer - Basis of Design: Ultra NT Radiant Barrier; rFoil, Covertech Fabricating, Inc., Etobicoke, Ontario, Canada

Description: Heavy duty radiant barrier made up of a single layer of woven polyethylene material bonded and sandwiched between two highly reflective aluminum surfaces.

Emissivity: 0.04; ASTM C1371

PART 3 EXECUTION

3.1 INSTALLATION

Install materials in accordance with manufacturer's instructions and recommendations.

3.1.1 Workmanship

Install barrier free of waves, lumps, and wrinkles.

-- End of Section --

SECTION 14 21 00.00 20

ELECTRIC TRACTION ELEVATORS
05/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME A17.1/CSA B44	(2010) Safety Code for Elevators and Escalators
ASME A17.2	(2010) Guide for Inspection of Elevators, Escalators, and Moving Walks Includes Inspection Procedures for Electric Traction and Winding Drum Elevators, Hydraulic Elevators, and Escalators and Moving Walks

INTERNATIONAL CODE COUNCIL (ICC)

ICC UBC	(1997; Erratas Vol 1, 2 & 3 01/2001; Vol 1 & 2 03/2001; Vol 2 10/2001) Uniform Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Elevator and accessories

Supporting systems

Machinery and controls

Wiring diagrams

Sequence of operations

SD-03 Product Data

Elevator and accessories

Elevator supporting systems

Data sheets

Maintenance and diagnostic tools

Logic control

SD-05 Design Data

Reaction loads

SD-07 Certificates

Welders' qualifications

SD-10 Operation and Maintenance Data

Elevator, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Maintenance and Repair Action Plan

1.3 QUALITY ASSURANCE

1.3.1 Qualification

Provide pre-engineered elevator system by a manufacturer regularly engaged in the manufacture of elevator systems. The manufacturer shall either install elevator system or shall provide letter of endorsement certifying that the elevator-system installer is acceptable to the manufacturer. An installer is required to be regularly engaged in the installation and maintenance of elevator system.

Perform work involving the installation or repair of elevator equipment under the supervision of a person who is licensed in elevator repair in the State of Florida or who possesses the equivalent experience. Furnish data to the Contracting Officer for verification that such experience is possessed by the person exercising direct supervision of the work.

1.3.2 Shop Drawing Requirements

Provide assembly and arrangement of elevators, accessories, and supporting

systems. Show location of machinery and controls in machine room. Provide details for materials and equipment, including but not limited to operating and signal fixtures, doors, door and car frames, car enclosure, controllers, motors, guide rails and brackets, layout of hoistway in plan and elevation, and other layout information and clearance dimensions. Submit complete wiring diagrams and sequence of operations, which show electrical connections and functions of elevator systems, for the machine room, hall and in the hoistway. Provide one set of wiring diagrams in plastic or glass cover, framed and mounted in the elevator machine room. Deliver other sets to the Contracting Officer. Coded diagrams are not acceptable unless adequately identified.

1.3.3 Product Data Requirements

Include information on motor, hall station, and buffer on elevators and accessories. For elevator supporting systems, include information on car control and emergency power systems, and for data sheets, provide document identification number or bulletin number, published or copyrighted prior to the date of contract bid opening.

1.3.4 Design Data: Reaction Load Data Requirements

Provide calculations to the Contracting Officer for reaction loads imposed on building by elevator system. Demonstrate calculations complying with ASME A17.1/CSA B44, Appendix F. Provide calculations certified by a licensed structural engineer registered in any state. Do not fabricate materials nor perform construction until approved by the Contracting Officer.

1.3.5 Certificates: Welders' Requirements

Comply with AWS D1.1/D1.1M, Section 5. Include certified copies of welders' qualifications. List welders' names with corresponding code marks to identify each welder's welding work.

1.4 NEW INSTALLATION SERVICE

Provide routine warranty service in accord with the manufacturer's warranty requirements, for a period of 12 months after the date of acceptance by Contracting Officer. Perform this work during regular working hours. Include 24-hour emergency service, with 1 hour response time, during this period without additional cost to the Government. Include adjustments, greasing, oiling, and cleaning. Provide routine inspection and tests of elevators in accordance with ASME A17.1/CSA B44 (Sections 1001 and 1002) and ASME A17.2. Provide supplies and parts to keep elevator system in operation. Perform service only by factory trained personnel.

1.4.1 Special Operations

Every six months, test systems for Emergency Power Operation, Firefighters' Service. Schedule to not interfere with building operations. For Firefighter's Service, test monthly in accordance with ASME A17.1/CSA B44. Deliver written results of each test operation to the Contracting Officer.

1.4.2 Maintenance and Diagnostic Tools

Provide all special tools and software necessary to service and maintain

each elevator; deliver at time of final acceptance. Provide one of each tool per group of elevators. Provide solid state or microprocessor diagnostic tools unavailable on the open market. Include necessary diagnostic software in cases where the solid state or microprocessor diagnostic tools are available on the open market.

1.4.3 Keys for Elevator Key Switches

Provide a minimum of twelve keys per unique cylinder used on all key switches for a single elevator. If there is more than one elevator, additional keys will not be required unless there are additional unique lock cylinders. Provide keys with brass or fiberglass tags marked "PROPERTY OF THE U.S. GOVERNMENT" on one side with function of key or approved code number on the other side.

1.5 FIRE PROTECTION SYSTEM

Additional fire protection requirements are located in; Division 13, Section 28 31 00 FIRE DETECTION AND ALARM SYSTEM .

1.6 MAINTENANCE

1.6.1 Maintenance and Repair Action Plan

Provide plan of action by the Elevator Installation Contractor to provide emergency and routine maintenance in accordance with paragraph entitled "New Installation Services". In addition to Data Package SD-19 "Operation and Maintenance Manuals", provide a list of phone numbers, personnel contacts, and all tools to be provided to the Contracting Officer.

Submit elevator manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 ELEVATOR DESCRIPTION

Provide elevator system that complies with ASME A17.1/CSA B44 in its entirety, ASME A17.2 in its entirety, and additional requirements specified herein.

Provide elevator by manufacturer regularly engaged in the manufacture of elevator systems. Manufacturer shall either install elevator system or provide letter of endorsement certifying that installer is acceptable to manufacturer. Installer is required to be regularly engaged in installation and maintenance of elevator systems.

2.1.1 Service Elevators (Elevator No. 6)

2.1.1.1 Description: Electric gearless traction, machine room-less type.

a. Type: Traction.

b. Rated load: 5,000 lb.

c. Rated Speed: 350 fpm

d. Travel Length: 110 ft. 0 in. (Elev. 6 only)

e. Number of Stops: 8 (Elev. 6 only)

f. Number of Hoistway Openings: 8 (Elev. 6 only) Front; 1 Rear

g. Car Inside Dimensions (nominal): 9 ft. 0 in. deep, 5 ft. 8-1/2 in. wide and 9 ft. 0 in. high

h. Car Door Opening: four ft. six in. wide and eight ft. 0 in. high

i. Car Door Types: Two-speed side opening.

j. Additional Features: Swing Car Operation.

2.1.1.2 Cab Enclosures and Door Finishes

Provide finishes as listed below:

a. Floor and Base: Resinous terrazzo flooring; refer to Section 09 66 23 Resinous Terrazzo Flooring. Coordinate subfloor requirements for flooring with terrazzo installer. Precast resinous matrix terrazzo base, refer to Section 09 66 24, Precast Resinous Matrix Terrazzo Base. See drawings.

b. Back Wall Opposite Door: Stainless steel, #4 finish, on particleboard. Provide each cab wall with equally spaced and equally sized wall hung panels. All wall hung panel fasteners shall be concealed. See Drawings.

c. Side Walls: Plastic laminate on particleboard to create wall hung panels. See Drawings.

d. Wall trim; stainless steel #4 finish.

e. Accessories: Hand rails; round stainless steel #4 finish, no return. See Drawings.

f. Interior face of door(s); stainless steel #4 finish.

g. Ceilings; stainless steel #4 finish; 6-LED drop ceiling. Ceiling finish is below nominal 9'-0" cab height.

Ceiling frame; stainless steel #4 finish; ceiling finish is below nominal 9'-0" cab height.

e. Hoistway Doors and Frame Finishes

Provide finishes on exterior of hoistway as follows:

(1). Frame; stainless steel #4 finish.

(2). Exterior face of door; stainless steel #4 finish.

2.1.2 Passenger Elevators (Elevator No. 1 and 2)

2.1.2.1 Description: Electric gearless traction, machine room-less type.

a. Type: Traction.

b. Rated load: 3,500 lb.

c. Rated Speed: 350 fpm

d. Travel Length: 95 ft. 0 inches

e. Number of Stops: 7

f. Number of Hoistway Openings: 7 Front; 0 Rear per cab

g. Car Inside Dimensions (nominal): 6 ft 8-1/2 inches wide, 5 ft. 5-1/4 in. deep and 9 ft. 0 in. high

h. Car Door Opening: 3 ft. 6 in. wide and 8 ft. 0 in. high

i. Car Door Types: Center-opening.

2.1.2.2 Cab Enclosures and Door Finishes

Provide finishes as listed below:

a. Floor and Base: Resinous terrazzo flooring; refer to Section 09 66 23 Resinous Terrazzo Flooring. Coordinate subfloor requirements for flooring with terrazzo installer. Precast resinous matrix terrazzo base, refer to Section 09 66 24, Precast Resinous Matrix Terrazzo Base. See drawings.

b. Back Wall Opposite Door: Stainless steel, #4 finish, on particleboard. Provide each cab wall with equally spaced and equally sized wall hung panels. All wall hung panel fasteners shall be concealed. See Drawings.

c. Side Walls: Plastic laminate on particleboard to create wall hung panels. See Drawings.

d. Wall trim; stainless steel #4 finish.

e. Accessories: Hand rails; round stainless steel #4 finish, no return. See Drawings.

f. Interior face of door(s); stainless steel #4 finish.

g. Ceilings; stainless steel #4 finish; 6-LED drop ceiling. Ceiling finish is below nominal 9'-0" cab height.

Ceiling frame; stainless steel #4 finish; ceiling finish is below nominal 9'-0" cab height.

e. Hoistway Doors and Frame Finishes

Provide finishes on exterior of hoistway as follows:

(1). Frame; stainless steel #4 finish.

(2). Exterior face of door; stainless steel #4 finish.

2.1.3 Passenger Elevator (Elevator No. 5)

2.1.3.1 Description: Electric gearless traction, machine room-less type.

a. Type: Traction.

b. Rated load: 3,500 lb.

c. Rated Speed: 350 fpm

d. Travel Length: 95 ft. 0 inches

e. Number of Stops: 7

f. Number of Hoistway Openings: 6 Front; 1 Rear per cab

g. Car Inside Dimensions (nominal): 6 ft 8-1/2 inches wide, 5 ft. 5-3/4 in. deep and 9 ft. 0 in. high

h. Car Door Opening: 3 ft. 6 in. wide and 8 ft. 0 in. high

i. Car Door Types: Center-opening.

2.1.1.1 Cab Enclosures and Door Finishes

Provide finishes as listed below:

a. Floor and Base: Resinous terrazzo flooring; refer to Section 09 66 23 Resinous Terrazzo Flooring. Coordinate subfloor requirements for flooring with terrazzo installer. Precast resinous matrix terrazzo base, refer to Section 09 66 24, Precast Resinous Matrix Terrazzo Base. See drawings.

b. Back Wall Opposite Door: Stainless steel, #4 finish, on particleboard. Provide each cab wall with equally spaced and equally sized wall hung panels. All wall hung panel fasteners shall be concealed. See Drawings.

c. Side Walls: Plastic laminate on particleboard to create wall hung panels. See Drawings.

d. Wall trim; stainless steel #4 finish.

e. Accessories: Hand rails; round stainless steel #4 finish, no return. See Drawings.

f. Interior face of door(s); stainless steel #4 finish.

g. Ceilings; stainless steel #4 finish; 6-LED drop ceiling. Ceiling finish is below nominal 9'-0" cab height.

Ceiling frame; stainless steel #4 finish; ceiling finish is below nominal 9'-0" cab height.

e. Hoistway Doors and Frame Finishes

Provide finishes on exterior of hoistway as follows:

(1). Frame; stainless steel #4 finish.

(2). Exterior face of door; stainless steel #4 finish.

2.2 SPECIAL OPERATION AND CONTROL

Provide all special operations and control systems in accordance with ASME A17.1/CSA B44. Provide special operation key switches with 5 pin

cylinder locks with removable cores. Provide a key control lock for each operation system.

2.2.1 Firefighters' Service

ASME A17.1/CSA B44, Section 211. Provide equipment and signaling devices. The designated level for firefighters' key operated switch is the ground floor.

2.2.2 Top-of-Car Operating Device

ASME A17.1/CSA B44, Section 306. Provide elevator with an operating device, mounted on or from the car crosshead, that will permit car operation at a speed not exceeding 150 fpm for purposes of adjustment, maintenance, testing, and repair. Include an integral or remote safety device, "UP" and "DOWN" switches or buttons, an emergency stop switch, and inspection switch.

2.2.3 Hoistway Access Switches

ASME A17.1/CSA B44, Section 110. Provide key-operated hoistway access switches that permit limited movement of the car at terminal floors for car door opening and car positioning, operative only when the "INSPECTION" switch in car operating panel is in inspection position. Locate switch 6 feet above floor level, with in 12 inches of hoistway entrance frame of an elevator or with the ferrule exposed when located in entrance frame.

2.2.4 Independent Service

Provide exposed key-operated switch in car operating panel to enable independent service and simultaneously disable in-car signals and landing-call responses. Provide indicator lights that automatically illuminate during independent service.

2.2.5 Elevator Operation

ASME A17.1/CSA B44, Introduction, Section 3, Definitions.

2.2.5.1 Duplex Selective Collective Automatic Operations

Provide Duplex Selective Collective Automatic Operation. Provide a single push button for terminal landings and dual push buttons, up and down, at intermediate landings. In each car operating panel, provide push buttons numbered to correspond to each landing. If a car is taken out of service or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to the other car functioning as a single car Selective Collective elevator until the out-of-service car is returned to the system. Provide a push button riser adjacent to elevators as shown on the drawings. A 2nd call push button riser is needed at the service elevator (no. 6) for when it is in swing car operation mode. It will serve as another group hall button in normal operation.

2.3 ELEVATOR MACHINE

ASME A17.1/CSA B44, Section 208, gearless traction, direct-drive machines. Paint or finish ferrous surfaces with minimum one coat of rust-inhibiting paint conforming to manufacturer's standard practice.

2.4 CONTROL EQUIPMENT

2.4.1 Motor Control Equipment

ASME A17.1/CSA B44, Section 210. Provide variable-voltage with silicon controlled rectifier (SCR), or variable-frequency alternating current (ac) drive control. Enclose control equipment in factory-primed and baked-enamel coated sheet-metal cabinets with removable or hinged doors with ventilation louvers.

2.4.1.1 SCR Control or Variable Voltage Variable Frequency (VVVF) AC Control

Provide individual isolation transformers and individual choke reactors for each individual hoist motor. Provide filtering to maintain harmonic distortion below IEEE standards as measured at the elevator machine room disconnect.

2.4.2 Logic Control

Provide a Programmable Automated Controller (PAC) system to enable programmable control of call allocation, logic functions, door control, speed sensing and car position. Provide a method of reprogramming adjustable parameters of computerized controls. Store all programming in non-volatile memory. The microprocessor control system is acceptable only if hardware and software required to maintain and utilize microprocessor is provided and training is provided to Government Personnel by the equipment manufacturer and supplier.

Provide an MMI/HMI on the elevator controllers for diagnostics and elevator status.

Provide ability to remotely monitor the elevators through the existing KCCS system.

Design the controls so the higher voltages are separated from the lower voltages with the intention on reducing the Arcflash incident energy levels down to ideally a Category 0 of the NFPA 70E.

2.4.2.1 Repair Requirements

For the repair of microprocessor control system, provide maintenance tools, supporting computer software, and software documentation required for complete maintenance of elevator system including diagnostics and adjustments. Tools may be hand-held or built into control system. Provide tools which do not require recharging to maintain their memory or authorization for use. Do not use software which requires periodic reprogramming, or reauthorization. Programs shall be stored in non-volatile memory.

2.5 OPERATING PANELS, SIGNAL FIXTURES, AND COMMUNICATIONS CABINETS

2.5.1 Capacity and Data Plates

ASME A17.1/CSA B44. Attach faceplates with spanner security screws. On car panel, provide stainless steel, #4 finish, capacity and data plates, with name of elevator manufacturer.

2.5.2 Car and Hall Buttons

Provide flush mount tamper-proof push buttons of minimum 3/4 inch size satin-finish stainless steel, #4 finish, with white LED illuminated halo.

2.5.2.1 Hall Station Door Operating Buttons

Provide flush mount tamper-proof push buttons of minimum 3/4 inch size satin-finish stainless steel #4 finish with white LED illuminated halo. Hall station faceplate to be vertical. See drawings for coordination of faceplate with custom stainless steel plate.

2.5.2.2 Car Door Operting Buttons

Provide flush mount tamper-proof push buttons of minimum 3/4 inch size satin-finish stainless steel #4 finish with white LED illuminated halo.

2.5.3 Passenger Car-Operating Panel

ASME A17.1/CSA B44, Section 211 and 306. Provide each car with one car operating panel that contains operation controls and communication devices. Provide flush mount tamper-proof push buttons of minimum 3/4 inch size satin-finish stainless steel #4 finish with white LED illuminated halofor the controls that must be passenger accessible. Provide service cabinet or keyed switches for those controls that should not be passenger accessible. Allow maximum 48 inches between car floor and center line of bottom button. Use engraving and backfilling or photo etching for button and switch designators. Do not use attached signs.

Provide car operating panels with a fire service panel which houses the fire service control switches behind a lockable hinged door.

2.5.3.1 Passenger Controls

Place all controls in the same panel (anything that is seen by occupants of the elevator); all controls shall align with each other.

a. Provide flush mount tamper-proof push operating call buttons of minimum 3/4 inch size satin-finish stainless steel #4 finish with white LED illuminated halo identified to correspond to landings served by elevator car. For two openings at a floor, provide two buttons marked "FRONT" and "REAR" above button location.

b. "DOOR OPEN" and "DOOR CLOSE" buttons.

c. Keyed "STOP" switch in accordance with ASME A17.1/CSA B44.

d. "ALARM" button in compliance with UFAS, ADA, and ASME A17.1/CSA B44. Alarm button shall be red with engraved legend "ALARM." Alarm button shall illuminate when pushed. Locate "ALARM" button at panel bottom.

e. "FIRE DEPARTMENT" key switch, with "OFF-HOLD-ON" positions, in that order with key to be removable in all positions. Provide fire sign or jewel and audible signal device, in accordance with ASME A17.1/CSA B44, Figure 211.3a. Both visual and audible signals are activated when Phase I key switch in hall is activated or when smoke detector activates return of elevator(s) to main fire response floor. Visual and audible signal shall remain activated until car has reached designated or alternate fire response floor. Upon arrival at fire

response floor visual signal remains illuminated and audible signal becomes silent.

f. Emergency two-way communication. Provide momentary pressure, single illuminating pushbutton operated communication device that complies with ASME A17.1/CSA B44, UFAS, and the Americans with Disabilities Act.

2.5.3.2 Service Controls

a. Inspection switch that transfers car control to top-of-car inspection operating controls and prevents car operation from in-car control panel.

b. Independent service switch.

c. Two car light switches, one for light in car and one for lights on top and bottom of car frame.

d. Fan switch, two-speed.

e. Infra-red curtain unit cutout switch.

f. 120-volt ac 60 Hz single-phase duplex electrical outlet of ground-fault-circuit-interrupt (GFCI) design.

g. Device for communication between car and elevator machine room.

2.5.3.3 Certificate Window

Provide a minimum 9 inches high by 6 inches wide certificate window in car operating panel for elevator inspection certificate.

2.5.4 Full-Selective Door Operation

For elevator with one or more rear openings at same level as front opening, provide full-selective operation with car and door operating buttons clearly marked for front and rear openings, front and rear car button for each such floor, and front and rear "DOOR OPEN" and "DOOR CLOSE" buttons. Only door for which the button was operated opens or closes.

2.5.5 Switches and Devices

Provide elevator manufacturer's standard grade for switches and devices on car operating panel. Legibly and indelibly identify each device and its operating positions. Locate car dispatching buttons in identical positions in car operating panels for corresponding floors.

2.5.6 In-Car Position and Direction Indicator and Signal

In-car direction indicator shall be included in the in-car position indicator fixture.

2.5.6.1 In-Car Position Indicator and Signal

Provide horizontal electrical or electronic digital position indicator located minimum of 84 inches above car floor. Arrange indicator to show floor position of car in hoistway and its traveling direction. Indicate position by illumination of numeral or letter corresponding to landing at

which car is passing or stopping. Provide audible signal to alert passenger that elevator is passing or stopping at a floor.

2.5.6.2 In-Car Direction Indicator and Signal

Provide visual and audible car direction indicators in car, indicating car traveling direction. For visual directional signal, provide arrow of minimum 2 1/2 inches in size. Use equilateral triangles for arrows, green for upward direction and red for downward direction. Provide audible signal that sounds once for upward direction and twice for downward direction.

2.5.7 Landing Position and Direction Indicator and Signal

Provide a single fixture containing the landing position and direction indicators.

2.5.7.1 Landing Direction Indicator and Signal

Provide landing direction indicator with visual and audible signal devices. Provide single direction indicator at terminal floors; "UP" and "DOWN" direction indicator at intermediate floors. Provide equilateral triangles not less than 2 1/2 inches in size, green for upward direction and red for downward direction. Provide electronic audible device that sounds once for upward direction and twice for downward direction. Hall lantern faceplate to be vertical or horizontal, see drawings to determine orientation and location. See drawings for coordination of faceplate with custom metal veneer faced panels.

2.6 HOISTWAY AND CAR EQUIPMENT

ASME A17.1/CSA B44, Parts I and II.

2.6.1 Car and Counterweight Guide Rails and Fastenings

ASME A17.1/CSA B44, Section 200. Paint rail shanks with one coat of black enamel. Provide pit channel for anchoring main guide-rail brackets and mounting buffers. Only T-section type guide rail is acceptable.

2.6.2 Car and Counterweight Buffers

ASME A17.1/CSA B44, Section 201. Provide data plate on each buffer.

2.6.3 Pit Equipment

ASME A17.1/CSA B44, Section 106. Provide pit channel for anchorage of main guide rail brackets and also for anchorage of counterweight guide rail brackets. Each channel shall span distance between guides. In addition, pit channel for main guide rails shall serve as mounting surface for car buffer(s). Pit channel for counterweight guide rails shall serve as mounting surface for counterweight buffer(s). Method of installation of channels, brackets and buffer mounts shall be such that pit waterproofing is not punctured. On completion of guide rail and buffer installation, both pit channels shall be fully grouted.

2.6.3.1 Pit "STOP" Switch

Provide push/pull type pit "STOP" switch for stopping elevator motor, independent of regular operating device. Locate switch on same side of

hoistway as ladder.

2.6.3.2 Ladder

Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS Locate ladder on hoistway side wall closest to hoistway door opening. See Drawings for location.

2.6.3.3 Lighting of Pits

ASME A17.1/CSA B44. Locate bottom of light approximately 4'-5" above pit floor in order to provide an illumination of not less than 10 foot-candles per code.. Locate switch on same side of hoistway as ladder. Provide GFCI duplex receptacle in each pit.

Provide the pit lighting to meet the foot-candle requirements in accordance with the latest edition of ASME A17.1/CSA B44.

2.6.4 Terminal Stopping Devices

ASME A17.1/CSA B44, Section 209.

2.6.5 Wiring and Traveling Cables

NFPA 70, Article 620 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Suspend traveling cables by means of self-tightening webbed devices. Access control system will require four cable pairs to be reserved for card readers for each traveling cable.

2.6.6 Emergency Signaling Devices

Provide an audible signaling device, operable from the Car Operating Panel button marked "ALARM". The audible signaling device shall be mounted in the hoistway and shall conform to the requirements of ASME A17.1/CSA B44.

2.7 PASSENGER CAR AND HOISTWAY DOOR ACCESSORIES

ASME A17.1/CSA B44, Sections 111, 112, and 204. Provide infra-red curtain unit. Provide high-speed electric operator, safety interlocks for car and hoistway doors, and electric safety contact to prevent car operation unless doors are closed.

Provide Hoistway door unlocking device.

2.7.1 Infra-red Curtain Unit

Provide Infra-red Curtain Unit (ICU) with multiple infra-red beams that protect to the full height of the door opening. Minimum coverage shall extend from 2 inches off the floor to 70 inches above floor level. Door operation must meet the requirements of ASME A17.1/CSA B44.

2.8 PASSENGER ELEVATOR GUIDES, PLATFORM, AND ENCLOSURE

2.8.1 Roller Guides

ASME A17.1/CSA B44, Section 200. Provide roller guide assemblies in adjustable mountings on each side of car and counterweight frames in accurate alignment at top and bottom of frames.

2.8.2 Car Frame and Platform

ASME A17.1/CSA B44, Section 203.

2.8.3 Car Enclosure, Car Door, and Car Illumination

ASME A17.1/CSA B44, Section 204. Provide natural and forced ventilation, emergency exit, and stainless-steel hooks with fire retardant protective pads.

2.8.3.1 Car Shell Return Panels, Entrance Columns, Cove Base, and Transom

Provide 14 Gauge minimum stainless steel, #4 finish. All exposed steel (able to be seen by passenger) shall be stainless steel #4 finish.

2.8.3.2 Car Top

Provide reinforced 12 gauge minimum steel with hinged exit, openable by hand from car top only. Provide electrical contact which prevents operation of elevator when emergency exit is open. Provide sound-deadening mastic on all exterior components.

2.8.3.3 Car Door

Provide 16 gauge minimum stainless steel, #4 finish, sandwich construction without binder angles. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading and one at trailing door edge with guides in the sill groove their entire length of travel.

2.8.3.4 Car Entrance Sill

Provide one piece cast nickel silver entrance sill. Set sills level and flush with floor finish. Use same material for hoistway and car entrance sills.

2.8.3.5 Car Vents

Provide concealed car vents behind wall hung interior cab panels per code. See drawings.

2.9 PASSENGER ELEVATOR HOISTWAY DOORS AND ENTRANCES

ASME A17.1/CSA B44, Sections 110 and 112. Provide hoistway entrance assemblies with a minimum 1-1/2 hour fire rating.

2.9.1 Hoistway Entrance Frames

14 gage stainless steel, #4 finish. Solidly grout uprights of entrance ways to height of 5 feet.

2.9.2 Hoistway Entrance Sills

Provide one-piece cast solid nickel silver entrance sills. After sill is set level and flush with finished floor height, solidly grout under full length of sill. Use same materials for hoistway and car entrance sills.

2.9.3 Hoistway Entrance Doors

ASME A17.1/CSA B44, hollow metal non-vision construction with flush

surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading edge and one at trailing edge with guides in the sill groove the entire length of travel.

2.9.4 Entrance Fascias

ASME A17.1/CSA B44.

2.9.5 Hoistway Pressurization

Provide hoistway pressurization as shown on the MEP drawings.

2.10 HANDICAPPED AND MEDICAL SERVICES ACCESS

36 CFR 1191, Sections 4.10 for Elevator, 4.30 for Signage, and 4.31 for Telephones.

2.10.1 Provision for Handicapped

2.10.2 Emergency Medical Services

ICC UBC, Chapter 30 for elevators and signage.

2.11 EMERGENCY POWER OPERATION

Upon outage of normal power and initiation of emergency power, provide circuitry and wiring to operate elevator, telephone and intercom to accomplish operation sequences. Standby power operation shall return each car automatically to a designated landing when the system is initially switched to standby power. One or more cars are returned at a time. Preference is given to loaded cars over empty cars in order to reduce passenger waiting times. A car must respond by beginning to move toward the designated landing within a pre-determined time. If a car does not respond, it is automatically placed in a "Not Available" mode while other cars are moved. If a car was not returned to the designated landing on the first try, a second attempt is made. If the second attempt is not successful, the car will remain in a "Not Available" mode and can only be moved by manual means. Once each car has returned to the designated landing, the doors will remain open for a predetermined amount of time.When all cars have successfully returned to the designated landing or have attempted to move twice, automatic selection of the car(s to run on normal operation will occur.
If for any reason a car selected for normal operation under standby power is delayed for 60 seconds, the car will be placed in a "Not Available" mode and another car will be selected for normal operation based on the priorities listed above.

Manual Override of Standby Power Operation is achieved by a manual input for each car via a strip switch. A manually selected car may be run either in a return operation to a designated landing or in normal operation under standby power. If a manually selected car has not yet returned to the designated landing, it will perform this operation first then immediately go into normal operation. If a manually selected car is delayed, no other car can be selected in the group unless it is manually selected.

If car selection is changed by Manual Override while a car is running in

return or normal operation under standby power, the newly selected car will not be permitted to run until the car that had been running has stopped, opened its doors, and gone into the Standby Power Wait state.For emergency power, operation, provide sign reading "EMERGENCY POWER" flashing in each car station. At same time, provide operable Firefighters' Service.

2.12 PROGRAMMABLE LOGIC CONTROLLER (PLC)

Provide a PLC control to each elevator sump pump. Include a communication connection (Cat 6 cable, fiber optic) to the communication room, as indicated. This connection will connect the PLC elevator to KCCS. All the inputs on that PLC will be available for display on KCCS to show the high level and pump alarm into the PLC that will be installed for controlling the elevator.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with manufacturer's instructions, ASME A17.1/CSA B44, 36 CFR 1191, and NFPA 70.

3.1.1 Traveling Cables

Do not allow abrupt bending of traveling cables.

3.1.2 Structural Members

Do not cut or alter. Restore any damaged or defaced work to original condition.

3.1.3 Safety Guards

Selector cables or tapes exposed to possibility of accidental contact in machine room shall be completely enclosed with 16 gage sheet metal or expanded metal guards, both horizontally and vertically. Exposed gears, sprockets, tape or rope sheaves, floor controllers, or signal machines, and their driving ropes, chains or tapes, and selector drums shall be guarded from accidental contact in accordance with ASME A17.1/CSA B44.

3.1.4 Miscellaneous Requirements

Include recesses, cutouts, slots, holes, patching, grouting, and refinishing to accommodate elevator installation. Use core drilling to drill all new holes in concrete. Finish work to be straight, level, and plumb. During installation, protect machinery and equipment from dirt, water, or mechanical damage. At completion, clean all work, and spot paint.

3.1.5 Firefighters' Service

Firefighters' service shall be complete including installation and wiring of all smoke detectors in accordance with ASME A17.1/CSA B44. Coordinate smoke detector installation for Firefighters' Service.

3.2 FIELD QUALITY CONTROL

After completing elevators system installation, notify Contracting Officer

that elevator system is ready for final inspection and acceptance test. Contracting Officer will obtain services of State of Florida certified elevator inspector.

Contractor shall perform all required tests and demonstrate proper operation of each elevator system and prove that each system complies with contract requirements and ASME A17.1/CSA B44, and the applicable requirements of Part XI, "Engineering and Type Tests". Inspection procedures in ASME A17.2 form a part of this inspection and acceptance testing. All testing and inspections shall be conducted in the presence of the elevator inspector. Demonstrate the proper operation of all equipment at various date settings, selected by the elevator inspector, ranging from the date of contract award through 1 January 2099.

Inspector shall complete, sign and post form KSC form 3-540 NS (REV.02/08), Elevator Inspection Certificate, after successful completion of inspection and testing.

3.2.1 Testing Materials and Instruments

Furnish testing materials and instruments required for final inspection. Include calibrated test weights, tachometer, 600-volt megohm meter, volt meter and ammeter, three Celsius calibrated thermometers, door pressure gage, spirit level, stop watch, dynamometer, and 100 foot tape measure.

3.2.2 Field Tests

3.2.2.1 Endurance Tests

Test each elevator for a period of one hour continuous run, with specified rated load in car. Restart the one hour test period from beginning, following any shutdown or failure. During test run, stop car at each floor in both directions of travel for standing period of 10 seconds per floor. The requirements for Rated Speed, Leveling, Temperature Rise and Motor Amperes Test specified herein are to be met throughout the duration of the Endurance Test.

3.2.2.2 Speed Tests

Determine actual speed of each elevator in both directions of travel with rated load and with no load in elevator car. Make Speed tests before and immediately after Endurance test. Determine speed by tachometer reading, excluding accelerating and slow-down zones per ASME A17.2. Minimum acceptable elevator speed is the Rated speed specified. Maximum acceptable elevator speed is 110 percent of Rated speed.

3.2.2.3 Leveling Tests

Test elevator car leveling devices for landing accuracy of plus or minus 1/4 inch at each floor with no load in car, symmetrical load in car, and with rated load in car in both directions of travel. Determine accuracy of floor landing both before and immediately after endurance tests.

3.2.2.4 Insulation Resistance Tests

Perform tests to ensure elevator wiring systems are free from short circuits and grounds. Minimum acceptable insulation resistance for electrical conductors is one megohm between each conductor and ground and between each conductor and other conductors. Prior to megohm meter test,

make provisions to prevent damage to electronic devices.

3.2.2.5 Brake Test

Conduct brake test with 125 percent of rated load in elevator. Verify that brakes hold the elevator with 125 percent of rated load according to requirements of A17.1/CSA B44.

3.2.2.6 Buffer Tests

Test buffers for car and counterweight as outlined in ASME A17.1/CSA B44.

3.2.2.7 Temperature Rise Tests

Determine temperature rise of elevator hoisting motor, motor-generator, exciter, and booster during full-load test run for one hour minimum. Under these conditions, maximum acceptable temperature rise shall not exceed acceptable temperature rise indicated on manufacturer's data plate. Start test only when equipment is within 5 degrees C of ambient temperature.

3.2.2.8 Balance Tests

Perform electrical and mechanical balance tests of car and counterweight.

3.2.2.9 Motor Ampere Tests

Measure and record motor amperage when motor is running and elevator is lifting at rated load and speed. Measure and record motor amperage at beginning and end of Endurance test.

3.3 MAINTENANCE SERVICE TRAINING

Provide qualified representative of elevator manufacturer to instruct Government personnel in care, adjustment, and maintenance of elevator equipment for a period of not less than 5 working days immediately following acceptance of elevator system.

-- End of Section --

SECTION 21 13 00.00 98

FIRE SUPPRESSION SPRINKLER SYSTEMS
02/12

PART 1 GENERAL

1.1 REQUIREMENTS

Provide design and installation in accordance with NFPA Standards. The interpretation of NFPA Standards rests with the Kennedy Space Center Fire Protection Engineer who is the Authority Having Jurisdiction (AHJ), and whose opinion is final.

This is a performance based specification with the Contractor responsible for providing engineering design, installation and testing associated with the work to be performed. As defined under Florida Statutes, Chapter 471, all design work will be performed by a "delegated engineer", who is a Professional Engineer, licensed to practice in Florida and competent in fire protection engineering.

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121	(2004) Standard Definitions for Use in the Design of Steel Structures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2011) Grooved and Shouldered Joints

ASME INTERNATIONAL (ASME)

ASME A112.18.1/CSA B125.1	(2011) Plumbing Supply Fittings
ASME B16.34	(2009; Supp 2010) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.4	(2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2007) Standard for Factory-Made Wrought

	Steel Buttwelding Fittings
ASME B31.1	(2012; INT 2-6, 8-10, 13, 15, 17-25, 27-31 and 42-46) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A135/A135M	(2009) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A183	(2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A234/A234M	(2011a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A307	(2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A795/A795M	(2008) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM C592	(2010) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/
FM AS 4991	(2001) Approval of Firestop Contractors

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2013) Standard for the Installation of Sprinkler Systems
NFPA 14	(2013) Standard for the Installation of Standpipes and Hose Systems
NFPA 1963	(2009; Errata 09-1) Standard for Fire Hose Connections
NFPA 24	(2013) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 251	(2006) Standard Methods of Tests of Fire Resistance of Building Construction and Materials
NFPA 70	(2014) National Electrical Code
NFPA 72	(2013) National Fire Alarm and Signaling Code
NFPA 75	(2013) Standard for the Protection of Information Technology Equipment

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2003) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(1970; Rev B) Color Code for Pipelines & for Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement
CID A-A-1922	(Rev A; Notice 2) Shield, Expansion (Caulking Anchors, Single Lead)
CID A-A-1923	(Rev A; Notice 2) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-1924	(Rev A; Notice 2) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors
CID A-A-1925	(Rev A; Notice 2) Shield Expansion (Nail

	Anchors)
CID A-A-55614	(Basic; Notice 2) Shield, Expansion (Non-Drilling Expansion Anchors)
CID A-A-55615	(Basic; Notice 2) Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors

UNDERWRITERS LABORATORIES (UL)

UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.4 ADMINISTRATIVE REQUIREMENTS

1.4.1 Pre-Installation Meeting

No later than 30 calendar days of Contract Award, mandatory attendance is required at a pre-installation meeting. Submit the following to the Contracting Officer for review:

a. Contractor's State Certification

b. Factory test data, including fully verified and dated copies of all results with a copy of the approved test procedure and any other related information.

c. Quality Assurance Plan

d. Test procedures and recording forms for the preliminary tests

Provide one (1) copy of the test procedures and recording forms for the preliminary tests. For the final acceptance tests, provide ten (10) copies of the test procedures and recording forms. In each test procedure, identify each sprinkler and standpipe component to be tested, describe the initial condition, each step or function in the test, required test results, and equipment to be employed. Provide test forms with suitable spaces for recording test results on all equipment, devices, and wiring to be tested. Provide test record forms that also have identified spaces for verification signatures of official witnesses and dates of the test.

1.4.1.1 Shop Drawings

Submit shop drawings for the following items in sufficient detail and scope to verify compliance with the requirements of the contract documents:

a. Records of Existing Conditions

Submit Records of existing conditions showing the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the job site. Commencement of work constitutes acceptance of existing conditions.

b. Schematics and Fabrication Drawings

Submit Schematics and Fabrication Drawings for automatic sprinkler and

standpipe systems, consisting of fabrication and assembly drawings to be performed in the shop, prior to installation and at the actual job site. Meet all requirements in NFPA 13 for fabrication drawings, stipulated for "working plans", to include a building cross-section. Provide working plans signed and sealed by a Professional Engineer, licensed to practice in the State of Florida.

Indicate on working plans all sprinkler and standpipe piping (size and length), pipe hangers, sprinkler head type and locations, valves, riser trim and associated components, etc. to comply with NFPA 13, "Working Plans."

c. Fire Service Floor Plans

Provide .DWG format computer generated floor plan layouts indicating all automatic sprinkler and standpipe systems components.

Locate sprinkler heads in a consistent pattern with ceiling grid, lights, and supply and return air diffusers. For spaces with lay-in type ceilings, locate heads in center of tile, unless otherwise approved by the Contracting Officer. In the design, give full consideration to blind spaces, other system piping, electrical equipment, HVAC ductwork, and all other types of obstructions which could prevent the proper installation and operation of the sprinkler and standpipe systems.

Indicate in the Fire Service Floor Plans, the location of the wet-pipe automatic sprinkler system, risers, standpipes, isolation valves. Coordinate with the requirements of the Fire Alarm System Fire Service Floor Plan such that all fire alarm and suppression system devices are combined on a single fire service floor plan. Provide a symbol legend, which clearly identifies each device shown on the fire service floor plan. Install a copy of the fire service floor plan minimum size 18 by 24 inches in a painted metal frame with a Plexiglas cover. Submit the floor plan and it's location for approval to the Contracting Officer prior to installation.

d. Connection Diagrams

Submit Connection Diagrams indicating the relations and connections of the following items. Indicate on the drawings the general physical layout of all controls, and internal tubing and wiring details.

1.4.1.2 Manufacturer's Product Data

Submit Manufacturer's Catalog Data in sufficient detail and scope to verify compliance with the requirements of the contract documents.

1.4.1.3 Fire-Protection System Performance Data

Submit Fire-Protection System Performance Data consisting of information on useful life, system functional flows, safety features, and mechanical automated details. As a minimum, include the following:

a. Design Analysis and Hydraulic Calculations

Provide hydraulic calculations for the hydraulically most remote area of the system riser and each occupancy classification. Provide hydraulic calculations signed and sealed by a Professional Engineer, licensed to practice in Florida.

Include in the design data design density, hydraulically most remote area, occupancy classification, sprinkler head orifice size, and pipe velocities. Specify the design density in gpm per sq ft or L/m per sq m of floor area. Provide discharge from individual heads in the hydraulically most remote area to be between 100 percent and 120 percent of the specified density. Design systems such that pipe velocities do not exceed 20 feet per second.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and section 01 33 29 LEED(TM) DOCUMENTATION:

SD-01 Preconstruction Submittals

Records of Existing Conditions; G

Contractor's State Certification; G

Factory Test Data; G

Quality Assurance Plan; G

Test Procedures and Recording Forms for the Preliminary Tests; G

SD-02 Shop Drawings

Connection Diagrams; G

Schematics and Fabrication Drawings; G

As-Built Drawings; G

Fire Service Floor Plans; G

Records of Existing Conditions; G

SD-03 Product Data

Piping Materials; G

Supporting Elements; G

Sprinkler Riser Equipment; G

Riser Alarm Equipment; G

Fire Department Connections; G

Standpipe Equipment; G

Sprinkler Heads; G

Valves; G

Miscellaneous Materials; G

Identification Tags; G

Inspector's Test Valve; G

Inspector's Test; G

Sound Stopping; G

Fire Stopping; G

Fire-Protection System Performance Data; G

SD-05 Design Data

Design Analysis and Hydraulic Calculations; G

SD-06 Test Reports

Pressure Tests; G

SD-07 Certificates

Test Gauge Accuracy; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.6 QUALITY ASSURANCE PLAN

Ensure all equipment provided under this sprinkler system specification is manufactured to meet the requirements of this paragraph. Provide system(s) that is (are) the latest standard design, that is listed by Underwriters' Laboratories or approved by Factory Mutual FM APP GUIDE, and is suitable for the intended use.

Components installed under this contract cannot be more than one (1) year older than the date of installation. Submit proof that all components are Underwriter Laboratory UL Fire Prot Dir listed or Factory Mutual FM APP GUIDE and FM AS 4991 approved for their intended use and function, and are installed per manufacturer instructions.

1.6.1 Services Of A Certified Automatic Sprinkler Specialist

Provide services of a Certified Specialist thoroughly experienced in automatic sprinkler system installations on site to perform or directly supervise the installation, make all necessary adjustments and perform all tests on the automatic sprinkler system at the site. The expectation for supervision by the Certified Specialist is not constant, but is considered to include at least two (2) weekly site visits to inspect installation progress, verify installation meets approved shop drawings, verify manufacturer's instructions/code requirements are followed for component installation, and provide advice as necessary to the installers. When specific installation issues are noted in the field by a government representative, the Certified Specialist shall respond to the site to physically review the issue within 24 hours.

Sprinkler System Specialist is certified when the specialist holds a valid

Sprinkler System Layout, Level III Certification from the National Institute for Certification in Engineering Technologies NICET 1014-7 or is licensed by the State of Florida as a Contractor Class I in accordance with Florida State Statute, Chapter 633, Section 633.521 and holds a current Certificate of Competency.

Also consider certification of other recognized agencies with equivalent requirements. Provide evidence of the Contractors State Certification and the basis of certification to the Contracting Officer and approve by the Contracting Officer prior to any work being performed at Kennedy Space Center.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide fire-protection system materials and equipment conforming to the requirements of Underwriters Laboratories UL Fire Prot Dir or the Factory Mutual FM APP GUIDE.

2.1.1 Design Requirements

The work includes designing and providing new automatic wet pipe sprinkler and standpipe system consisting of but not limited to an easy riser type swing check valve, with all associated trim, including gauges, 2 inch main drain connection, floor drains, flow switches, and sprinkler heads for the wet-pipe sprinkler system. Hydraulically design the automatic sprinkler system(s) to meet density and area of coverage requirements using a UL listed or FM approved hydraulic design program. Provide the design, equipment, materials, installation, workmanship, examination, inspection, and testing in strict accordance with the required and advisory provisions of NFPA 13, NFPA 72, NFPA 14, NFPA 24, and NFPA 75 except as modified herein. Include in each system all materials, accessories, and equipment inside and outside the building to provide an operationally compliant system. In the system design give full consideration to blind spaces, piping, electrical equipment, ductwork, and other construction and equipment in accordance with working plans to be submitted for approval prior to installation. Locate sprinkler heads in a consistent pattern with ceiling grids, lights, speakers, supply diffusers and return diffusers.

Provide all additional equipment, junction boxes, conduit, and labor to meet the requirements and intent of this specification.

2.2 PIPING MATERIALS

2.2.1 Type BCS - Black Carbon Steel

Pipe 1/8 through 2 inches: Schedule 40 furnace butt welded or electric-resistance welded black-carbon steel conforming to ASTM A53/A53M, ASTM A135/A135M, ASTM A795/A795M, Type F (furnace butt welded) or Type E (electric-resistance welded), Grade B.

Pipe 2-1/2 through 8 inches: Schedule 40 seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M, ASTM A135/A135M, ASTM A795/A795M, Type E (electric-resistance welded), Grade B, or Type S (seamless), Grade B.

Unions 2 inches and under: 300-pounds per square inch gage (psig) working

steam pressure (wsp) female, screwed, black malleable iron, with ground joint and brass-to-iron seat conforming to ASME B16.39

Standard Pipe Couplings: Extra-heavy screwed black steel.

Fittings 2 inches and under: listed to at least the maximum fire suppression distribution system working pressure (i.e. pump churn pressure plus water supply pressure), cast iron, screwed conforming to ASTM A126, Class A, and ASME B16.4.

Fittings 2-1/2 inches and larger: listed to at least the maximum fire suppression distribution system working pressure (i.e. pump churn pressure plus water supply pressure), wrought steel, buttweld fittings, wall thickness to match piping system, complying with ASME B16.9 and 150 pound steel flanges complying with ASME B16.5.

Provide elbows that are of the long radius type.

Provide grooved pipe couplings 2-1/2 inch and larger: listed to at least the maximum fire suppression distribution system working pressure (i.e. pump churn pressure plus water supply pressure) with a housing fabricated in two or more parts of black malleable-iron castings. Ensure grooved couplings do not require a specific torque setting for housing bolt installation. Provide piping that is grooved in accordance with AWWA C606, or the manufacturer's specifications, for proper installation of the grooved couplings used. Provide couplings of the same part number for use on a single system.

Provide coupling gaskets of molded synthetic rubber conforming to requirements of ASTM D2000. Provide coupling bolts that are oval-neck, track-head type with heavy hexagonal nuts, conforming to ASTM A183.

Grooved fittings 2-1/2 inch and larger: listed to at least the maximum fire suppression distribution system working pressure (i.e. pump churn pressure plus water supply pressure) fittings used with grooved couplings that are fabricated of black malleable-iron castings, and are of the same manufacture as the pipe couplings. If a manufacturer's standard-size malleable-iron fitting pattern is not available, use fabricated fittings; fabricate fittings from Grade B seamless-steel pipe and long-radius seamless welding fittings, with wall thickness to match pipe, conforming to ASTM A234/A234M and ASME B16.9.

Do not use bushings; only pre-manufactured concentric or eccentric reducing fittings or reducing tees/elbows can be used to reduce pipe size.

Pre-manufactured shaped welded outlets (weld-o-lets) can be used in lieu of "tee" fittings where the branch pipe outlet is at least one pipe diameter smaller than the main.

Do not use non-grooved products which rely in any way upon gasketing, clamps, straps, or setscrews for maintaining system integrity.

Do not use adjustable "drop nipples" which utilize an O-ring type seal arrangement.

2.3 SUPPORTING ELEMENTS

Provide piping system components and miscellaneous supporting elements, including, but not limited to, building-structure attachments; standpipe

equipment; supplementary steel; hanger rods, stanchions, and fixtures; vertical-pipe attachments; horizontal-pipe attachments; restraining anchors; and guides. Provide supporting elements suitable for stresses imposed by systems pressures and temperatures, natural, and other external forces. Include an additional 250 pound load at each anchor per NFPA 13.

Provide FM approved or UL listed supporting elements conforming to ASME B31.1, MSS SP-58, and ASME B16.34.

2.3.1 Building-Structure Attachments

2.3.1.1 Anchor Devices, Concrete and Masonry

Conform anchor devices to CID A-A-1922, CID A-A-1923, CID A-A-1924A, CID A-A-1925, CID A-A-55614 and CID A-A-55615:

Group I: Shield, expansion (lead, bolt, and stud anchors)

Group II: Shield, expansion (bolt anchors), Type 2, Class 2, Style 1 or 2

Group III: Shield, expansion (self drilling tubular expansion shell bolt anchors

Provide adjustable positions for cast-in floor-mounted equipment-anchor devices.

Do not use powder-actuated anchoring devices to support mechanical-systems components.

2.3.1.2 Beam Clamps

Provide beam clamps that are center-loading Types 21, 28, 29, and 30, UL listed, cataloged, and load-rated commercially manufactured products.

Type 20 beam clamps can be used for pipe 2 inch and under.

Where Type 25 beam clamps are used, use two per point of pipe support.

2.3.1.3 C-Clamps

Do not use C-clamps.

2.3.1.4 Inserts, Concrete

Provide concrete inserts in accordance with the requirements of MSS SP-58 for Type 18. When applied to piping in sizes 2-inch iron pipe size (ips) and larger, and where otherwise required by imposed loads, insert and wire a 1-foot length of 1/2-inch reinforcing rod through wing slots.

2.3.2 Horizontal-Pipe Attachments

2.3.2.1 Single Pipes

Support piping in sizes up to and including 2-inch ips by Type 1, 5, 6, 7, 9, 10, 11, or 12 solid, split-ring, or band type attachments.

Support piping in sizes 2-1/2 inches and larger by Type 1, 2, 3, or 4

attachments or with Type 41 or Type 49 pipe rolls.

2.3.2.2 Parallel Fire-Protection Pipes

Use trapeze hangers fabricated from approved structural steel shapes, with U-bolts, when so specified. Provide structural-steel shapes that conform to supplementary steel requirements or provide supports that are commercially available, approved proprietary-design rolled steel.

2.3.3 Vertical-Pipe Attachments

Provide single Type 8 vertical-pipe attachments.

2.3.4 Hanger Rods and Fixtures

Use only circular solid cross section rod hangers to connect building structure attachments to pipe-support devices. Use pipe, straps, or bars of equivalent strength for hangers.

Provide turnbuckles, swing eyes, and clevises as required by support system to accommodate temperature changes, pipe accessibility, and adjustment for load and pitch.

2.3.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, design and fabricate such supplementary steel in accordance with AISC/AISI 121.

Provide supplementary steel that is hot dipped galvanized or otherwise protected from corrosion as acceptable to the Contracting Officer.

2.4 SPRINKLER RISER EQUIPMENT

Provide UL listed or FM approved Riser alarm equipment for fire-protection use.

2.4.1 Standard Check Valve

Provide check valve that is UL listed or FM approved standard swing-check type with elastomer-disc seat. Provide check valve that has a ductile iron body with flanged or grooved ends and is of the clear opening type with flanged inspection and access cover plate for sizes 4 inches and larger. Provide check valve that is able to be installed vertically or horizontally, and that is rated for 300 psi working pressure. Provide clapper that is type 304 stainless steel, Teflon-coated hot-rolled steel, ductile iron, coated ductile iron, or bronze with field replaceable EDPM or Nitrite seal, with nickel or bronze seat. Provide a valve with springs, hinge shafts and retaining rings that are stainless steel. Provide a valve that has a valve body manufacturer painted with a corrosion resistant non-lead coating.

2.4.2 Wet Pipe Valve

Wet-pipe sprinkler systems require a UL listed or FM approved OS&Y isolation valve with tamper switch, check valve, flow switch and test/drain valve for each floor, as indicated on the contract drawings, complete with standard accessories and trim necessary to give alarm,

supervisory, and trouble signals. Provide all necessary piping, fittings, and valves for proper operation of the systems, including pressure gauges immediately before and after the check valve..

2.5 WATER FLOW ALARM DEVICE

Provide water flow alarm devices that are UL listed for the particular type of system. Wire water flow switch to make or break a circuit on rise of water pressure. Provide water flow switch that has an integral field adjustable 0-90 second retard feature, and activates within 60 seconds, plus or minus ten (10) seconds upon opening of the inspectors test station.

Provide water flow alarm device that has a design working pressure of 300 psi, include two (2) sets of single pole, double throw contacts rated for not less than 2.0 amps at 30 VC. Provide housing that is die cast, suitable for both indoor and outdoor use and includes knockouts for conduit connections.

2.6 PRESSURE GAUGE

Provide pressure gauge with a 3-1/2" minimumdiameter, brass or stainless steel case with chrome finish, glass or polycarbonate window, brass dial with white background, black markings, dual units (English and Metric), phosphor bronze bourdon tube, brass precision geared movement, plus or minus 3 percent accuracy, 300 psi working pressure, and three-way globe style gauge isolation valve with plugged end.

2.7 INSPECTOR'S TEST

Provide an inspector's test valve that is a three-position (OFF-TEST-DRAIN) combination test, drain, and pressure relief device with bronze body, bronze ball valve, one quarter turn handle, integral sight glass (on discharge side), and internal corrosion resistant orifice, sized to match the sprinkler head orifice size. Ensure pressure relief device is factory set to relieve pressure at the maximum system working pressure at the prespective elevation of the riser..

2.8 CLASS 1 STANDPIPE

Provide an automatic Class 1 standpipe system as established by NFPA 14, with 2-1/2 inch, 175-psi hose connections in the stairwells, at the locations indicated on the contract drawings. Hydraulically design the standpipe systems to provide a minimum water flow rate of 500 gpm, with a pressure of 75 psig. Base hydraulic calculations and pipe sizes for the standpipe system on providing 500 gpm for the first standpipe and 250 gpm from the most remote valve on each additional standpipe, with the total not to exceed 1000 gpm.

2.9 FIRE DEPARTMENT CONNECTIONS

Provide hose connections that have National Fire hose standard-thread form and rocker lugs in accordance with NFPA 1963. Provide hose connection sizes and threads that are compatible with the equipment used by the fire department serving the facility.

2.9.1 Wall Siamese

Provide unit that has a cast brass or bronze flush-mounted escutcheon-plate with two 2-1/2inch, fire-department, swivel, female

inlets; double-clapper valves; rocker-lug caps and chains; and cast-in function-identifying lettering. Provide model that has chrome-plated or polished surface finish in accordance with ASME A112.18.1/CSA B125.1.

2.10 SPRINKLER HEADS

2.10.1 Head Types

Use standard 1/2-inch orifice sprinkler heads, except that 17/32-inch heads can be used where required by hydraulic calculation. All sprinkler heads must be rated for 300 pci.

For concealed heads use heads with a low profile, small diameter cover plate with a factory applied finish to match suspended ceiling tiles.

Pendent heads are required to be located in the center of the suspended ceiling tiles. Provide return bends or an FM approved flex head commercial ceiling sprinkler assembly with a maximum overall length of 7 feet.

Provide concealed pendent type sprinkler heads in all areas with a finish ceiling (acoustic tile, hard ceiling, etc.). Provide cover plate with a factory applied finish to match adjacent ceiling finish as closely as possible. For example, white for areas with white acoustic ceilings, black for upper ceiling in cafeteria seating area. The metal pan ceilings in the lobbies (see FP drawings) have a custom color. Submit color samples to the Architect and Contracting Officer for approval prior to furnishing paint to sprinkler manufacturer.

Provide upright type heads in unfinished areas or above suspended ceilings.

Use dry pendent or sidewall (as appropriate to the application) type heads for areas prone to freezing, such as walk in coolers or loading docks used for storage.

Where needed (for example, exterior locations), provide corrosion-resistant heads that are Nickel-Teflon coated, or manufacturer coated with an equivalent UL listed or FM approved corrosion-resistant coating.

2.10.2 Temperature Rating

Provide fusible links that have ordinary temperature classification, except where otherwise indicated or in locations defined in NFPA 13 as requiring intermediate or high temperature heads.

2.10.3 Spares

Furnish spares for each type of sprinkler head, complete with appropriate storage cabinet and wrench. Provide quantity of spare heads in accordance with NFPA 13. Mount cabinet next to riser or other location as directed by the Contracting Officer.

2.10.4 Head Protection

Protect heads with paper or plastic bags during painting operations. Immediately remove protection upon finishing painting operations.

Provide steel wire head guards wherever mechanical damage could occur.

Provide head guards UL listed or FM approved for use with the sprinkler heads installed. Provide head guards with a manufacturer applied red finish, except where head guards UL listed or FM approved for use with the sprinkler heads installed do not come in a manufacturer applied red finish.

Provide water shields of cold rolled galvanized steel, and install on all heads located beneath other heads within their spray areas. Provide shields with red finish.

2.11 VALVES

2.11.1 Aboveground

Provide FM approved or UL listed gate, globe, and check valves (all sizes).

Provide FM approved ball valves, 2 inches and under, rated to 300 psi, with provisions to wire or lock handle in place where a critical alarm function is isolated.

Provide gate valves that are of the outside screw and yoke configuration with cast iron body and wedge and bronze yoke bushing, seat ring and face ring. Provide gate valves with a solid wedge, constructed of cast iron or bronze. Provide valves that have flanged or grooved ends and are rated for at least the maximum system working pressure for non-shock cold water.

Provide angle valves (for main drain) of the screwed or union bonnet type that have bodies constructed of bronze with a bronze disk. Provide angle valves having rubber disk seats and screwed ends rated for at least the maximum system working pressure for non-shock cold water.

Supervise all control and isolation valves using a tamper switch, except for OS&Y valves on double check valve backflow prevention assemblies, unless otherwise directed by the AHJ.

2.12 MISCELLANEOUS MATERIALS

2.12.1 Bolting

Provide flange and general-purpose bolting that is hex-head and conforms to ASTM A307, Grade B. Provide heavy hex-nuts that conform to ASTM A563. Square-head bolts and nuts are not acceptable.

2.12.2 Escutcheons

Provide escutcheons manufactured from ferrous metals. Provide only chrome-plated escutcheons, except when AISI 300 series corrosion-resistant steel is provided. Provide metals and finishes conforming to ASME A112.18.1/CSA B125.1.

Provide escutcheons that are one-piece type where mounted on chrome-plated pipe or tubing and one-piece or split-pattern type elsewhere. Provide escutcheons that have internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.12.3 Flange Gaskets

Provide gaskets that are suitable for the intended use and contain no asbestos.

2.12.4 Pipe-Thread Compounds

Use tetrafluoroethylene tape or other suitable compounds.

2.13 FIRE-PROTECTION SYSTEM IDENTIFICATION

Provide a coordinated system of piping and equipment identification which includes the following:

Framed and plastic-protected diagrammatic layout of all piping systems, identifying and locating piping, equipment, and valves. Where existing systems are being modified, bring existing layouts up to date.

Metal-tag-identified major valves, piping-system components, and equipment

Metal identification plate at controlling alarm valve identifying system and area protected

Service-labeled piping

2.13.1 Diagrams

Provide chart listing of equipment by designation number and show pertinent data. Provide diagrams that are neat, mechanical drawings mounted in extruded aluminum frames, with 1/8-inch thick acrylic plastic protection. Provide at a location directed by the Contracting Officer. Provide minimum of one mounted chart and diagram, plus one extra copy of each, for each fire-protection system.

2.13.2 Metal Tags

Install Identification tags made of brass or aluminum and indicating function of valve or similar component on each system device. Provide tags that are not less than 2 inches in diameter and that have stamped markings.

Provide equipment with metal identification tags bearing an equipment designation number matching the drawing or diagram designations.

Secure tags to valve or equipment items with 12-gage galvanized wire.

Provide risers with a stamped metal tag containing the hydraulic design data. Also identify main drain and inspectors test stations using metal nameplates with minimum 2 inch high lettering chained to the valve.

2.13.3 Service Labeling

Label piping, including that concealed in accessible spaces, to designate service. Provide labels with an arrow or arrows to indicate flow direction. Provide labels or tag designations as follows:

SERVICE	LABEL OR TAG DESIGNATION
Main sprinkler supply	MAIN SPRINKLER SUPPLY
Sprinkler riser number	SPRINKLER RISER NO.

SERVICE	LABEL OR TAG DESIGNATION
Sprinkler branch	SPRINKLER BRANCH
Standpipe equipment	STANDPIPE

Provide labels and arrows in accordance with the following:

Each point of entry and exit through walls

Each change in direction

In congested or hidden areas, at each point required to clarify service or indicate hazard

In long straight runs, locate labels at a distance visible to each other, but in no case can the distance between labels exceed 40 feet.

Provide label lettering to be 2 inches high. Where the size of pipes is 2-1/2-inch outside diameter and smaller, attach labels to 16-gage aluminum sheet that is attached to the pipe with 12-gage galvanized wire. Provide labels that are legible from the primary service and operating area.

Provide labels that are made of self-sticking plastic film designed for permanent installation. Provide labels that have red letters on white background.

Do not construe label and valve tag schedule above as defining or limiting the work. Label all piping systems.

2.14 PAINTING

Furnish equipment of the manufacturer's standard product with the manufacturer's standard finish coat.

Refer to Painting subpart in Execution Part of this specification section for additional painting requirements.

2.15 MAIN DRAINS

Provide dedicated drain piping at riser to discharge to the building exterior or to discharge to storm pipe of adequate size to readily accept the full flow from each drain under maximum pressure. Select discharge location to avoid creating a nuisance or hazardous condition and that is acceptable to the Contracting Officer. For multi-story buildings using a common drain system, increase drain size by one pipe size as required by NFPA.

Sleeve and caulk penetrations of exterior walls. Provide penetrations of exterior walls no greater than 24 inches and no less than 6 inches above grade. Provide drain lines that terminate in a 45 or 90 degree elbow turned down discharging to an 18 inch concrete splash block.

PART 3 EXECUTION

3.1 GENERAL

Install system materials and equipment in accordance with the

recommendations and provisions of NFPA 13, NFPA 14, and NFPA 24, and related Codes and Standards contained herein. Perform work in the presence of the Contracting Officer who will be notified by the Contractor 48 hours in advance of the start of work.

Provide licensed fire protection sprinkler contractors, licensed for such work in the state where the work is to be performed, to perform all installation work.

Riser locations, pipe sizes, and the number of risers shown on the drawings is approximate in nature. Coordinate final riser location with the building construction, system design, Code requirements, and water supply limitations and maintenance requirements. The number of risers shown on the documents are the minimum to be provided. Indicate on Contractor's shop drawing submittal the exact location and number of risers approved by the Contracting Officer.

For heads which could be damaged, provide wire head guards. For heads located beneath other heads where the spray from the upper head could cool the lower head, provide water shields. For locations where existing building elements could disrupt sprinkler or nozzle spray patterns, provide multiple levels of protection.

Provide return bends for all pendent sprinkler heads.3.2 ABOVEGROUND PIPING-SYSTEMS INSTALLATION

Run piping parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting can be removed between adjacent pipes and so that there is not less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Arrange hangers on different adjacent service lines running parallel to be in line with each other and parallel to the lines of the building.

Base load rating for pipe-hanger supports on all lines filled with water. Do not exceed slope gradient of pipe for deflection per span. Install schedule 40 and heavier ferrous pipe supports in accordance with the following minimum rod size and maximum allowable hanger spacing. For concentrated loads such as valves, reduce allowable span proportionately.

PIPE SIZE (INCHES)	ROD SIZE (INCHES)	HANGER SPACING FOR STEEL PIPE (FEET)
1	3/8	8
1-1/4	3/8	12
1-1/2	3/8	15
2-1/2 to 3-1/2	3/8	15
5	1/2	15
6	1/2	15
8	1/2	15

Support vertical risers at the base where possible and at intervals

specified. Guide piping for lateral stability as necessary. Place clamps under fittings wherever possible. Support carbon-steel at each floor at not more than 15 feet intervals for pipe 2 inches and smaller, and at not more than 20 feet intervals for pipe 2-1/2 inches and larger.

Securely support piping with allowance for thrust forces and thermal expansion and contraction and do not subject to mechanical, chemical, irrational, or other damage, in conformance with ASME B31.1.

Extend riser main drain piping full size to discharge outdoors in a location approved by the Contracting Officer.

Install 2-1/2 inch fire hose connection valves for the Class I standpipe at 4'-0" above the finished floor, measured from the top of the valve discharge outlet.

The intent is for piping to slope back towards the riser or the auxiliary drains to allow for drainage. Where trapped piping is unavoidable, provide auxiliary drains.

Install grooved couplings in accordance with manufacturer's instructions and provide means for the government inspector to access and verify proper installation. Provide access to piping materials prior to installation for the government inspector to verify proper grooves exist on all piping with grooved ends.

Locate inspector's test valve approximately 5 feet above finished floor. Provide inspector's test valve for each sprinkler system, or portion thereof equipped with an alarm device, for testing purposes. Locate inspector's test valve at the hydraulically most remote portion of the sprinkler system. Provide inspector's test piping that discharges to the building exterior. Do not discharge to janitors sinks and similar locations.

Provide penetrations of exterior walls that are no greater than 24 inches and no less than 6 inches above grade, and are sleeved and caulked. Terminate inspector's test discharge in a 45 or 90 degree elbow turned down, discharging to an 18 inch concrete splash block. Size inspector's test lines to be capable of development of the design flow from one sprinkler without creating excessive back pressure.

3.3 SOUND STOPPING

Provide effective sound stopping and adequate operating clearance to prevent structure contact where piping penetrates walls, floors, or ceilings; into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces include space above ceiling where no special acoustic treatment of ceiling is provided. Finish penetrations to be compatible with surface being penetrated.

Sound stopping and vapor-barrier sealing of pipe shafts and large floor and wall openings can be accomplished by packing with properly supported mineral fiber insulation or by foaming-in-place with self-extinguishing, 2-pound density polyurethane foam to a depth not less than 6 inches. Finish foam with a rasp. Provide vapor barrier that is not less than 1/8-inch thickness of vinyl mastic applied to visible and accessible surfaces.

3.4 FIRE STOPPING

Seal through-penetrations in fire walls, partitions, or any floors to allow passage of cables, ducts, pipes and conduits with a "fire stopping assembly" that is UL listed or FM approved, with a fire-resistance rating equal to the fire resistance rating of the walls, partitions, or floors, in accordance with NFPA 251. For sealing purposes, consider all floors to have a fire-resistance rating of 2 hours. Seal openings no longer required with a material of equal or greater fire resistance to that of the walls, partitions, or floors.

3.5 SLEEVES

Provide sleeves where piping passes through roofs, masonry or concrete walls, or floors.

Continuously weld or braze sleeves passing through steel decks to the deck.

Provide sleeves extending through floors, roofs, or load-bearing walls, and sleeves through fire barriers that are continuous and fabricated from Schedule 40 steel pipe with welded anchor lugs. Form other sleeves by molded linear polyethylene liners or similar materials that are removable. Provide sleeves with diameters that are large enough to accommodate pipe, insulation, and jacketing without touching the sleeve, and additionally provide a minimum 3/8-inch clearance. Provide sleeve that accommodates mechanical and thermal motion of pipe to preclude transmission of vibration to walls and generation of noise.

Pack solid the space between a pipe and the inside of a pipe sleeve or a construction surface penetration with mineral fiber conforming to ASTM C592 wherever the piping passes through firewalls, equipment-room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction-surface penetrations occur between conditioned and unconditioned spaces, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction-surface penetration with an elastomer caulk to a depth of 1/2 inch. Provide oil and grease free surfaces to be caulked.

Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

3.6 ESCUTCHEONS

Provide escutcheons at penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, provide escutcheons on both sides of the partition. Where suspended ceilings are installed, provide plates at the underside only of such ceilings. Provide escutcheons that are chrome plated in occupied spaces and that conceal openings in building construction. Firmly attach escutcheons.

3.7 PAINTING

Bring manufacturer's standard-finish equipment surfaces damaged during construction to as-new condition by touchup or repainting to the satisfaction of the Contracting Officer, or replace with new undamaged equipment at no additional cost to the Government.

Thoroughly clean and paint with one coat of primer paint pipe hangers, supports, and other iron work in concealed spaces.

Thoroughly clean and give all automatic sprinkler piping, valves, and appurtenances, a prime coat and two coats of enamel, color No. 11105 (red) in accordance with MIL-STD-101 and FED-STD-595.

3.8 ELECTRICAL WORK

Provide electrical work that is specified in DIVISION 26 ELECTRICAL for control system wiring under Section 28 31 00.00 98 FIRE DETECTION AND ALARM and this section in accordance with UL 6 and NFPA 70. Use rigid metal conduit or intermediate metal conduit, except that electrical metallic tubing can be used in dry locations not enclosed in concrete or where not subject to mechanical damage.

3.9 SYSTEM TESTING

Prior to acceptance of the work, test completed systems in the presence of the Contracting Officer. Upon approval, provide certificates of testing.

Prior to filling any system with water for a hydrostatic test or after minor repairs or modifications, the Contractor shall perform a 2 hour test with air at 40 psig demonstrating 0 psig leakage over 2 hours.

Provide hydrostatic Pressure tests, unless otherwise specified. Use only potable water for testing.

Full opening of the inspector's test connection has to activate the riser water flow alarm device indicator and deliver a steady stream of water at the test outlet through a calibrated orifice equivalent in diameter to a single system sprinkler head.

Government will supply testing water at a location determined by the Contracting Officer, but the Contractor is responsible for approved disposal of test water.

Prepare and maintain test records of piping-system tests. Provide records that show personnel responsibilities, dates, test-gage identification numbers, ambient and test-water temperatures, pressure ranges, rates of pressure drops, and leakage rates. Each test acceptance requires the signature of the Contracting Officer.

3.9.1 Test Gages

Provide test gauges that have 4-1/2-inch dials or larger with accuracy of plus or minus 1/2 of 1 percent of full-scale range and dial graduations and pointer width compatible with readability to within one-half of the accuracy extremes. Include maximum permissible scale range for a given test to be such that the pointer during a test can only have a starting position at midpoint of the dial or within the middle third of the scale range. For each test gage, include a table indicating test gauge accuracy certification and corrections made within 90 days prior to the test, the test gage number, and the project number.

3.9.2 Test and Acceptable Criteria

Hydrostatically test above ground systems at 200 psi or where the maximum normal working pressure exceeds 150 psi, test the system at the maximum

normal working pressure plus 50 psi. Maintain the applied pressure without further addition of test media for not less than 2 hours. Maximum allowable pressure drop is 0 psi.

Test underground systems, rubber jointed ferrous-pipe water systems at 200 psi, or where the maximum normal working pressure exceeds 150 psi, test the system at the maximum normal working pressure plus 50 psi. Maintain the applied test pressure for not less than 2 hours. Maximum allowable pressure drop is 2 psi.

Test backflow prevention connected to potable-water systems and system devices for proper functioning under conditions normal to their application.

Repair dripping or weeping joints.

3.10 DISINFECTION

Disinfect water piping, including valves, fittings, and other devices, with a solution of chlorine and water. Solution cannot contain less than 50 parts per million (ppm) of available chlorine. Hold solution for a period of not less than 8 hours, at which time the solution has to contain a minimum residue of 2 ppm of available chlorine or the system will be re-disinfected. After successful disinfections, thoroughly flush the piping before placing into service. Water for disinfecting, and flushing will be furnished by the Government.

3.11 CLEANING AND ADJUSTING

At the completion of the work, thoroughly clean all parts of the installation. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that accumulated from the installation and testing of the system. Adjust automatic control devices for proper operation.

3.12 AS-BUILT DRAWINGS

Submit As-Built drawings for approval 21 days prior to the acceptance testing phase of the project as described in the paragraph entitled, "System Testing," of this section. Provide two (2) sets of magnetic media as-built drawings in .DWG or .DGN electronic format, and hard copies of all new and revised software and drawings with the submittal. Document on as-Built drawings the final system configuration including deviations from and amendments to the drawings, and field installation changes, concealed and visible.

3.13 OPERATION AND MAINTENANCE

Submit Operation and Maintenance Manuals, grouped by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to performing acceptance tests.

-- End of Section --

SECTION 21 23 00.00 98

WET-CHEMICAL FIRE-EXTINGUISHING SYSTEMS
12/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A106/A106M	(2011) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 17A	(2009; Errata 09-1) Standard for Wet Chemical Extinguishing Systems
NFPA 72	(2013) National Fire Alarm and Signaling Code
NFPA 96	(2011) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

UNDERWRITERS LABORATORIES (UL)

UL 300	(2005) Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 SYSTEM REQUIREMENTS

1.2.1 Design Requirements

Provide a new pre-engineered wet chemical fire extinguishing systems for protection of new cooking equipment including exhaust hood, ducts, polution control unit on roof, and related work. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required and advisory provisions of the manufacturer's installation manual, NFPA 17A and NFPA 96, except as modified herein. In

each system include materials, accessories, and equipment necessary to provide each system complete and ready for use. Provide each system with full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed working drawings submitted for approval. Provide devices and equipment for fire protection service that are UL Fire Prot Dir listed or FM APP GUIDE approved for use with wet chemical fire extinguishing systems and meet the requirements of UL 300. In the NFPA publications referred to herein, consider the advisory provisions (statements reading "should") to be mandatory,and interpret reference to the "authority having jurisdiction" to mean the Kennedy Space Center, Fire Protection Engineer.

1.2.2 Detail Drawings

Submit electrical wiring diagrams and dimensioned or scaled piping layout showing components, pipe sizes, manual activation stations pipe lengths, nozzles, electrical power and gas isolation devices, and valve locations in relation to cooking appliances and fusible link locations.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit detailed computer generated drawings in DWG or DGN format of the pre-engineered wet chemical fire extinguishing system. In details include electrical wiring diagrams, and dimensioned or scaled isometric piping layout showing components, pipe size, pipe lengths, nozzles and valve locations in relation to cooking appliances and fusible link locations and submit for approval.

Submit Factory Installation Drawings for approval ten days prior to start of installation.

Submit Record (As-Built Conditions) computer generated drawings for approval ten (10) days prior to the acceptance testing phase of the project, as described in the paragraph entitled, "Formal Tests and Inspection," of this section.

Submit .DXF or .DWG format computer generated shop drawings, schematics and Record Drawings; G.

SD-03 Product Data

Submit Manufacturers Catalog Data for the following items:

Agent; G

Storage Cylinder; G

Fusible Links; G

Regulator; G

Electrical Equipment and Gas Line Shut-Off Devices; G

Release Mechanisms; G

Blow-Off Caps; G

Discharge Nozzle; G

Piping and Fittings; G

Manual Actuators; G

Remote Manual Pull Stations; G

Pressure Switches; G

Manufacturer's Installation Manuals; G

Pulley Elbows; G

SD-06 Test Reports

Provide testing of the system in accordance with paragraph entitled, "Field Quality Control," of this section.

Prepare a Test Procedure and Test Record Forms; G for conducting and recording complete test on the suppression system in accordance with manufacturer's requirements and these specifications. Submit the test procedure for approval to the Contracting Officer at least 30 days prior to the preliminary system test described in the paragraph entitled, "Preliminary Tests," of this section. In the test procedure identify the initial condition, each step or function in the test, required test results, and provide for recording test results on all equipment devices, and wiring to be tested. On test record forms also identify spaces for verification signature of official witnesses and dates of the test.

SD-07 Certificates

Qualifications of Installer; G

SD-08 Manufacturer's Instructions; G

Fire Extinguishing Systems; G

Submit the extinguishing system manufacturer's installation manual.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.4 ELECTRICAL WORK

Provide electrical work conforming to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING, except for control and fire alarm wiring. Fire alarm system wiring and components are specified in Section 28 31 00.00 98 FIRE DETECTION AND ALARM. Provide wiring in rigid metal conduit or intermediate metal conduit, except electrical metallic tubing

conduit can be provided in dry locations not enclosed in concrete or where not subject to mechanical damage.

1.5 QUALITY ASSURANCE

1.5.1 Qualifications of Installer

Qualifications of System Technician: Prepares installation shop drawings, and Record Drawings of as-built conditions, by or under the supervision of an individual who is experienced with the types of works specified herein, and is currently certified by the National Institute for Certification in Engineering Technologies as an engineering technician with minimum Level-III certification in Special Hazard System program. Submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.

Submit Record Drawings of as-built conditions for approval 21 days prior to the acceptance testing phase of the project as described in the paragraph entitled, "Formal Tests and Inspections," of this section. Provide (2) sets of magnetic media and hard copies of all new and revised software and drawings with the submittal. On Record Drawings document final system configuration including deviations from and amendments to the drawings, and field installation changes, concealed and visible.

1.5.2 Components

Provide components in the installation that are not more than one year old.

Provide devices and equipment for fire protection service that are UL Fire Prot Dir or FM APP GUIDE approved for their intended use and function.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver, store, protect, and handle products to site in such a manner as to prevent damage caused by dirt, debris, and weather. During storage of materials do not impact safety or work operations in areas adjacent to the storage site.

Deliver materials to the job site in sealed, original containers, each bearing the manufacturer's labels.

Do not accept materials that arrive at the site without labels, opened, damaged, or containing less material than specified for use.

Store materials in a well ventilated area at temperatures not exceeding 130 degrees F or less than 32 degrees F.

PART 2 PRODUCTS

2.1 PRE-ENGINEERED WET CHEMICAL FIRE EXTINGUISHING SYSTEMS

Provide systems conforming to NFPA 17A and NFPA 96, except as modified herein. Provide piping and accessories within the hood that are Schedule 40 stainless steel or chrome plated. Provide all other piping to be Schedule 40 galvanized steel, painted to match the adjacent surface. Exhaust hoods with grease extractors UL Fire Prot Dir listed or FM APP GUIDE approved are not required to have protection downstream of the grease extractors. Provide a wet chemical agent that is listed for

the particular system and recommended by the manufacturer of the system. Provide systems for protection of new cooking equipment, including exhaust hoods, ducts, and polution control unit for cooking equipment requiring protection by NFPA 96.

Use UL 300 as a guide to list all system components as part of the manufacturer's UL approved, integrated fire suppression system. Install systems within their maximum and minimum piping and temperature limitations as established by testing laboratories, and as published in the manufacturers installation manual, to comply with their UL 300 listing.

2.2 SYSTEM CONTROLS

Provide a system that can be mechanically actuateed by fusible links and by remote manual actuation stations connected to the extinguishing system release mechanisms by stainless steel cables. Arrange each system to automatically shut off the flow of fuel and electrical power to cooking appliances as indicated automatically, shutdown makeup air units is provided, and to automatically actuate the building fire alarm system as indicated. Provide gas valves that are UL listed and are of the manual mechanical reset type. Do not shut off electrical power to hood exhaust fans unless specifically required by the UL Fire Prot Dir listing or FM APP GUIDE approval. Provide operating instructions at all system remote manual actuation stations.

2.3 BUILDING FIRE ALARM CONTROL PANEL

Discharge of the extinguishing system is to actuate the fire alarm control panel in the same manner as other actuating devices in accordance with NFPA 72. Provide extinguishing system wiring connected to the fire alarm system in the same manner as other devices connected to the fire alarm system. Refer to Section 28 31 00.00 98 FIRE DETECTION AND ALARM for related requirements.

2.4 COMPONENTS

Provide a basic wet chemical suppression system that consists of a regulated release assembly, which includes a regulated release mechanism and a wet chemical storage cylinder housed within a single enclosure. Piping, fittings, discharge nozzles, blow-off caps, cartridges, agent, fusible links, and pulley elbows. Provide additional equipment to include remote manual pull stations, mechanical gas valves, pressure switches, and electrical switches for automatic electrical equipment and gas line shut-off devices.

2.4.1 Manual Actuators

Provide manual actuators that do not require a force of more than 40 lbs or a movement of more than 14 inches to secure operation. Provide all manual actuators with operating instructions. Permit these instructions to include the use of pictographs and have lettering at least 1/4 inch in height. Identify all remote manual operating devices as to the hazard they protect.

2.4.2 Electric Dual Snap-Action Switch

Provide UL listed electric dual snap-action switch(s). Make all electrical connections to the snap action switch wiring harness in junction boxes mounted adjacent to the stainless steel enclosure for the

wet chemical suppression system.

2.4.3 Distribution Piping

Provide distribution piping that is Schedule 40 black iron, chrome-plated or stainless steel pipe conforming to ASTM A53/A53M, or ASTM A106/A106M.

2.4.4 Wet Chemical Agent

Provide extinguishing agent that is a potassium carbonate, potassium acetate-base formulation designed for flame knockdown and securement of grease-related fires. Provide the agent in a plastic container, labeled with handling and usage instructions.

2.4.5 Agent Tank

Install the agent tank in a stainless steel enclosure. Provide a tank constructed of deep drawn carbon steel, finished in red enamel, 1.5 gallon or 3.0 gallon in size, as required by manufacturer's design. Provide tanks that have 100 psi working pressure, 300 psi minimum burst pressure.

2.4.5.1 Tank Adaptor

Provide tank adaptor assembly that is chrome-plated steel with a 1/4 inch NPT female inlet and a 3/4 inch, NPT male outlet.

2.4.5.2 Regulated Release Mechanism

Provide a spring-loaded mechanical/fusible link pneumatic type regulator capable of providing expellant gas supply to agent tank(s), that contains a factory installed regulator deadset at 100 psi and is compatible with mechanical and electrical gas shut-off devices.

2.4.5.3 Regulated Actuator Assembly

Provide expellant gas for additional tanks in systems requiring three or more tanks, complete with a factory installed regulator deadset at 100 psi.

2.4.5.4 Discharge Nozzles

Provide tested discharge nozzles which are listed for a specific application, and stamped with flow designation and tip part number. Provide nozzles equipped with a protective cap to keep the nozzle tip orifice free of cooking grease build-up.

2.5 IDENTIFICATION SIGNS

Provide red rigid plastic signs with engraved 0.25 inch high white lettering at each remote manual actuation station. Provide sign legends to read "Fire Extinguishing System" followed by a brief description of the equipment protected.

PART 3 EXECUTION

3.1 INSTALLATION

Provide equipment, materials, installation, workmanship, inspection, and testing in accordance with the manufacturer's installation manuals and maintenance manuals and NFPA 17A, except as modified herein.

3.1.1 Piping

Install piping in accordance with the manufacturers UL listing. Where possible, run piping concealed or otherwise located to minimize the potential of inadvertent damage. Install piping parallel or perpendicular to the line of buildings and within hoods.

Seal all piping, fittings, and connections with pipe tape. When applying pipe tape, start on second male thread and wrap the tape (two turns maximum) clockwise around the threads, away from the pipe opening. Do not allow tape to overlap the pipe opening as this could cause possible blockage of the gas pressure.

Properly support piping to withstand static and dynamic loading. Install piping to prevent contact of dissimilar metals.

3.2 FIELD QUALITY CONTROL

Perform tests to determine compliance with the specified requirements in the presence of the Contracting Officer. Test, inspect, and obtain government approval for piping before covering or concealing. Provide Test Procedure and Test Record Formsfor approval 21 days prior to formal testing and inspection.

3.2.1 Preliminary Tests

Upon completion and before final acceptance of the work, test each piping and fittings system by discharging a minimum of one storage cylinder of same size as system cylinder of compressed air or nitrogen (do not use wet chemical) to demonstrate the reliability and proper functioning of all pressure switches, electrical and gas shutoff features, and the discharge of gas from each system discharge nozzle. Individually test remote control stations and other components and accessories to demonstrate proper functioning. In testing also include automatic and manual actuation, fuel or electrical power shutoff, and automatic actuation of the building fire alarm system. When tests have been completed and corrections made, submit a signed and dated certificate, with a request for formal inspection and tests.

3.2.2 Formal Tests and Inspection

Ensure that the Contracting Officer and AHJ representative witness formal tests and approve systems before acceptance. Submit Record Drawings of As-Built conditions and a written request for formal inspection at least 21 working days prior to inspection date. Provide an experienced technician regularly employed by the system installer to be present during the inspection. At the inspection, repeat all of the required tests as directed. Provide nitrogen or compressed air and discharge each system to demonstrate uniform distribution of the wet chemical among the nozzles. Furnish nitrogen, or compressed air, and personnel for the tests. Refill and reset systems after tests have been completed.

3.3 OPERATION AND MAINTENANCE

Provide Operation and Maintenance Manuals, grouped by technical sections consisting of manufacturer's standard catalog data, as-built schematics,

testing and maintenance procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to acceptance test being performed.

-- End of Section --

SECTION 21 30 00.00 98

FIRE PUMPS
11/11

PART 1 GENERAL

This is a performance based specification with the Contractor responsible for providing engineering design, installation and testing associated with the work to be performed.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C500	(2009) Metal-Seated Gate Valves for Water Supply Service

ASME INTERNATIONAL (ASME)

ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.1	(2012; INT 2-6, 8-10, 13, 15, 17-25, 27-31 and 42-46) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM B135	(2010) Standard Specification for Seamless Brass Tube

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2013) Standard for the Installation of Sprinkler Systems
NFPA 20	(2013) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 24	(2013) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(2014) National Electrical Code
NFPA 72	(2013) National Fire Alarm and Signaling Code

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2003) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UNDERWRITERS LABORATORIES (UL)

UL 262	(2004; Reprint Oct 2011) Gate Valves for Fire-Protection Service
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 DEFINITIONS

a. Authority Having Jurisdiction(AHJ) - The Kennedy Space Center Fire Protection Engineer, whose opinion is final regarding interpretation of the National Fire Protection Association(NFPA) codes.

b. Delegated engineer - A Professional Engineer, as defined under Florida Statutes, Chapter 471, licensed to practice in the State of Florida.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Piping Layout and Sensing Piping Arrangement; G

Pump Room; G

SD-03 Product Data

Fire Pumps; G

Jockey Pump; G

Driver; G

Fire Pump Controller; G

Jockey Pump Controller; G

Pipe and Fittings; G

Valves; G

Hose Valve Manifold Test Header; G

Pipe Hangers and Supports; G

Automatic Transfer Switches; G

Surge Protective Devices; G

SD-07 Certificates

Qualifications of Welders; G

Qualifications of Installer; G

Contractor's State Certification; G

Signed and Dated Flushing Certificate; G

Preliminary Test Certificate; G

Final Test Certificate; G

Manufacturer's Certified Test Characteristic Curves for Each Pump; G

SD-10 Operation and Maintenance Data

Fire Pumps; G

Driver; G

Fire Pump Controller; G

Valves; G

Operation and Maintenance Manuals; G

SD-11 Closeout Submittals

Posted Operating Instructions; G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications of Welders

Submit certificates of each welder's qualifications prior to site welding; do not provide certifications that are more than one year old.

1.4.2 Qualifications of Installer

Qualifications of System Technician: Prepare installation drawings, shop drawings and as-built drawings, by or under the supervision of, an individual who is experienced with the types of work specified herein, and is currently certified by the National Institute for Certification in Engineering Technologies (NICET 1014-7) as an engineering technician with minimum Level-III certification in Automatic Sprinkler System layout program. Submit data for approval showing the name and certification of all involved individuals with such qualifications prior to submittal of drawings. Provide a Florida Contractor's State Certification as a Class I, Fire Pump Installation Services by the installing fire pump contractor.

1.4.3 Preliminary Test Certificate

When preliminary tests have been completed and corrections made, submit a signed and dated certificate with a request for a formal inspection and tests.

1.4.4 Components

Do not include components installed under this contract that are more than one (1) year older than the date of installation.

Provide UL Fire Prot Dir listed or FM APP GUIDE approved devices and equipment for fire protection services.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide fire pumps and associated equipment complete and ready for operation. Provide equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing in accordance with NFPA 20, NFPA 70, and NFPA 72, except as modified herein.

2.1.1 Design Requirements

Prepare working drawings on sheets not smaller than 24 by 36 inches. Sign and seal drawings by a registered engineer, licensed to practice in Florida. In addition to hard copies, provide an electronic .DWG, .DXF or .DGN computer format on a CD ROM.

2.1.1.1 Pump Room

Show detail plan view of the pump room including elevations and sections showing the fire pumps, associated equipment, and piping. Show piping schematic of pumps, devices, valves, pipe, and fittings. Provide an isometric drawing of the fire pump and all associated piping. Show point to point electrical wiring diagrams. Show piping layout and sensing piping arrangement. Show engine fuel and cooling system. Include:

a. Pumps, drivers, and controllers

b. Hose valve manifold test header

c. Circuit diagrams for pumps

d. Wiring diagrams of each controller

2.1.1.2 Fire Pumps

Provide electric motor driven horizontal split-case factory skid mounted fire pump. Provide fire pump that are manual pushbutton start and stop and are automatic start and automatic stop. Provide each pump with capacity at rated head to be not less than 1000 gpm at a discharge pressure of 90 psig. Furnish with each pump not less than 150 percent of rated capacity at not less than 65 percent of total rated head. Provide pumps that are of the centrifugal horizontal split case with automatic air release type.

Provide fire pump bearings that have an L-10 rating of not less than 5,000

hours, based on load ratings and fatigue life.

Submit manufacturer's certified test characteristic curves for each pump.

2.1.1.3 Electrical Motors, Controllers, Contactors, And Disconnects

Furnish motors, controllers, contactors, and disconnects with their respective pieces of equipment. Provide motors, controllers, contactors, and disconnects as specified herein and that have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING. Provide controllers and contactors that have a maximum of 120-volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, provide additional electrical service and related work required for an operational system.

2.1.1.4 Electrical Work

Provide electrical power work associated with this section under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING except for control and fire alarm wiring. Provide Automatic Transfer Switch in accordance with Section 26 36 23.00 20 AUTOMATIC TRANSFER SWITCHES. Provide surge protective devices in accordance with Specification Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Provide fire alarm system under Section 28 31 00.00 98 FIRE DETECTION AND ALARM. Provide control wiring under this section in accordance with NFPA 20 and NFPA 70. Provide wiring in metal conduit of a type as specified in DIVISION 26 ELECTRICAL.

2.2 SYSTEM COMPONENTS

2.2.1 Fire Pumps

Provide a double suction type impeller, made of cast bronze, balanced hydraulically and dynamically, keyed to the shaft and securely retained in an axial position by positive mechanical means.

Locate suction and discharge connections on opposite sides of the lower half casing, allowing removal of the rotating element without disturbing the system piping connections.

Rate fire pump discharge flange for 175 pounds.

Provide a fire pump casting that is smooth, free of scale, lumps, cracks, sand holes, and defects of any nature, which make the casting unfit for it's intended use.

Provide the bolting of pressure-holding castings to be such that the maximum stress on any bolt does not exceed 1/4 the elastic limit of the material as computed by using the stress area and on the basis of the water pressure equivalent to the shut-off pressure effective over the area out of the centerline of the bolts.

Provide a sealed shaft with a stuffing box and packing with external water-seal piping. Provide stuffing box glands that exert uniform pressure on the packing.

Furnish replaceable shaft sleeves constructed of a corrosion-resistant material.

Provide the following accessories:

a. Suction eccentric reducer, with the flat side on top, at the pump inlet. Provide a reducer of cast iron or wrought steel material with flanged connections.

b. Automatic air release valve with threaded inlet and discharge connections, to vent air from the pump casing.

c. Casing relief valve, non-adjustable bronze-type, set above the design pressure anticipated but below the combined suction pressure and shut-off head pressure, to discharge water from the system to avoid pump overheating. Ensure valve conforms to NFPA 20.

2.2.2 Fire Pump Alarms

Provide audible and visual alarms as required by NFPA 20 on the controller. Provide remote supervision as required by NFPA 20, in accordance with NFPA 72 under Section 28 31 00.00 98 FIRE DETECTION AND ALARM. Provide weatherproof exterior alarm devices where shown. Provide alarm silencing switch and red signal lamp, with signal lamp arranged to come on when switch is placed in OFF position.

Activate alarm signal upon the following conditions:

a. Electric motor controller has operated into a pump running condition

b. Pump controller has been turned to manual or to off position

c. Loss of electrical power to electric motor starter

d. Phase reversal on line side of motor starter

2.2.3 Pressure Maintenance (Jockey) Pump

Provide a jockey pump with an UL listed full voltage combination motor controller to maintain a pressure of 165 psig on the system. Provide a pump that is in-line vertical shaft centrifugal type with rated discharge pressure of 10 gpm at 95 psig. Ensure the pump shut off pressure does not exceed the design working pressure of the system 175 psig. Start pump when the fire system pressure drops to 155 psig and stops when the pressure reaches 165 psig.

Rate the jockey pump to 300 psi . Provide drain and gauge tappings on the pump. Provide pump impeller that is hydraulically balanced, non-vapor-binding type, mechanically keyed to the shaft. Provide pump that has replaceable bronze impeller (casing) wear rings, threaded connections, mechanical seal, non-regreasable cast iron cartridge roller ball bearings, close-coupled to an open-drip proof motor.

Arrange pump to draw water from the suction supply side of the gate valve of the fire pumpas indicated and discharge into the system on the downstream side of the pump discharge gate valve. Provide an approved indicating gate valve of the outside stem and yoke (O.S.&Y.) type in the jockey pump discharge and suction piping. Provide an approved oil-filled with a pulsation snubber or glycerin filled pressure gauge and approved check valve in the jockey pump discharge piping. Provide a check valve that is a swing type with removable inspection plate.

2.2.3.1 Jockey Pump Controller

Provide a Jockey pump controller that is UL listed, completely assembled, wired, and tested at the factory. Provide a lockable disconnect switch adjacent to, or as an integral part of the jockey pump controller.

Provide a unit that is complete with:

a. Across-the-line magnetic starter equipped with overload protection

b. 3-pole fusible disconnect switch, H-O-A selector switch

c. 300 psi bourdon tube type pressure regulator, with independent high and low setpoints

d. Solid-state pressure switch with independent high and low adjustment for automatic starting and stopping

e. Pump run light

f. NEMA 2 enclosure with lockable handle

g. Automatic stop function

h. Minimum run time clock

i. Contacts for remote start.

Provide and connect a sensing line to the pressure maintenance pump discharge piping between the control valve and the check valve. Conform the sensing line in accordance with the paragraph entitled, "Pressure Sensing Line," of this section. Completely separate the jockey pump sensing line from the fire pump sensing line(s). Provide an adjustable relay (0-60 minute) with a Form "C" NO/NC alarm contact such that if the jockey pump cycles off and then is restarted before the expiration of the relay timer, the alarm contact is energized and an excessive cycling alarm is sent to the FEMS and KCCS. Exceed start/stop pressure settings by those of the main fire pump(s). Also include a run timer to ensure the jockey pump runs for the minimum time, as recommended by the manufacturer of the jockey pump motor.

2.2.3.2 Pressure Sensing Line

Provide a completely separate pressure sensing line for each fire pump and jockey pump. Arrange the sensing line in accordance with Figure A-7-5.2.1 of NFPA 20. Provide a sensing line that has 1/2 inch H58 brass tubing complying with ASTM B135. Equip the sensing line with two (2) restrictive orifice unions each. Provide restricted orifice unions that are ground-face unions with brass restricted diaphragms drilled for a3/32 inch. Mount restricted orifice unions in the horizontal position, not less than 5 feet apart on the sensing line. Provide two (2) test connections that consist of two (2) brass 1/2 inch globe valves and 1/4 inch gauge connection tee arranged per NFPA 20. Equip one of the test connections with a 0 to 300 psi water oil-filled gauge. Connect sensing line to the pump discharge piping between the discharge piping control valve and the check valve.

2.2.4 Electric Motor Driver

Provide an electric motor drive by the fire pump manufacturer, with the electrical characteristics indicated. Provide a motor that is open drip-proof (ODP), with a 1.15 service factor. Provide an electric motor that has an energy efficiency of 93 percent or greater.

Provide fire pump and jockey pump electrical motors, controllers, contactors, and disconnects as specified herein. Conform power supply to each motor and controller as indicated.

2.2.4.1 Motors

Provide motor power that is not less than the pump power requirements at all points on the pump operating curve.

2.2.4.2 Fire Pump Controller, Electric Driven

Conform the fire pump controller to meet NFPA 20 requirements for fire pump service.

Provide controllers for electric motor driven fire pump service and arrange for manual pushbutton and automatic starting and manual pushbutton shutdown and automatic shutdown following expiration of a minimum running period of 10 minutes, then begin the timing after all starting causes have returned to normal. Provide a controller that is completely terminally wired, ready for field connections, and mounted in a moisture resistant NEMA 2 enclosure arranged so that controller current carrying parts is not less than 12 inches above the floor. Provide controllers with sequential start timers as required by NFPA 20. Provide a NEMA rated starting contactor sized for the motor load.

Provide the controller with:

a. Digital pressure readout which displays water system pressure

b. Paperless recorder which records water pressure, time, and date for at least the previous 7 days into a non-volatile memory

c. Low voltage monitor which alarms when the starting and running voltage drops below the level required by NFPA 20

d. Motor overload monitor which alarms when the motor exceeds 125 percent of the full load motor current

e. Low pump room temperature monitor which alarms when the pump room temperature drops below 40 degrees F

Furnish controllers to include:

a. A built-in 0 to 300 psi bourdon tube type pressure switch with independent high and low setpoints

b. Automatic Transfer Switches

c. Automatic and manual start and manual stop pushbuttons

d. An adjustable minimum run timer

e. Power available light

f. Power monitoring sensing all phases for loss of any phase

g. Under voltage or phase reversal

h. Surge Protective Devices

i. Pump or motor running siqual

j. Controller connected to alternate source siqual

Provide controller with Form "C" dry contacts for remote monitoring of each condition required to be monitored by NFPA 20 and by this specification. Provide controller enclosures with legs that are a minimum of 12 inches long. Provide controller that is of the wye delta open transition starting type with a fault current interrupting capacity of 100,000 amperes RMS. Design controller for 100 horsepower (HP) at 480 volts and include service entrance label. Provide an approved power transfer switch to transfer emergency power to the fire pump.

2.2.5 Pressure Gauges

Provide pressure gauges that are a minimum of 3.5 inch in diameter, brass cased with chrome finish, glass or polycarbonate window, brass dial with white background, black markings, dual units (English and metric), phosphor bronze bourdon tube, brass precision geared movement, plus or minus 3 percent accuracy, 300 psi working pressure, and three-way globe style gauge isolation valve with a plugged end. Provide liquid filled gauges or pulsation dampers for gauges located at pumps.

2.3 ABOVEGROUND WATER PIPING SYSTEMS

Primary requirements for aboveground water piping system components, including piping, fittings, and valves, are defined in Specification Section 21 13 00.00 98, and all product and installation requirements apply wherever those components defined are used in relation to this specification section. Requirements below are for specific components only required where fire pumps are installed.

2.3.1 Valves

Provide valves of types listed or approved for fire protection service with flanged grooved or threaded end connections.

2.3.1.1 Circulating Relief Valve

Provide an adjustable circulating relief valve for each fire pump in accordance with NFPA 20.

2.3.2 Hose Valve Manifold Test Header

Construct manifold test header of steel pipe as specified in paragraph entitled "Aboveground Water Piping Systems," of this section. Provide ASME B16.5, Class 150 flanged inlet connection to hose valve manifold assembly. Provide an approved bronze hose gate valve with four 2.5 inch National Standard male hose threads with cap and chain; locate 3 feet above grade in the horizontal position for each test header outlet. Ensure metallic arc process welding is in accordance with ASME B31.1.

2.4 BURIED WATER PIPING SYSTEMS

2.4.1 Pipe and Fittings

Provide outside-coated, cement mortar-lined, ductile-iron pipe and fittings conforming to NFPA 24 for piping under the building and less than 5 feet outside of the building walls. Anchor the joints in accordance with NFPA 24; provide concrete thrust block at the elbow where the pipe turns up toward the floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. Minimum pipe size is 6 inches. Provide minimum depth of cover as required by NFPA 24, but no less than 3 feet. Provide piping more than 5 feet outside of the building walls to be provided under Section 33 11 00 WATER DISTRIBUTION..

2.4.2 Valves

Provide as required by NFPA 24. Ensure gate valves conform to AWWA C500 or UL 262 with cast-iron body and bronze trim and that open by counterclockwise rotation.

2.4.3 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Provide tape that is detectable by an electronic detection instrument. Provide tape in rolls, 3 inches minimum width, color coded for the utility involved, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Provide warning and identification that states CAUTION BURIED WATER PIPING BELOW or similar statement. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Bury tape with the printed side up at a depth of 12 inchesbelow the top surface of earth or the top surface of the subgrade under pavements.

2.5 PAINTING

Furnish equipment of the manufacturer's standard product with the manufacturer's standard finish coat.

Furnish other mechanical equipment with a shop-applied prime paint.

Paint piping in accordance with Specification Section 21 13 00.00 98 FIRE SUPPRESSION SPRINKLER SYSTEMS.

2.6 SUPPORTING ELEMENTS

Provide piping system components and miscellaneous supporting elements, including, but not limited to, building-structure attachments; standpipe equipment and fire hose cabinet stations; supplementary steel; hanger rods, stanchions, and fixtures; vertical-pipe attachments; horizontal-pipe attachments; restraining anchors; and guides. In accordance with Specification Section 21 13 00.00 98 FIRE SUPPRESSION SPRINKLER SYSTEMS. Provide supporting elements that are suitable for stresses imposed by systems pressures and temperatures, natural, and other external forces. Include an additional 250 pound load at each anchor per NFPA 13.

PART 3 EXECUTION

3.1 INSTALLATION

Conform equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing in accordance with NFPA 20, except as modified herein. Provide all materials required for a completely functional and operational system. Install piping straight and true to bear evenly on supports.

Install fire pumps, jockey pumps and controllers on minimum 6 inch thick concrete housekeeping pads. Anchor pumps to the housekeeping pads using leveling bolts and grouted with non-shrink grout. Anchor controllers to the pad, jockey pump controller can be of the wall mount type.

3.1.1 Pumps

Factory test the pump and motor combination prior to shipment. Cover the suction and discharge flanges with wood or metal blanks. Thoroughly clean and paint the pump with one coat of machinery enamel, and assemble and seal the entire pump unit in plastic for shipment.

Prior to fire pump testing, verify proper rotation and check for excessive noise or vibration. Install vibration isolation for the fire and jockey pump according to the manufacturers recommendations.

Install pumps with recommended clearances provided for service and maintenance. Provide capability to completely service the pump without breaking piping or motor connections.

Align the pump and motor with a dial indicator to within 1.97 mil misalignment tolerance.

3.1.2 Accessories

Unless otherwise indicated, include in pump assemblies suction and discharge isolation valves with tamper switches and discharge check valve. Rigidly connect suction and discharge piping. Provide strain relief coupling where pump and suction piping are installed on separate foundations.

Provide pressure gauges with gauge valves and equip with a pulsation snubber or fill with glycerin. Locate the gauges as close to the pump impeller as possible on each suction and discharge. Provide suction side gauge of the compound type.

Extend all drain and outlets from relief valves, drip rims, and similar items full size to discharge directly above floor drains. Provide drain piping that is Type "L" copper with soldered joints or galvanized Schedule 80 steel with threaded or welded joints.

Provide conduit, wiring, relays, contacts, and related devices for control signals between the fire pump controller, jockey pump controller and the remote alarm panel. Test each alarm point and control point.

3.1.3 Cleaning of Piping

Keep the interior and ends of new piping and existing piping affected by construction thoroughly cleaned of water and foreign matter. Keep piping

systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping and fittings so that water and foreign matter does not enter the pipes or fittings. Inspect piping before placing into position.

3.2 PIPE AND FITTINGS

Test, inspect, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for all connections. Make changes in piping sizes through tapered reducing pipe fittings; do not use bushings. Perform welding in the shop, field welding is not permitted. Photograph all piping prior to burying, covering, or concealing. Where further or more stringent direction is indicated in Specification Section 21 13 00.00 98 for installation of piping and fittings, it applied to installation of piping and fittings under this specification section, as well.

3.2.1 Threaded Connections

Provide jointing compound for pipe threads that is Teflon pipe thread paste; apply only on male threads. Provide exposed ferrous pipe threads with one coat of zinc molybdate primer applied to a minimum dry film thickness of one mil.

3.2.2 Pipe Hangers and Supports

Provide additional hangers and supports for concentrated loads in piping between hangers and supports, such as for valves.

3.2.2.1 Vertical Piping

Support metal piping at each floor, but at not more than 10 feet intervals.

3.2.2.2 Horizontal Piping

Support piping as follows:

MAXIMUM SPACING (FEET)										
Nominal Pipe Size (inches)	One and under	1.25	1.5	2	2.5	3	3.5	4	5	6
Copper Tube	6	7	8	8						
Steel Pipe	7	8	9	10	11	12	13	14	15	15

3.3 NAMEPLATES

Provide laminated plastic nameplates for equipment, gages, thermometers, and valves. Provide nameplates that are melamine plastic, 0.125 inch thick, black with white center core. Matte finish the surface and square the corners. Accurately align lettering and engrave into the white core. Provide nameplates with minimum size of 1 by 2.5 inches. Provide lettering with minimum of 0.25 inch high normal block style. Key the nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed by the Contracting Officer near each system. Furnish two copies of each chart and schedule. Identify each inscription's function. On equipment nameplates show the

following information:

a. Manufacturer, type, and model number;

b. Contract number and accepted date;

c. Capacity or size;

d. System in which installed; and

e. System which it controls.

3.4 FLUSHING

Flush all new pump suction and discharge piping at 150 percent of rated pump capacity. Where the pump installation involves more than one pump, provide the flushing volume to be the total quantity of water flowing when all pumps are discharging at 150 percent of their rated capacities. The new pumps can be used to attain the required flushing volume. Do not flush any underground piping by using the fire pumps. Continue flushing operations until water is clear, but for not less than 10 minutes. Submit a signed and dated flushing certificate with a request for field testing.

3.5 FIELD INSPECTIONS AND TESTS

3.5.1 Inspections

Prior to initial operation, inspect equipment and piping systems for compliance with drawings, specifications, and manufacturer's submittals.

3.5.2 Preliminary Tests

Use only potable water for testing. Perform tests on pumps, drivers, and equipment, including visual equipment checks to ensure compliance with approved detail drawings; pump start-run to ensure proper operation and to detect leakage of piping, valves, and fittings; sequence of operation check; verification that required pump accessories have been provided; test of pump alarm devices; and additional inspections and tests necessary to ensure that the entire pump installation is correct, complete, and ready for operation.

Hydrostatically pressure test each above ground piping system at 50 psig above maximum system static pressure or 200 psig, whichever is greater, for a period of 2 hours in accordance with NFPA 20. No drop in pressure or observed leakage is allowed.

Hydrostatically test below ground piping at not less than 200 psi pressure for not less than two hours, or at 50 psi in excess of the maximum static pressure when the maximum static pressure is in excess of 150 psi. Measure leakage in underground systems by pumping from a calibrated container at the required test pressure. For new piping, do not exceed a leakage rate of two quarts per hour per 100 gaskets or joints irrespective of pipe diameter. This rate can be adjusted upwards where the test section contains metal seated valves or dry barrel hydrants under pressure by the amounts specified in NFPA 24.

Upon completion of the preliminary test, submit a preliminary test certificate to the Contracting Officer.

3.5.3 Final Formal Inspection and Tests

The Contracting Officer and NASA AHJ will witness the final formal tests and approve all systems before they are accepted. Conduct tests in accordance with NFPA 20. Submit the request for formal inspection at least 15 days prior to the date the inspection is to take place. Ensure an experienced technician regularly employed by the pump installer is present during the inspection. Where pumps are engine driven, ensure an experienced technician regularly employed by the engine manufacturer capable of demonstrating that all engine trouble alarms and operating features perform as required is present. Provide portable radios, hoses, nozzles, calibrated pitot gauges, calibrated pressure gauges, digital tachometer, and volt/ammeter to conduct a complete fire pump acceptance test. Include in acceptance test a full water flow test. Secure all hoses and nozzles during the tests. Conduct water flow testing in a safe manner with no destruction to the existing facility or new construction. Include tests for 100 and 150 percent capacity flows and pressures, along with no-flow pressures for compliance with manufacturer's characteristic curves. At this inspection repeat the required tests as directed. Correct defects in the work, and make additional tests to demonstrate that the system complies with the contract requirements. Furnish appliances, equipment, water, electricity, instruments, connecting devices, and personnel for the tests.

The Government will furnish water for the tests. Upon completion of the final test, submit a final test certificate to the Contracting Officer.

3.5.4 Operational Testing

Perform system operating tests, valve operating test, fire pump/controller test, and jockey pump/controller test in accordance with NFPA 20. Ensure the controller manufacturer's representative and transfer switch manufacturer's representative is present.

3.5.4.1 Sequence

Set the jockey pump pressure switch to energize the jockey pump when the system pressure falls through the pressure deadband, and open upon re-pressurizing the system to the set point pressure. Upon further loss of pressure, the pressure switch for the lead fire pump is to close and start the main pump.

Provide the fire pump to start automatically whenever the pressure in the main system is reduced to 150 psig or manually when the starter is operated. Automatically shut down pump(s) if pressure is satisfied after a running time of 10 minutes, unless manually shut down.

Base final pressure settings upon actual performance during acceptance testing with approval of the Contracting Officer.

3.5.4.2 Testing

Perform testing of the automatic operation of the jockey and fire pump. Slowly partially open an inspectors test station until the jockey pump starts. Then fully close the inspectors test and restore the system to "normal" status. Then fully open the inspectors test station, which first starts the jockey pump then the lead fire pump. If the inspectors test station does not generate sufficient pressure loss when opened, use the main drain or other approved method to activate the pump.

3.5.4.3 Adjusting

Adjust and record the pressure switch setpoints and deadbands upon successful completion of the above test. Correct deficiencies such as rapid cycling of the jockey pump, activation of both fire pumps (non-sequential starting) and similar anomalies for final acceptance. Verify all trouble, supervisory and alarm conditions.

3.6 CLEANING AND ADJUSTING

At the completion of the work, thoroughly clean all parts of the system. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that accumulated from the installation and testing of the system. Adjust automatic control devices for proper operation.

3.6.1 Painting

Provide painting in accordance with Specification Section 21 13 00.00 98 FIRE SUPPRESSION SPRINKLER SYSTEMS.

3.7 DEMONSTRATION

3.7.1 Operating Personnel Instruction

Upon completion of the work and at a time designated by the Contracting Officer, provide the services of experienced technicians regularly employed by the manufacturer of the pumps and the drivers to instruct Government operating personnel in the proper operation and maintenance of the equipment for a period of not less than two separate four hour sessions on two separate days.

At the option of the Contracting Officer, all training sessions are documented by the Government using audio, visual, or a combination of methods. Contain all training information presented in the Operations and Maintenance Manuals.

3.8 OPERATION AND MAINTENANCE MANUALS

Submit operation and maintenance manuals, grouped by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to acceptance tests being performed.

Include manufacturers catalog data, installation instructions, maintenance manuals, wiring diagrams, and test results. Organize data in a three ring loose-leaf notebook binder, into sections with identifying tabbed dividers, a table of contents and identifying front and spline covers.

3.8.1 Posted Operating Instructions

Post operating instructions for all devices to include pumps, drivers, controllers, valves, and flow meters. Include warning statements as to actions that can take the system out of service, or that can cause accidental discharge and/or activation in the instructions.

-- End of Section --

SECTION 22 00 00

PLUMBING, GENERAL PURPOSE
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.10.3/CSA 4.3	(2011) Gas Water Heaters Vol.III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous
ANSI Z21.22/CSA 4.4	(1999; Addenda A 2000, Addenda B 2001; R 2004) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2010; INT 1 2011; Errata 2011, Errata 2011; Errata 2011, INT 2-12 2011, Errata 2011; Addenda A, B, C, G, H, J, K, O, P, S, Y, Z, BZ, CG, CI, AND DS 2012; INT 13 2012; Errata 2012, Errata 2012, Errata 2012, Errata 2012) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2008) Performance Requirements for Atmospheric Type Vacuum Breakers (ANSI approved 2009)
ASSE 1003	(2009) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1010	(2004) Performance Requirements for Water Hammer Arresters (ANSI approved 2004)
ASSE 1011	(2004; Errata 2004) Performance Requirements for Hose Connection Vacuum Breakers (ANSI approved 2004)
ASSE 1012	(2009) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent - (ANSI approved 2009)

ASSE 1013	(2009) Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers - (ANSI approved 2010)
ASSE 1018	(2001) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002
ASSE 1019	(2011) Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type (ANSI Approved 2004)
ASSE 1020	(2004; Errata 2004; Errata 2004) Performance Requirements for Pressure Vacuum Breaker Assembly (ANSI Approved 2004)
ASSE 1037	(1990) Performance Requirements for Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2005) Standard Methods for the Examination of Water and Wastewater
AWWA C606	(2011) Grooved and Shouldered Joints
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains
AWWA C652	(2011) Disinfection of Water-Storage Facilities

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2011) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2/B2.2M	(2010) Specification for Brazing Procedure and Performance Qualification

ASME INTERNATIONAL (ASME)

ASME A112.1.2	(2012) Standard for Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
ASME A112.14.1	(2003; R 2008) Backwater Valves
ASME A112.19.2/CSA B45.1	(2008; Update 1 2009; Update 2 2011) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME A112.19.3/CSA B45.4	(2008; Update 1 2009; Update 2 2011)

	Stainless Steel Plumbing Fixtures
ASME A112.19.5	(2011) Trim for Water-Closet Bowls, Tanks and Urinals
ASME A112.36.2M	(1991; R 2008) Cleanouts
ASME A112.6.1M	(1997; R 2008) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2001; R 2007) Standard for Floor and Trench Drains
ASME A112.6.4	(2003: R 2008) Roof, Deck and Balcony Drains
ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
ASME B16.12	(2009) Cast Iron Threaded Drainage Fittings
ASME B16.15	(2011) Cast Bronze Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2012) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2012) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(2011) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(2011) Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.29	(2007) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.34	(2009; Supp 2010) Valves - Flanged, Threaded and Welding End
ASME B16.4	(2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.50	(2001; R 2008) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME B31.1	(2012; INT 2-6, 8-10, 13, 15, 17-25, 27-31 and 42-46) Power Piping

ASME B31.5	(2010) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2005; R 2010) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IV	(2010) BPVC Section IV-Rules for Construction of Heating Boilers
ASME CSD-1	(2012) Control and Safety Devices for Automatically Fired Boilers

ASTM INTERNATIONAL (ASTM)

ASTM A105/A105M	(2011a) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A193/A193M	(2012) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A515/A515M	(2010) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2010) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A74	(2009) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A888	(2011) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B306	(2009) Standard Specification for Copper Drainage Tube (DWV)
ASTM B32	(2008) Standard Specification for Solder Metal
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B42	(2010) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B43	(2009) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B584	(2012a) Standard Specification for Copper Alloy Sand Castings for General

	Applications
ASTM B813	(2010) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B828	(2002; R 2010) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM B88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2005; R 2011) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C564	(2011) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM D2822/D2822M	(2005e1; R 2011) Asphalt Roof Cement
ASTM D3139	(1998; R 2011) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2007) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3311	(2011) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM E1	(2007) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM F477	(2010) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(2009) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(2011) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(1994; R 1995) Copper Tube Handbook

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2009) Accessible and Usable Buildings and Facilities
ICC IPC	(2009) International Plumbing Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z358.1	(2009) American National Standard for Emergency Eyewash and Shower Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-25	(2008) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2011) Butterfly Valves
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2011) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2008) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2011; Errata 2012) Motors and Generators
NEMA MG 11	(1977; R 2007) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2012) National Fuel Gas Code
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF/ANSI 61	(2012; Errata 1013; Addenda 2013) Drinking Water System Components - Health Effects

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA Fire Man	(2010) Firestopping: Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI G 101	(2010) Testing and Rating Procedure for Hydro Mechanical Grease Interceptors with Appendix of Installation and Maintenance
PDI WH 201	(2010) Water Hammer Arresters Standard

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508	(2009) Hose Clamp Specifications

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

PL 93-523	(1974; A 1999) Safe Drinking Water Act

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 430	Energy Conservation Program for Consumer Products
40 CFR 141.80	National Primary Drinking Water Regulations; Control of Lead and Copper; General Requirements
PL 109-58	Energy Policy Act of 2005 (EPAct05)

UNDERWRITERS LABORATORIES (UL)

UL 1951	(2011) Electric Plumbing Accessories
UL 499	(2005; Reprint Apr 2012) Electric Heating Appliances

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See Section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and Section 01 33 29 LEED(TM) DOCUMENTATION:

SD-02 Shop Drawings

Plumbing System; G

Detail drawings consisting of schedules, performance charts, instructions, diagrams, and other information to illustrate the requirements and operations of systems that are not covered by the Plumbing Code. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

SD-03 Product Data

Fixtures; (LEED NC)

List of installed fixtures with manufacturer, model, and flow rate.

Flush valve water closets; (LEED NC); G

Flush valve urinals; (LEED NC); G

Wall hung lavatories; (LEED NC) ;G

Undercounter lavatories; (LEED NC); G

Breakroom sinks; (LEED NC); G

Electric water coolers; G

Water heaters; G

Pumps; G

Backflow prevention assemblies; G

Shower mixing valves and shower heads; (LEED NC); G

Grease Interceptor; G

SD-06 Test Reports

Tests, Flushing and Disinfection; G

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and

testing of the installed system. Each test report shall indicate the final position of controls.

Test of Backflow Prevention Assemblies; G.

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

SD-07 Certificates

Materials and Equipment

Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

SD-10 Operation and Maintenance Data

Plumbing System; G.

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.4.1 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.2 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.4.3 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.4.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC. Energy consuming products and systems shall be in accordance with PL 109-58 and ASHRAE 90.1 - IP

1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 Materials

Materials for various services shall be in accordance with TABLES I and II. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Material or equipment containing lead shall not be used in any potable water system. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF/ANSI 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors.

2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used under ground. Solder containing lead shall not be used with copper pipe. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A74, AWWA C606. For hubless type: CISPI 310

b. Flange Gaskets: Gaskets shall be made of non-asbestos material in

accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

c. Brazing Material: Brazing material shall conform to AWS A5.8/A5.8M, BCuP-5.

d. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.

e. Solder Material: Solder metal shall conform to ASTM B32.

f. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B813, Standard Test 1.

g. PTFE Tape: PTFE Tape, for use with Threaded Metal.

h. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C564.

i. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.

j. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A105/A105M. Blind flange material shall conform to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A193/A193M.

l. Copper tubing shall conform to ASTM B88, Type K or L.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201. Water hammer arrester shall be diaphragm type.

b. Copper, Sheet and Strip for Building Construction: ASTM B370.

c. Asphalt Roof Cement: ASTM D2822/D2822M.

d. Hose Clamps: SAE J1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

h. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.100.

i. Thermometers: ASTM E1. Mercury shall not be used in thermometers.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85

Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASME BPVC SEC IV, Part HLW-810: Requirements for Potable-Water Heaters Bottom Drain Valve
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22/CSA 4.4
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

2.3.1 Backwater Valves

Backwater valves shall be either separate from the floor drain or a combination floor drain, P-trap, and backwater valve, as shown. Valves shall have cast-iron bodies with cleanouts large enough to permit removal of interior parts. Valves shall be of the flap type, hinged or pivoted, with revolving disks. Hinge pivots, disks, and seats shall be nonferrous metal. Disks shall be slightly open in a no-flow no-backwater condition. Cleanouts shall extend to finished floor and be fitted with threaded countersunk plugs.

2.3.2 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

2.3.3 Wall Hydrants (Frostproof)

ASSE 1019 with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4 inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.

2.3.4 Yard Hydrants

Yard box or post hydrants shall have valve housings located below frost lines. Water from the casing shall be drained after valve is shut off. Hydrant shall be bronze with cast-iron box or casing guard. "T" handle key shall be provided.

2.3.5 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22/CSA 4.4. Relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with ICC IPC. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1. Vitreous China, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Shower mixing valves and shower heads shall have concealed thermostatic control valve with check-stops, complete with vinyl hose and hand/mounted shower head with wall rod mount, vacuum breaker, and 1 gpm flow control. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Wall mounted water closets, urinals and lavatories shall be supported by floor mounted fixture carriers. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature.

2.4.1 Lavatories

Vitreous china lavatories shall be provided with two integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.

2.4.2 Automatic Controls

Provide automatic, sensor operated faucets and flush valves to comply with ASSE 1037 and UL 1951 for lavatory faucets, urinals. Flushing and faucet systems shall consist of battery-activated valves with light beam sensors. Flush valve for water closet shall include an override pushbutton. Flushing devices shall be provided as described in paragraph

FIXTURES AND FIXTURE TRIMMINGS.

2.4.3 Flush Valve Water Closets

ASME A112.19.2/CSA B45.1, white vitreous china, siphon jet, elongated bowl, wall mounted, wall outlet. Top of toilet seat height above floor shall be 14 to 15 inches, except 17 to 19 inches for wheelchair water closets. Provide white solid plastic elongated open-front seat .

Water flushing volume of the water closet and flush valve combination shall not exceed1.28 gallons per flush.

Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components shall be chromium-plated or polished stainless steel. Flush valves shall be nonhold-open type. Mount flush valves not less than 11 inches above the fixture. Mounted height of flush valve shall not interfere with the hand rail in ADA stalls. Provide battery-activated flush valves including electrical-operated light-beam-sensor to energize the solenoid.

2.4.4 Flush Valve Urinals

ASME A112.19.2/CSA B45.1, white vitreous china, ,wall-mounted, wall outlet, siphon jet, integral trap, and extended side shields. Provide urinal with the rim 17 inches above the floor. Provide urinal with the rim 24 inches above the floor. Water flushing volume of the urinal and flush valve combination shall not exceed 0.125 gallons per flush. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports. Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components shall be chromium-plated or polished stainless steel. Flush valves shall be nonhold-open type. Mount flush valves not less than 11 inches above the fixture. Provide battery-activated flush valves including electrical-operated light-beam-sensor to energize the solenoid.

2.4.5 Wheelchair Flush Valve Type Urinals

ASME A112.19.2/CSA B45.1, white vitreous china, ,wall-mounted, wall outlet, blowout action, integral trap, elongated projecting bowl, 20 inches long from wall to front of flare, and ASME A112.19.5 trim. Provide large diaphragm (not less than 2.625 inches upper chamber inside diameter at the point where the diaphragm is sealed between the upper and lower chambers), nonhold-open flush valve of chrome plated cast brass conforming to ASTM B584, including vacuum breaker and angle (control-stop) valve with back check. The water flushing volume of the flush valve and urinal combination shall not exceed 0.125 gallon per flush. Furnish urinal manufacturer's certification of conformance. Provide ASME A112.6.1M concealed chair carriers. Mount urinal with front rim a maximum of 17 inches above floor and flush valve handle a maximum of 44 inches above floor for use by handicapped on wheelchair. Provide battery-activated flush valves including electrical-operated light-beam-sensor to energize the solenoid.

2.4.6 Wall Hung Lavatories

ASME A112.19.2/CSA B45.1, white vitreous china, ,straight back type, minimum dimensions of 19 inches, wide by 17 inches front to rear, with supply openings for use with top mounted centerset faucets, and openings

for concealed arm carrier installation. Provide aerator with faucet. Water flow rate shall not exceed 0.5 gpm when measured at a flowing water pressure of 60 psi. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports and concealed arms for the lavatory. Mount lavatory with the front rim 34 inches above floor and with 29 inches minimum clearance from bottom of the front rim to floor. Provide top mounted washerless centerset lavatory faucets with 4 inch wrist blade handles.

2.4.7 Undercounter Lavatories

ASME A112.19.2/CSA B45.1, white vitreous china, self-rimming, minimum dimensions of 19 inches wide by 17 inches front to rear. Furnish template and mounting kit by lavatory manufacturer. Provide aerator with faucet. Water flow rate shall not exceed 0.5 gpm when measured at a flowing water pressure of 60 psi. Mount counter with the top surface 34 inches above floor and with 29 inches minimum clearance from bottom of the counter face to floor. Provide top-mounted battery-activated lavatory faucets including electrical-operated light-beam-sensor to energize the solenoid.

2.4.8 Breakroom Sinks

ASME A112.19.3/CSA B45.4, 20 gage stainless steel with integral mounting rim for flush installation, minimum dimensions of 19 inches wide by 18 inches front to rear and 6-1/2 inches deep, single compartment, with undersides fully sound deadened, with supply openings for use with top mounted washerless sink faucet and with 3.5 inch drain outlet. Provide aerator with faucet. Water flow rate shall not exceed 0.5 gpm when measured at a flowing water pressure of 60 psi. Provide stainless steel drain outlets and stainless steel cup strainers. Provide separate 1.5 inch P-trap and drain piping to vertical vent piping. Provide top mounted washerless sink faucets.

2.4.9 Electric Water Coolers

Barrier free wall mounted bi-level electric water cooler. Unit shall provide 8 gallons of chilled water per hour. Finish shall be brushed stainless steel. Mount unit to conform to the latest ADA requirements for barrier free access.

2.4.10 Precast Terrazzo Shower Floors

Terrazzo shall be made of marble chips cast in white portland cement to produce 3000 psi minimum compressive strength 7 days after casting. Provide floor or wall outlet copper alloy body drain cast integral with terrazzo, with polished stainless steel strainers.

2.4.11 Precast Terrazzo Mop Sinks

Terrazzo shall be made of marble chips cast in white portland cement to produce 3000 psi minimum compressive strength 7 days after casting. Provide floor or wall outlet copper alloy body drain cast integral with terrazzo, with polished stainless steel strainers.

2.4.12 Emergency Eyewash and Shower

ANSI/ISEA Z358.1, floor supported free standing unit. Provide deluge shower head, stay-open ball valve operated by pull rod and ring or triangular handle. Provide eyewash and stay-open ball valve operated by

foot treadle or push handle.

2.5 BACKFLOW PREVENTERS

Backflow prevention devices must be approved by the State or local regulatory agencies. If there is no State or local regulatory agency requirements, the backflow prevention devices must be listed by the Foundation for Cross-Connection Control & Hydraulic Research, or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention devices and assemblies.

Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be meet the above requirements.

Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

2.6 DRAINS

2.6.1 Floor and Shower Drains

Floor and shower drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.6.3. Provide drain with trap primer connection, trap primer, and connection piping. Primer shall meet ASSE 1018.

2.6.1.1 Drains and Backwater Valves

Drains and backwater valves installed in connection with waterproofed floors or shower pans shall be equipped with bolted-type device to securely clamp flashing.

2.6.2 Area Drains

Area drains shall be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain shall be circular or square with a 12 inch nominal overall width or diameter and 10 inch nominal overall depth. Drains shall be cast iron with manufacturer's standard coating. Grate shall be easily lifted out for cleaning. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.6.3.

2.6.3 Floor Sinks

Floor sinks shall be square, with 12 inch nominal overall width or diameter and 10 inch nominal overall depth. Floor sink shall have an acid-resistant enamel interior finish with cast-iron body, aluminum sediment bucket, and perforated grate of cast iron in industrial areas and stainless steel in finished areas. The outlet pipe size shall be as indicated or of the same size as the connecting pipe.

2.6.4 Roof Drains and Expansion Joints

Roof drains shall conform to ASME A112.6.4, with dome and integral flange, and shall have a device for making a watertight connection between roofing and flashing. The whole assembly shall be galvanized heavy pattern cast iron. For aggregate surface roofing, the drain shall be provided with a gravel stop. On roofs other than concrete construction, roof drains shall be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided when required to suit the building construction. Strainer openings shall have a combined area equal to twice that of the drain outlet. The outlet shall be equipped to make a proper connection to threaded pipe of the same size as the downspout. An expansion joint of proper size to receive the conductor pipe shall be provided. The expansion joint shall consist of a heavy cast-iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve shall have a nominal thickness of not less than 0.134 inch. Gaskets and packing shall be close-cell neoprene, O-ring packing shall be close-cell neoprene of 70 durometer. Packing shall be held in place by a packing gland secured with bolts.

2.7 SHOWER PAN

Shower pan may be copper, or nonmetallic material.

2.7.1 Sheet Copper

Sheet copper shall be 16 ounce weight.

2.8 TRAPS

Unless otherwise specified, traps shall be chrome plated copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be withouta cleanout. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured

unit and may have a rubber-gasketed swivel joint.

2.9 INTERCEPTORS

2.9.1 Grease Interceptor

Grease interceptor of the size indicated shall be commercially available steel grease interceptor with removable three-section, 3/8 inch checker-plate cover, and shall be installed outside the building. Steel grease interceptor shall be epoxy-coated to resist corrosion as recommended by the manufacturer. Interceptors shall be tested and rated in accordance with PDI G 101.

2.10 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 90 to 160 degrees F. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 200 degrees F water temperature and 150 psi working pressure. The expansion tank size and acceptance volume shall be as indicated.

2.10.1 Automatic Storage Type

Heaters shall be complete with control system, temperature gauge, and pressure gauge, and shall have ASME rated combination pressure and temperature relief valve.

2.10.1.1 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.3/CSA 4.3 for heaters with input greater than 75,000 BTU per hour.

2.10.2 Electric Instantaneous Water Heaters (Tankless)

UL 499 and UL listed flow switch activated, tankless electric instantaneous water heater for wall mounting below sink or lavatory.

2.11 PUMPS

2.11.1 Sump Pumps

Sump pumps shall be of capacities indicated. The pumps shall be of the automatic, electric motor-driven, submerged type, complete with necessary control equipment and with a split or solid cast-iron or steel cover plate. The pumps shall be direct-connected by an approved flexible coupling to a vertical electric motor having a continuous oiling device or packed bearings sealed against dirt and moisture. Motors shall be totally enclosed, fan-cooled of sizes as indicated and shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 4 enclosure. A float switch assembly, with the switch completely enclosed in a NEMA 250, Type 4 enclosure, shall start and stop each motor at predetermined water

levels.The discharge line from each pump shall be provided with a union, a nonclog swing check valve, and a stop valve in an accessible location near the pump.

2.11.2 Circulating Pumps

Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump and motor shall be supported by the piping on which it is installed. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze.

Motor shall be totally enclosed, fan-cooled and shall have sufficient horsepower for the service required. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover.

Integral size motors shall be premium efficiency type in accordance with NEMA MG 1. Pump motors smaller than 1 hp Fractional horsepower pump motors shall have integral thermal overload protection in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Guards shall shield exposed moving parts.

2.11.3 Flexible Connectors

Flexible connectors shall be provided at the suction and discharge of each pump that is 1 hp or larger. Connectors shall be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors shall be line size and suitable for the pressure and temperature of the intended service.

2.12 WATER PRESSURE BOOSTER SYSTEM

2.12.1 Variable Speed Pumping System

Variable speed pumping system shall provide system pressure by varying speed and number of operating pumps. The factory prepiped and prewired assembly shall be mounted on a steel frame complete with pumps, variable speed drives, motors, and controls. The variable speed drives shall be the oil-filled type capable of power transmission throughout their complete speed range without vibration, noise, or shock loading. Each variable speed drive shall be run-tested by the manufacturer for rated performance, and the manufacturer shall furnish written performance certification. System shall have suppressors to prevent noise transmission over electric feed lines. Required electrical control circuitry and system function sensors shall be supplied by the variable speed drive manufacturer. The primary power controls and magnetic motor controllers shall be installed in the controls supplied by the drive manufacturer. The sensors shall be located in the system to control drive speed as a function of constant pump discharge pressure. Connection between the sensors and the variable speed drive controls shall be accomplished with hydraulic sensing lines. Controls shall be in NEMA 250, Type 1 enclosures. Controller to have a set of Auxilary Alarm Output contacts for connection to BAS.

2.13 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors,

motor starters, and controls as specified herein and in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11. In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide polyphase, squirrel-cage medium induction motors with continuous ratings, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Controllers and contactors shall have auxiliary contacts for use with the controls provided. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers, including the required monitors and timed restart.

Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.14 MISCELLANEOUS PIPING ITEMS

2.14.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

2.14.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade, except where penetrating a membrane waterproof floor.

2.14.2.1 Sleeves in Masonry and Concrete

Provide steel pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2.14.2.2 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet pipe sleeves.

2.14.3 Pipe Hangers (Supports)

Provide MSS SP-58 and MSS SP-69, Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

2.14.4 Nameplates

Provide 0.125 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 0.25 inch high normal block lettering into the white core. Minimum size of nameplates shall be 1.0 by 2.5 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

2.14.5 Labels

Provide labels for sensor operators at flush valves and faucets. Include the following information on each label:

a. Identification of the sensor and its operation with graphic description.

b. Range of the sensor.

c. Battery replacement schedule.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA Fire Man. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A full port ball valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 18 inches below the finish grade or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

3.1.1 Equipment Access

a. Install piping, conduit and accessories to permit access to equipment for maintenance. Relocate piping, equipment or accessories to provide access at no additional cost to Owner.

b. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment without moving other future or installed equipment or system components.

c. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 05 - Access Doors and Frames, unless otherwise indicated. Access doors for valves, shock stops or other equipment shall provide access for servicing, repairs, and/or maintenance.

d. Provide necessary coordination and information to the Trade Contractor under Division 05 - Access Doors and Frames. This information shall include required locations, sizes, and rough-in dimensions.

3.1.2 Water Pipe, Fittings, and Connections

3.1.2.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

3.1.2.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.2.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.2.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance

from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.2.5 Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and full port ball valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.2.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.2.7 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

3.1.3 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.3.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.3.2 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.3.3 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.3.4 Copper Tube and Pipe

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2/B2.2M, ASME B16.50, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015.

c. Press connection. Copper press connections shall be made in **strict** accordance with the manufacturer's installation instructions for manufactured rated size. The joints shall be pressed using the tool(s) approved by the manufacturer **of that joint**. Minimum distance between fittings shall be in accordance with the manufacturer's requirements.

3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.5 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.5.1 Sleeve Requirements

Unless indicated otherwise, provide pipe sleeves meeting the following requirements:

Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.

A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved.

Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor.

Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/2 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.

Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C920 and with a primer, backstop material and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.

Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.1.5.2 Flashing Requirements

Pipes passing through roof shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be

suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.5.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

3.1.5.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 6 inches in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.1.5.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.1.5.6 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.6 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided to meet the UL Listing requirements for the fire rating.

3.1.7 Supports

3.1.7.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.7.2 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 4 inches.

(2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.

(3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 8 pcf or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.7.3 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

3.1.8 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.9 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron .

3.2 WATER HEATERS

3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water heater.

3.2.2 Installation of Gas Fired Water Heater

Installation shall conform to NFPA 54. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 24 inches just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

3.2.3 Heat Traps

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

3.2.4 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

3.2.5 Expansion Tank

A pre-charged expansion tank shall be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve. The Contractor shall adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. In addition, for water closets intended for handicap use, the flush valve handle shall be installed on the wide side of the enclosure and mounted 30 inches above floor and arranged to avoid interference with grab bars. Bumpers for water closet seats shall be installed on the flushometer stop or flushometer spud.

3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor.

Wall-hung drinking fountains and water coolers shall be installed with rim 42 inches above floor. Wall-hung service sinks shall be mounted with rim 28 inches above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with ICC A117.1.

3.3.4 Shower Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

3.3.5 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.5.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.3.5.2 Support for Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the concrete wall using through bolts and a back-up plate.

3.3.5.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.5.4 Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs shall be fastened with not less than No. 10 wood screws, 1/4 inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

3.3.5.5 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

3.3.6 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with ICC IPC at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.3.7 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

3.3.8 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 2 inches above the flood rim of the funnel to provide an acceptable air gap.

3.3.9 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D3311. Traps for acid-resisting waste shall be of the same material as the pipe.

3.3.10 Shower Pans

Before installing shower pan, subfloor shall be free of projections such as nail heads or rough edges of aggregate. Drain shall be a bolt-down, clamping-ring type with weepholes, installed so the lip of the subdrain is flush with subfloor.

3.3.10.1 General

The floor of each individual shower, the shower-area portion of combination shower and drying room, and the entire shower and drying room where the two are not separated by curb or partition, shall be made watertight with a shower pan fabricated in place. The shower pan material shall be cut to size and shape of the area indicated, in one piece to the maximum extent practicable, allowing a minimum of 6 inches for turnup on walls or partitions, and shall be folded over the curb with an approximate return of 1/4 of curb height. The upstands shall be placed behind any

wall or partition finish. Subflooring shall be smooth and clean, with nailheads driven flush with surface, and shall be sloped to drain. Shower pans shall be clamped to drains with the drain clamping ring.

3.3.10.2 Metal Shower Pans

When a shower pan of required size cannot be furnished in one piece, metal pieces shall be joined with a flintlock seam and soldered or burned. The corners shall be folded, not cut, and the corner seam shall be soldered or burned. Pans, including upstands, shall be coated on all surfaces with one brush coat of asphalt. Asphalt shall be applied evenly at not less than 1 gallon per 50 square feet. A layer of felt covered with building paper shall be placed between shower pans and wood floors. The joining surfaces of metal pan and drain shall be given a brush coat of asphalt after the pan is connected to the drain.

3.3.10.3 Nonplasticized Chlorinated Polyethylene Shower Pans

Corners of nonplasticized chlorinated polyethylene shower pans shall be folded against the upstand by making a pig-ear fold. Hot-air gun or heat lamp shall be used in making corner folds. Each pig-ear corner fold shall be nailed or stapled 1/2 inch from the upper edge to hold it in place. Nails shall be galvanized large-head roofing nails. On metal framing or studs, approved duct tape shall be used to secure pig-ear fold and membrane. Where no backing is provided between the studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding 1/2 inch from upper edge. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it will be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Surfaces to be solvent-welded shall be clean. Surfaces to be joined with xylene shall be initially sprayed and vigorously cleaned with a cotton cloth, followed by final coating of xylene and the joining of the surfaces by roller or equivalent means. If ambient or membrane temperatures are below 40 degrees F the membrane and the joint shall be heated prior to application of xylene. Heat may be applied with hot-air gun or heat lamp, taking precautions not to scorch the membrane. Adequate ventilation and wearing of gloves are required when working with xylene. Membrane shall be pressed into position on the drain body, and shall be cut and fit to match so that membrane can be properly clamped and an effective gasket-type seal provided. On wood subflooring, two layers of 15 pound dry felt shall be installed prior to installation of shower pan to ensure a smooth surface for installation.

3.4 IDENTIFICATION SYSTEMS

3.4.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.4.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00

PAINTS AND COATINGS.

3.5 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.6 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS.

3.6.1 Painting of New Equipment

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.6.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.6.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film

thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

3.7 TESTS, FLUSHING AND DISINFECTION

3.7.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC IPC, except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure to the Contracting Officer for approval.

a. Drainage and Vent Systems Test. The final test shall include a smoke test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

3.7.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies.

Backflow prevention assembly test gauges shall be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges shall be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test

Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.7.1.2 Shower Pans

After installation of the pan and finished floor, the drain shall be temporarily plugged below the weep holes. The floor area shall be flooded with water to a minimum depth of 1 inch for a period of 24 hours. Any drop in the water level during test, except for evaporation, will be reason for rejection, repair, and retest.

3.7.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.7.3 System Flushing

3.7.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF/ANSI 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

3.7.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Comply with ASHRAE 90.1 - IP for minimum efficiency requirements. Unless more stringent local requirements exist,

lead levels shall not exceed limits established by 40 CFR 141.80 (c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.7.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of each domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

3.7.5 Disinfection

After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

Test the chlorine residual level in the water at 6 hour intervals for a

continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet shall be opened and closed several times.

After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet shall be opened and closed several times.

Take addition samples of water in disinfected containers, for bacterial examination, at locations specified by the Contracting Officer Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.8 WASTE MANAGEMENT

Place materials defined as hazardous or toxic waste in designated containers, stored and handled in accordance to Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION. Separate copper and ferrous pipe waste in accordance with Section 01 74 19 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

3.9 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.10 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, minimum overall efficiency.

ET = Minimum thermal efficiency with 70 degrees F delta T.

SL = Standby loss is maximum (Btu/h) based on a 70 degrees F

temperature difference between stored water and ambient requirements.

V = Rated volume in gallons

Q = Nameplate input rate in kW (Btu/h)

3.10.1 Storage Water Heaters

3.10.1.1 Gas

a. Storage capacity of 50 gallons or less shall have a minimum energy factor (EF) of 0.62 or higher per FEMP requirements.

b. Storage capacity of 20 gallons - or more and input rating of 75,000 Btu/h or less: minimum EF shall be 0.62 - 0.0019V per 10 CFR 430.

c. Rating of less than 22980 W: (75,000 Btu/h) ET shall be 80 percent; maximum SL shall be (0/800+100x(V^^1/2)), per ANSI Z21.10.3/CSA 4.3

3.11 TABLES

TABLE I

PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A74 with compression gaskets. Pipe and fittings shall be marked with the CISPI trademark.	X	X	X	X	X	
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A888. Pipe and fittings shall be marked with the CISPI trademark.		X	X	X	X	
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X		
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	X	

TABLE I

PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F
5	Seamless red brass pipe, ASTM B43				X	X	
6	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X	
7	Cast copper alloy solder joint pressure fittings, ASME B16.18for use with Item 14				X	X	
8	Seamless copper pipe, ASTM B42						
9	Cast bronze threaded fittings, ASME B16.15				X	X	
10	Copper drainage tube, (DWV), ASTM B306	X*	X	X*	X	X	
11	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X	
12	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X	

SERVICE:
- A - Underground Building Soil, Waste and Storm Drain
- B - Aboveground Soil, Waste, Drain In Buildings
- C - Underground Vent
- D - Aboveground Vent
- E - Interior Rainwater Conductors Aboveground
- F - Corrosive Waste And Vent Above And Belowground
- * - Hard Temper

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
1	Bronze flanged fittings, ASME B16.24 for use with Item 7	X	X		X
2	Seamless copper pipe, ASTM B42	X	X		X
3	Seamless copper water tube, ASTM B88, ASTM B88M	X**	X**		X***
4	Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7	X	X		X
5	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 5, 7 and 8	X	X	X	X
6	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Item 8	X	X	X	X
7	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B828	X	X		

-- End of Section --

SECTION 22 07 19.00 40

PLUMBING PIPING INSULATION
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C534/C534M	(2011) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2012) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C795	(2008) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(1985; R 2007) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM D579	(2010) Standard Specification for Greige Woven Glass Fabrics

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 220	(2012) Standard on Types of Building Construction
NFPA 255	(2006; Errata 2006) Standard Method of Test of Surface Burning Characteristics of Building Materials

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS 3779	(1990; Rev A; R 1994) Tape Adhesive, Pressure Sensitive Thermal Radiation Resistant, Aluminum Foil/Glass Cloth

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See Section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements.

1.3 SYSTEM DESCRIPTION

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION AND EXHAUST SYSTEMS applies to work specified in this section.

1.4 PERFORMANCE REQUIREMENTS

Provide noncombustible thermal-insulation system materials, as defined by NFPA 220. Provide adhesives, coatings, sealants, facings, jackets, and thermal-insulation materials, except cellular elastomers, with a flame-spread classification (FSC) of 25 or less , and a smoke-developed classification (SDC) of 50 or less . Determine these maximum values in accordance with NFPA 255. Provide coatings and sealants that are nonflammable in their wet state.

Provide adhesives, coatings, and sealants with published or certified temperature ratings suitable for the entire range of working temperatures normal for the surfaces to which they are to be applied.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and Section 01 33 29 LEED(TM) DOCUMENTATION:

SD-02 Shop Drawings

Installation Drawings

SD-03 Product Data

Adhesives

Insulation Materials

Jacketing

Tape

SD-07 Certificates

Recycled Materials

SD-08 Manufacturer's Instructions

Installation Manual

1.6 RECYCLED MATERIALS

Provide thermal insulation containing recycled materials to the extent practicable, provided that the material meets all other requirements of this section. The minimum recycled material content of the following insulation types are:

a. Fiberglass - 20-25 percent glass cullet by weight

Submit recycled materials documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

1.7 PRE-INSTALLATION REQUIREMENTS

Within 30 days of Contract Award, submit installation drawings for pipe insulation, conforming with the adhesive manufacturer's written instructions for installation. Submit installation manual clearly stating the manufacturer's instructions for insulation materials

PART 2 PRODUCTS

Submit manufacturer's catalog data for the following items:

a. Adhesives

b. Insulation Materials

c. Jacketing

d. Tape

Provide compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state. Meet ASTM C795 requirements for materials to be used on stainless steel surfaces. Provide materials that are asbestos free and conform to the following.

2.1 INSULATION MATERIALS

Provide materials with maximum value conductances as tested at any point, not an average. Replace or augment insulation conductance found by test to exceed the specified maximum by an additional thickness to bring it to the required maximum conductance and a complete finishing system.

2.1.1 Cellular Elastomer Insulation - Condensate Drains and Clear Water Waste Piping

Provide cellular elastomer insulation conforming to ASTM C534/C534M, ensuring the water vapor permeability does not exceed 0.30 perms per foot per inch per hour per square foot mercury pressure difference for 1 inch thickness of cellular elastomer.

2.1.2 Fiberglass Insulation - Cold Water, Hot Water, Hot Water Return and Storm Piping

Conform to ASTM C547. Ensure the apparent thermal conductivity does not exceed 0.54 Btu-inch per hour per square foot per degree F at 200 degrees F mean.

All fiber glass insulation to be 1 inch thick except for branch piping located in walls supplying idividual fixtures. Fiberglass insulation to have all service jacket.

2.1.3 Pipe Fittings

Provide molding pipe fitting insulation covering for use at temperatures up to and including 1200 degrees F.

2.2 ADHESIVES

2.2.1 Cloth Adhesives

Provide adhesives for adhering, sizing, and finishing lagging cloth, canvas, and open-weave glass cloth with a pigmented polyvinyl acetate emulsion conforming to the requirements of ASTM C916, Type I.

2.2.2 Vapor-Barrier Material Adhesives

Provide adhesives for attaching laps of vapor-barrier materials and presized glass cloth for attaching insulation to itself, to metal, and to various other substrates, of nonflammable solvent-base, synthetic-rubber type conforming to the requirements of ASTM C916, Type I, for attaching fibrous-glass insulation to metal surfaces.

2.3 CAULKING

Provide elastomeric joint sealant for caulking specified insulation materials in accordance with ASTM C920, Type S, Grade NS, Class 25, Use A.

2.4 JACKETING

2.5 TAPE

Provide a knitted elastic cloth glass lagging specifically suitable for continuous spiral wrapping of insulated pipe bends and fittings and produce a smooth, tight, wrinkle-free surface. Conform to requirements of SAE AMS 3779, SAE AMS 3779, ASTM D579, and ASTM C921 for tape, weighing not less than 10 ounces per square yard.

2.6 COLD-WATER, HOT WATER, HOT WATER RETURN, STORM AND CLEAR WATER WASTE PIPING

Insulate aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces.

PART 3 EXECUTION

3.1 INSTALLATION OF INSULATION SYSTEMS

Install smooth and continuous contours on exposed work. Smoothly and securely paste down cemented laps, flaps, bands, and tapes. Apply adhesives on a full-coverage basis.

Apply insulation only to system or component surfaces that have been tested and approved.

Install insulation lengths tightly butted against each other at joints. Where lengths are cut, provide smooth and square and without breakage of end surfaces. Where insulation terminates, neatly taper and effectively seal ends, or finish as specified. Direct longitudinal seams of exposed insulation away from normal view.

Apply materials in conformance with the recommendations of the manufacturer.

Clean surfaces free of oil and grease before insulation adhesives or mastics are applied. Provide solvent cleaning required to bring metal surfaces to such condition.

Submit installation drawings for pipe insulation, conforming with the adhesive manufacturer's written instructions for installation. Submit installation manual clearly stating the manufacturer's instructions for insulation materials.

3.2 ACCEPTANCE

Final acceptance is dependent upon providing construction (Record Drawings) details to the Contracting Officer. Include construction details, by building area, the insulation material type, amount, and installation method. An illustration or map of the duct routing locations may serve this purpose. With data, provide a cover letter/sheet clearly marked with the system name, date, and the words "Record Drawings insulation/material." Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION 23 00 00

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 99	(2010) Standards Handbook
AMCA 201	(2002; R 2011) Fans and Systems
AMCA 203	(1990; R 2011) Field Performance Measurements of Fan Systems
AMCA 204	(2005; R 2012) Balance Quality and Vibration Levels for Fans
AMCA 210	(2007) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2008) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2006; INT 2007; Errata 2008) Methods for Calculating Fan Sound Ratings from Laboratory Test Data

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(1990; R 2008) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990; R 2008) Load Ratings and Fatigue Life for Ball Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S2.19	(2004) Balance Quality Requirements of Rigid Rotors - Part 1: Determination of Permissible Residual Unbalance

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2010; Errata 2011; INT 3 2012; INT 4 2012) Ventilation for Acceptable Indoor Air Quality

ASME INTERNATIONAL (ASME)

ASME A13.1	(2007; R 2013) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A924/A924M	(2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B766	(1986; R 2008) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C553	(2011) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM D1654	(2008) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D3359	(2009e2) Measuring Adhesion by Tape Test
ASTM D520	(2000; R 2011) Zinc Dust Pigment

GREENGUARD ENVIRONMENTAL INSTITUTE (GEI)

GEI	Greenguard Standards for Low Emitting Products

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011; Errata 2012) Motors and Generators
NEMA MG 10	(2001; R 2007) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2007) Energy Management Guide for

Selection and Use of Single Phase Motors

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	Scientific Certification Systems (SCS)Indoor Advantage

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL 705	(2004; Reprint Mar 2012) Standard for Power Ventilators
UL Bld Mat Dir	(2012) Building Materials Directory

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements.

1.3 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.3.1 Mechanical Equipment Identification

The number of charts and diagrams shall be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.3.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

1.3.1.2 Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. Provide neat mechanical drawings provided with extruded aluminum frame under 1/8-inch glass or laminated plastic, system diagrams that show

the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.

1.3.2 Service Labeling

Label equipment, including fans, air handlers, energy recovery units, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Labels shall be in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Air handling unit Number	AHU - _____
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF - _____

Identify similar services with different temperatures or pressures. Where pressures could exceed 125 pounds per square inch, gage, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

a. Each point of entry and exit of pipe passing through walls.

b. Each change in direction, i.e., elbows, tees.

c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 75 feet. All labels shall be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch
2-1/2 inch and larger	1-1/4 inch

1.3.3 Color Coding

Color coding of all piping systems shall be in accordance with ASME A13.1 .

1.3.4 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this

section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Centrifugal Fans; G
In-Line Centrifugal Fans; G
Centrifugal Type Power Roof Ventilators; G
Plenum Fans; G
Utility Sets; G
Mixed Flow Fans; G
Propeller Hooded Roof Supply Fan; G
Test Procedures; G
Diagrams; G

SD-06 Test Reports

Performance Tests; G

SD-07 Certificates

Bolts
Certification; G

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions; G
Operation and Maintenance Training; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

Centrifugal Fans; G
Plenum Fans; G
Utility Sets; G
In-Line Centrifugal Fans; G
Centrifugal Type Power Roof Ventilators; G
Mixed Flow Fans; G
Propeller Hooded Roof Supply Fan; G

1.5 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is

based on manufacturer's published data.

a. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.

b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.

c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

1.5.1 Prevention of Corrosion

Protect metallic materials against corrosion. Manufacturer shall provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations. Provide written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, and the number of each type of bolt to be furnished in the certification.

1.5.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.5.3 Ozone Depleting Substances Used as Refrigerants

Minimize releases of Ozone Depleting Substances (ODS) during repair, maintenance, servicing or disposal of appliances containing ODS's by complying with all applicable sections of 40 CFR 82 Part 82 Subpart F. Any person conducting repair, maintenance, servicing or disposal of appliances owned by NASA shall comply with the following:

a. Do not knowingly vent or otherwise release into the environment, Class I or Class II substances used as a refrigerant.

b. Do not open appliances without meeting the requirements of 40 CFR 82 Part 82.156 Subpart F, regarding required practices for evacuation and collection of refrigerant, and 40 CFR 82 Part 82.158 Subpart F, regarding standards of recycling and recovery equipment.

c. Only persons who comply with 40 CFR 82 Part 82.161 Subpart F, regarding technician certification, can conduct work on appliances containing refrigerant.

In addition, provide copies of all applicable certifications to the Contracting Officer at least 14 calendar days prior to initiating maintenance, repair, servicing, dismantling or disposal of appliances, including:

a. Proof of Technician Certification

b. Proof of Equipment Certification for recovery or recycling equipment.

c. Proof of availability of certified recovery or recycling equipment.

1.5.4 Use of Ozone Depleting Substances, Other than Refrigerants

The use of Class I or Class II ODS's listed as nonessential in 40 CFR 82 Part 82.66 Subpart C is prohibited. These prohibited materials and uses include:

a. Any plastic party spray streamer or noise horn which is propelled by a chlorofluorocarbon

b. Any cleaning fluid for electronic and photographic equipment which contains a chlorofluorocarbon; including liquid packaging, solvent wipes, solvent sprays, and gas sprays.

c. Any plastic flexible or packaging foam product which is manufactured with or contains a chlorofluorocarbon, including, open cell foam, open cell rigid polyurethane poured foam, closed cell extruded polystyrene sheet foam, closed cell polyethylene foam and closed cell polypropylene foam except for flexible or packaging foam used in coaxial cabling.

d. Any aerosol product or other pressurized dispenser which contains a chlorofluorocarbon, except for those listed in 40 CFR 82 Part 82.66 Subpart C.

Request a waiver if a facility requirement dictates that a prohibited material is necessary to achieve project goals. Submit the waiver request in writing to the Contracting Officer. The waiver will be evaluated and dispositioned.

1.5.5 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

1.5.6 Test Procedures

Submit proposed test procedures and test schedules for the ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

1.5.7 Sustainable Design Certification

Product shall be third party certified by GEI Greenguard Indoor Air Quality Certified, SCS Scientific Certification Systems Indoor Advantage or equal. Certification shall be performed annually and shall be current.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. This requirement applies to all equipment, including diffusers, registers, fire dampers, and balancing dampers. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. These manufacturers' catalogs, or brochures shall have been copyrighted documents or have been identified with a manufacturer's document number. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization. Where applicable, provide equipment that is an ENERGY STAR Qualified product or a Federal Energy Management Program (FEMP) designated product.

2.2 FABRICATED PRODUCTS

Fabricated duct, plenums and casings specified in paragraphs "Metal Ductwork" and "Plenums and Casings for Field-Fabricated Units" are not required to be categorized as standard product.

2.3 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Identification plates shall be three layers, black-white-black, engraved to show white letters on black background. Letters shall be upper case. Identification plates 1-1/2-inches high and smaller shall be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high shall be 1/8-inch thick, with engraved lettering of

suitable height. Identification plates 1-1/2-inches high and larger shall have beveled edges. Install identification plates using a compatible adhesive.

2.4 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard.

2.5 ELECTRICAL WORK

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Integral size motors shall be the premium efficiency type in accordance with NEMA MG 1.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system , and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

e. Provide variable frequency drives for motors as specified in Section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS. Each VFD driven fan motor shall be furnished with a shaft grounding brush similar to AEGIS SGR to prevent bearings from shaft current.

2.6 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the

equipment manufacturer and located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

2.7 WIND AND SEISMIC ANCHORAGE

Provide all necessary design requirements for wind restraints as required to meet local wind codes and provide all necessary wind restraints connections to equipment. All rooftop equipment and supports shall be designed to comply with and be secured to the structure in compliance with the requirements of Chapter 16 (High-Velocity Hurricane Zones) of the Florida Building Code. Unit assembly, structural connection, and supports shall be designed and stamped by a professional engineer licensed in the state of Florida to meet Florida building code requirements (Miami-Dade County NOA-09-0511.03 and Florida Product Approval FL12917.1).

Anchor equipment in accordance with applicable seismic criteria for the area and as defined in SMACNA 1981

2.8 PAINTING

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing.

2.9 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.10 AIR SYSTEMS EQUIPMENT

2.10.1 Fans

2.10.1.1 Submittals

Shop Drawings, including but not limited to, the following:

a. Manufacturer's name and model number
b. Identification as referenced in the Documents
c. Capacities/ratings for 100% scheduled fan capacity
d. Capacities/ratings for 110% scheduled fan capacity
e. Fan curves
f. Materials of construction
g. Sound power levels
h. Fan type, size, class, drive arrangement, discharge/rotation, bearings, drives
i. Wheel type, diameter, rpm, tip speed
j. Required fan horsepower including drive losses
k. Motor data
l. Vibration isolators furnished with fans
m. Dimensions and weights
n. Special coatings where applicable
o. Color selection charts where applicable
p. Manufacturer's installation instructions
q. All other appropriate data

Fan curves shall include series of curves indicating relationship of flow rate (cfm) to static or total pressure for various fan speeds, brake horsepower curves, and selection range (surge curves, maximum rpm, etc).

Fan curves shall clearly indicate operating point. For parallel fan applications, indicate operating point of combined case as well as operating point of only one fan.

Indicate performance data, based on both (100%) design air quantity and 110% of design air quantity at design static pressure.

For variable air volume application, indicate operating points at 100, 80, 60 and 40% of design capacity on fan curves including data to indicate effect of variable frequency drives on flow, pressure and horsepower.

2.10.1.2 DESIGN CRITERIA

Fan ratings shall be tested and certified in accordance with AMCA Standards 211 and 311 and fans shall bear AMCA Seal.

Fans shall be furnished complete with motors, wheels, drive assemblies, bearings and accessories as hereinafter specified. Motors for V-belt drives shall be furnished with adjustable rails or bases. All fans are to be provided with VFD rated, premium efficiency motors with all motors provided with shaft grounding.

Provide all units with scheduled high efficiency, VFD rated motors with factory mounted and wired NEMA Standard disconnect switches. Exterior and rooftop units shall be furnished with factory mounted and wired NEMA weatherproof disconnect switches.

Entire fan motor assemblies, including but not limited to bearings and insulation, shall be rated for continuous operation above synchronous motor speed, up to 120 Hz.

Each fan wheel shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19. Complete fan assembly shall be factory balanced statically and dynamically in accordance with Standard AMCA 204 for Balance Quality and Vibration Levels for Fans and meet or exceed guidelines in Application Category BV-3.

For fans furnished with 5 hp or larger hp motors, each fan assembly shall have factory run test including vibration signatures taken on each bearing in horizontal, vertical and axial direction. Filter-in reading as measured at fan, scheduled rpm shall not exceed the following values when fan is rigidly mounted:

a. Belt Drive (except Vane Axial) 0.15 inches per second peak velocity
b. Belt Drive Vane Axial 0.08 inches per second peak velocity
c. Direct Drive 0.08 inches per second peak velocity
d. Written records of run test and vibration test shall be available upon request.

Unless otherwise indicated, belt drives shall be V-belt drives selected for 150% of motor nameplate horsepower.

Furnish fans specified with V-belt drives with either variable-pitch or fixed-pitch sheaves for drives 3 hp and smaller and fixed-pitch sheaves for drives 5 hp and larger. Select variable pitch sheaves to drive fan at such speed as to produce specified capacity at approximate midpoint of sheave adjustment.

When fixed-pitch sheaves are furnished, system air balancing shall be

accomplished by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves. This Contractor shall provide necessary trial and final sheaves and drive belts as required by TAB Contractor.

Select each fan to operate at single stable operating point as predicted by fan curve. Fans having 2 potential operating points on fan curves are not acceptable.

Provide OSHA Compliant belt and shaft guards for belt driven fans. Provide speed test openings at shaft locations. Paint guards bright yellow.

Sound power levels shall be based on tests performed in accordance with AMCA Standards AMCA 300 and AMCA 301.

Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. Motor furnished with fan shall not operate into motor service factor in any of these cases. Fan motors shall be premium efficiency.

Consider drive efficiency in motor selection according to manufacturer's published recommendation, or according to AMCA 203AMCA Publication 203, Appendix L.

Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of change and system effect factor calculations indicating increased static pressure requirements as described in AMCA Publication 201. This Contractor shall be responsible for costs associated with any motor, drive, and/or wiring changes required as a result of duct configuration changes at fan.

All fans shall be marked with arrows to indicate proper direction of rotation.

Unless otherwise scheduled, AMCA Type C spark resistant construction shall be used for fans handling flammable or grease laden, vapors. Fans having spark resistant construction shall be electrically grounded so as to prevent static electricity from building up.

Fans scheduled with baked phenolic coating shall have internal parts in contact with air stream sand blasted to white metal finish and coated within 24 h. Coating thickness shall be 5 mils minimum, equal to Heresite P-4403 (first 3 coats) and L-66L (final 2 coats) with each coat baked separately. Dry film thickness must be verified before final baking. Paint all exterior metal parts with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to all exterior surfaces.

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans shall not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than 150 percent of the connected

driving capacity. Provide variable pitch motor sheaves for 5 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable OSHA compliant metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label. Provide fans with a factory mounted and wired NEMA 4 disconnect switch.

Smoke Control fans as scheduled for use in Smoke Control Systems when scheduled with V-belt drives shall be provided with V-belt drives that have a minimum of 1.5 times the number of belts required for the design duty, with the minimum number of belts being two. Fans shall be selected for stable performance based on normal temperature and, where applicable, elevated temperature. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Fans shall be supported and restrained by noncombustible devices. Motors driving fans shall not be operated beyond their nameplate horsepower, as determined from measurement of actual current draw, and shall have a minimum service factor of 1.15.

2.10.1.3 Centrifugal Fans

Provide fully enclosed, single-width single-inlet, or double-width double-inlet centrifugal fans, with AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Provide impeller wheels that are rigidly constructed and accurately balanced both statically and dynamically. Provide forward curved or backward-inclined airfoil design fan blades as scheduled. Provide backward-inclined airfoil design fan blades for wheels over 30 inches in diameter. Provide fan wheels over 36 inches in diameter with overhung pulleys and a bearing on each side of the wheel. Provide fan wheels 36 inches or less in diameter that have one or more extra long bearings between the fan wheel and the drive. Provide sleeve type, self-aligning and self-oiling bearings with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Connect grease fittings to tubing for serviceability from a single accessible point. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide steel, accurately finished fan shafts, with key seats and keys for impeller hubs and fan pulleys. Provide fan outlets of ample proportions, designed for the attachment of angles and bolts for attaching flexible connections. Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have totally enclosed enclosures. Provide specified scheduled motor starter or variable frequency drive and enclosure.

Manufacturers: Twin City, Greenheck, Chicago Blower, PennBarry or

approved equal.

Supply fan SF-5 is part of the Stair Pressurization Systems and is to be designed for Smoke Control duty.

Housings: Heavy gauge steel, continuously welded throughout, braced and supported by structural channels or angle irons to prevent vibration or pulsation, flanged outlet, fully streamlined inlet.

Wheels: Non-overloading airfoil blades welded to spun wheel cones unless otherwise indicated.

Shaft: Fan shaft shall be turned and polished steel and sized so first critical speed is at least 25 percent over maximum operating speed for each pressure class.

Bearings: Air handling quality, heavy duty, grease lubricated ball or roller, self-aligning, pillow block type. Bearings shall be selected for minimum life (ABMA L-10) of not less than 40,000 h operation at maximum cataloged operating speed based on ABMA 9 and 11. Furnish bearings with pressure relief type external grease fittings.

Provide units with scheduled high efficiency VFD rated motors with factory mounted and wired NEMA Standard disconnect switches. Exterior and rooftop units shall be furnished with factory mounted and wired NEMA weatherproof disconnect switches.

Painting: All metal parts shall be painted with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to all exterior surfaces.

Mounting Rails: Furnish common mounting rails for fan and motor as appropriate for fan arrangement indicated.

Discharge Dampers: Provide gravity backdraft dampers where shown on drawings, for fans not provided with motorized dampers, for mounting at fan discharge outlet. Backdraft dampers shall be similar to Ruskin Model CBS 92, having aluminum airfoil-shaped blades, ball bearings and be rated to 4000 fpm. Dampers shall have blade and jamb seals with leakage rating no higher than 13.5 cfm/ft2 for damper width 36 inches and larger based on pressure differential of 1 inch WGUse of backdraft damper at fan discharge is not standard. Above specified Ruskin model is fine up to 4000 fpm. If velocity exceeds 4000 fpm, do not use backdraft damper.

Inlet Screens: Minimum 16 ga galvanized, 1 inch wire mesh for fans without inlet ductwork where shown on drawings.

Access Doors: Bolted and gasketed type in fan housing for inspection of interiors and wheel.

Drain Connection: 3/4 inches NPT external threads located at the lowest point of housing.

2.10.1.4 Plenum Fans

Manufacturers: Twin City, Greenheck, Chicago Blower, or PennBarry or approved equal.

General: Fans shall be airfoil centrifugal type designed for industrial duty and suitable for continuous operation. Fans shall be single width, single inlet, arrangement 3, plenum fans with capacities and operating characteristics as indicated on schedules.

Hubs: Hubs shall be cast or welded fabricated hubs with straight bores and keyways. Hubs shall be screwed to the shaft with a minimum of 2 set screws for positive attachment. Hubs using taper lock bushings are not acceptable.

Wheels: 12-blade, airfoil type, double skinned and welded to center and wheel sideplates. Fan impeller diameters shall conform to Standard AMCA 99 -2412. Fan blades shall be designed to provide smooth airflow over all surfaces of blade.

Shaft: Fan shafts shall be solid AISI 1040 or 1045 steel. Straight shafts shall be turned, ground and polished to a minimum 16 micro-inch finish. Shaft shall be sized for first critical speed of 200 percent over the maximum fan operating speed.

Bearings: Air handling quality, heavy-duty, grease lubricated, pillow block, self-aligning ball or roller type. Bearings shall be selected for minimum life (ABMA L10) of not less than 80,000 h operation at maximum cataloged operating speed.

Provide units with scheduled high efficiency VFD rated motors with factory mounted and wired NEMA Standard disconnect switches. Exterior and rooftop units shall be furnished with factory mounted and wired NEMA weatherproof disconnect switches.

Fans, fan wheels, motors, VFDs, fan drives, bearings and all components in air handling units shall all be compatible and be designed for above synchronous motor speed, up to 120 hertz.

Screen Enclosure: Entire plug fan and drive assembly shall be encased with protective screen enclosure. Enclosure shall be constructed of aluminum or galvanized steel mesh or expanded metal and sized to have no measurable system effect on fan performance. Screen shall be reinforced as required to maintain stable structure during fan operation. Access shall be provided for periodic service. Door shall be of suitable size to allow service personnel into enclosure. Enclosure shall be designed and constructed to allow for complete disassembly.

Inlet Screens: Heavy gauge, corrosion resistant, zinc plated steel wire for fans without inlet ductwork.

Painting: All metal parts to be painted with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to all exterior surfaces.

2.10.1.5 In-Line Centrifugal Fans

Provide in-line fans with centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Mount fans in a welded tubular casing. Provide a fan that axially flows the air in and out. Streamline inlets with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Enclose and isolate fan bearings and drive shafts from the air stream. Provide precision, self aligning ball or roller type fan bearings

that are sealed against dust and dirt and are permanently lubricated. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide motors with totally enclosed enclosure. Provide specified scheduled motor starter or variable frequency drive and enclosure.

Manufacturers: Twin City, Greenheck, PennBarry, ACME, Chicago Blower or approved equal

Supply fans SF-6 is part of the Stair Pressurization Systems and shall be designed for Smoke Control duty.

Supply fan SF-7 is part of the Elevator Shaft Pressurization System and shall be designed for Smoke Control duty.

Fan housing shall be designed for installation in straight run of duct with transitions as indicated. Housing shall be designed for complete access to fan and motor without removing fan assembly from ductwork.

Wheels shall have backward inclined blades. Motor or drive compartment shall be isolated from airstream and be externally ventilated. Bearings shall be pre-lubricated and sealed and designed for minimum life of 40,000 h operation (ABMA L-10).

Paint fan parts with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to exterior surfaces.

Provide units with scheduled high efficiency VFD rated motors with factory mounted and wired NEMA Standard disconnect switches. Exterior and rooftop units shall be furnished with factory mounted and wired NEMA weatherproof disconnect switches.

2.10.1.6 Mixed Flow Fans

Manufacturers: Twin City, Greenheck, Chicago Blower, PennBarry, or approved equal.

Housings: Heavy gauge steel with welded fabrication, adequate reinforcing to prevent housing distortion, fully streamlined inlet cones, multiple straightening vanes following fan wheel to redirect air flow to minimize noise and reduce turbulence and flanged inlet and outlet. Fan housings shall be designed to promote straight line, air flow from entrance to discharge.

Wheels: Wheels shall be mixed flow type with single-thickness cambered blades. Blades shall be continuously welded to back plate and wheel cone. Wheels shall be statically and dynamically balanced and complete fan assembly including motor and drive shall be test balanced at or near operating speed at factory prior to shipment.

Shaft: Fan shaft shall be turned and polished steel and sized so first critical speed is at least 25% over maximum operating speed for each pressure class.

Bearings: Air handling quality, heavy duty, grease packed, cast iron, pillow block type with grease seal, furnished with external grease fittings, selected for minimum life (ABMA L-10) of not less than 80,000 h operation at maximum cataloged operating speed. Drives and bearings shall be contained within belt tube, isolating drives completely away from

airstream.

Painting: Fan parts shall be painted with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to exterior surfaces.

Motor Mounting: Fan motor shall be mounted on adjustable platform appropriate to fan arrangement.

Inlet Bells and Screens: Furnish inlet bells and 1 inch mesh screens for fans shown without inlet ductwork.

2.10.1.7 Utility Sets

Manufacturers: Twin City, Greenheck, Chicago Blower, PennBarry, or ACME.

Housings: Heavy gauge steel with welded or lockseam fabrication and adequate reinforcing to prevent housing distortion. Furnish access doors.

Bearings: Grease lubricated, self-aligning ball bearing type with grease seal.

Painting: All fan parts shall be painted with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to all exterior surfaces.

Motor Supports: Motor supports shall be designed to adequately hold motor in place and provide adjustment on V-belt drive models.Utility sets usually use Arrangement - 10.

Provide units with scheduled high efficiency VFD rated motors with factory mounted and wired NEMA Standard disconnect switches. Exterior and rooftop units shall be furnished with factory mounted and wired NEMA weatherproof disconnect switches.

Backdraft Dampers: Provide gravity backdraft dampers, for fans not provided with motorized dampers, for mounting in discharge ductwork.

Inlet Screens: 1 inch mesh for fans without inlet ductwork.
Drain Connection: Drain connection to be located at the lowest point of fan housing.

Weather Covers: Where fans are indicated for outdoor installation, they shall be equipped with factory fabricated weather covers and weather-resistant enamel finish.

2.10.1.8 Centrifugal Type Power Roof Ventilators

Provide direct or V-belt driven centrifugal type fans with backward inclined, non-overloading wheel. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge aluminum. Provide fans with birdscreen, disconnect switch, motorized dampers, sound curb, roof curb, and extended base. Provide totally enclosed fan cooled type motor enclosure. Provide centrifugal type kitchen exhaust fans according to UL 705, fitted with V-belt drive, round hood, and windband upblast discharge configuration, integral residue trough and collection device, with motor and power transmission components located in outside positively air ventilated compartment. Use only lubricated bearings.

Manufacturers: Twin City, Greenheck, PennBarry, Chicago Blower, ACME or approved equal.

Construct housings of spun aluminum.

Construct housings of galvanized steel with baked enamel finish; color to be selected by Architect.

Exhauster wheels shall be centrifugal, non-overloading type with full inlet cones to reduce air turbulence.

Provide units with scheduled high efficiency VFD rated motors with factory mounted and wired NEMA Standard disconnect switches. Exterior and rooftop units shall be furnished with factory mounted and wired NEMA weatherproof disconnect switches.

Units shall be listed and bear UL 705 Label.

Mount units on factory installed vibration isolators.

Furnish units with bird screens.

Provide gravity backdraft dampers for fans when control dampers or motorized dampers are not scheduled or specified.

Units shall be furnished with factory fabricated, curb and extended base, as required for mounting minimum of 18 inches above roof.

Curbs shall be constructed of galvanized steel or extruded aluminum with continuous welded corner seams, treated wood nailer, minimum 1-1/2 inches thick, 3 lb density, rigid mineral fiberboard insulation with metal liner.

Units shall be furnished with factory fabricated sound curb as indicated.

2.10.1.9 Power Roof Exhausters (Upblast or Downblast (Mushroom) Type)

Provide direct or V-belt driven centrifugal type fans with backward inclined, non-overloading wheel. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge aluminum. Provide fans with birdscreen, disconnect switch, motorized dampers or gravity backdraft damper (as scheduled), sound curb, roof curb, and extended base. Provide totally enclosed fan cooled type motor enclosure. Use only lubricated bearings.

Manufacturers: Twin City, Greenheck, PennBarry, ACME or approved equal.

Construct housing of heavy gauge seamless spun aluminum.

Housing shall be finished with baked enamel; color selected by Architect.

Fan wheels shall be centrifugal, backward inclined, non-overloading type, and be spark proof aluminum construction.

Motor, bearings and drives to be completely enclosed and sealed from exhaust air stream and be positively ventilated with outside air by forced air cooling tubes.

Entire drive assembly or entire unit to be mounted on factory installed vibration isolators.

Provide all units with scheduled high efficiency VFD rated motors with factory mounted and wired NEMA Standard disconnect switches. Exterior and rooftop units shall be furnished with factory mounted and wired NEMA weatherproof disconnect switches.

Where identified units shall be furnished with hinged access arrangement, hold-open retainer chain, and flexible weatherproof electric cable.

Units shall be furnished with minimum 18 inches high factory fabricated curb. Curbs for kitchen hood exhaust application to be vented type.

2.10.1.10 Propeller Hooded Roof Supply Fan

Provide V-belt driven propeller type supply fans with non-overloading fabricated steel propellers. Fan base and hood are to be fabricated from galvanized steel. All other components are to be provided with a polyester powder coat finish. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge galvanized steel. The hood and fan frame shall be provided with required factory wind restraint tie-down points. Provide fan with rain hood with bird screen, disconnect switch, motorized isolation damper, roof curb, and extended curb base with latching hinged side access door for accessing isolation damper and duct smoke detector below the fan but above the roof. Provide totally enclosed fan cooled type motor enclosure. Provide pillow block bearings and extended lube lines for bearings.

Manufacturers: Twin City, Greenheck, PennBarry, Chicago Blower, ACME or approved equal.

Supply fan SF-8 is part of the Elevator Shaft Pressurization System and shall be designed for Smoke Control duty.

Provide units with scheduled high efficiency VFD rated motors with factory mounted and wired NEMA Standard disconnect switches. Exterior and rooftop units shall be furnished with factory mounted and wired NEMA weatherproof disconnect switches.

Provide an actuated isolation damper for each fan. Provide a weather proof cover for the damper actuator.

Units shall be furnished with factory fabricated, curb and extended base, as required for mounting minimum of 18 inches above roof. Refer to schedules and mechanical details for curb and curb extension design.

Curbs shall be constructed of galvanized steel or extruded aluminum with continuous welded corner seams, treated wood nailer, minimum 1-1/2 inches thick, 3 lb density, rigid mineral fiberboard insulation with metal liner.

Provide a curb mounting systems and fan tie-down systems that meet the requirements of section 2.7 WIND and SEISMIC ANCHORAGE in this specification section. Coordinate fan anchorage and tie down design with architect. The fan system design shall comply with the requirements of the listed codes.

2.11 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM D1654, and ASTM D3359. Submit evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 1/8 inch. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to ASTM D520 Type I.

Factory painting that has been damaged prior to acceptance by the Contracting Officer shall be field painted in compliance with the requirements of section 3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT.

2.12 SUPPLEMENTAL COMPONENTS/SERVICES

2.12.1 Chilled, Water Piping

The requirements for chilled, water, or condensate drain water piping and accessories are specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

2.12.2 Water System Accessories

The requirements for chilled water heating hot water, or condensate drain system accessories such as expansion tanks are specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.12.3 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS except as modified herein.

2.12.4 Backflow Preventers

The requirements for backflow preventers are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.12.5 Insulation

The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.12.6 Controls

The requirements for controls are specified in Section 23 09 33.13 98 ELECTRIC AND ELECTRONIC CONTROL SYSTEMS FOR HVAC.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of 3 feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices)and an additional one foot.

c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

3.2.1 Equipment Access

a. Install piping, conduit and accessories to permit access to equipment for maintenance. Relocate piping, equipment or accessories to provide access at no additional cost to Owner.

b. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment without moving other future or installed equipment or system components.

c. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 05 - Access Doors and Frames, unless otherwise indicated. Access doors for valves, shock stops or other equipment shall provide access for servicing, repairs, and/or maintenance.

d. Provide necessary coordination and information to the Trade Contractor under Division 05 - Access Doors and Frames. This information shall include required locations, sizes, and rough-in dimensions.

3.2.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete

pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

3.2.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

3.2.4 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

3.2.5 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums up to the point where the outdoor air reaches the conditioning unit.

3.2.6 Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

3.2.7 Power Roof Ventilator Mounting

Provide foamed 1/2 inch thick, closed-cell, flexible elastomer insulation to cover width of roof curb mounting flange. Where wood nailers are used, predrill holes for fasteners.

3.2.8 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 3-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum

of 28 calendar days before being loaded.

3.4 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.5 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. The cleaning process shall be done with environmentally friendly products that are all LEED compliant. When the work area is in an occupied space such as office, laboratory or warehouse protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

a. Sleeves: Fabricate sleeves, except as otherwise specified or indicated, from 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A53/A53M, Schedule 20.

b. Framed Prepared Openings: Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

c. Insulation: Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

d. Closure Collars: Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or

insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.

e. Firestopping: Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.

a. Temperatures less than 120 degrees F: Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat to metal surfaces subject to temperatures less than 120 degrees F.

b. Temperatures between 120 and 400 degrees F: Apply two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of two mils to metal surfaces subject to temperatures between 120 and 400 degrees F.

c. Temperatures greater than 400 degrees F: Apply two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of two mils to metal surfaces subject to temperatures greater than 400 degrees F.

3.7.1 Finish Painting

The requirements for finish painting of items only primed at the factory, and surfaces not specifically noted otherwise, are specified in Section 09 90 00 PAINTS AND COATINGS.

3.7.2 Color Coding Scheme for Locating Hidden Utility Components

Use scheme in buildings having suspended grid ceilings. Provide color coding scheme that identifies points of access for maintenance and operation of components and equipment that are not visible from the finished space and are accessible from the ceiling grid, consisting of a color code board and colored metal disks. Make each colored metal disk approximately 3/8 inch diameter and secure to removable ceiling panels with fasteners. Insert each fastener into the ceiling panel so as to be

concealed from view. Provide fasteners that are manually removable without the use of tools and that do not separate from the ceiling panels when the panels are dropped from ceiling height. Make installation of colored metal disks follow completion of the finished surface on which the disks are to be fastened. Provide color code board that is approximately 3 foot wide, 30 inches high, and 1/2 inches thick. Make the board of wood fiberboard and frame under glass or 1/16 inch transparent plastic cover. Make the color code symbols approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. Mount the color code board where indicated in the mechanical or equipment room.

3.8 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.9 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.10 PERFORMANCE TESTS

After testing, adjusting, and balancing is complete as specified, test each system as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Record the testing during the applicable season. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Conduct capacity tests and general operating tests by an experienced engineer. Provide tests that cover a period of not less than 14 days for each system and demonstrate that the entire system is functioning according to the specifications. Make coincidental chart recordings at points indicated on the drawings for the duration of the time period and record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

Submit test reports for the ductwork leak test, and performance tests in booklet form, upon completion of testing. Document phases of tests performed including initial test summary, repairs/adjustments made, and final test results in the reports.

3.11 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of room fan-coil units coil-induction units, air terminal units, unit ventilators, thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide

temporary filters prior to startup of all fans that are operated during construction, and install new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.12 OPERATION AND MAINTENANCE

3.12.1 Operation and Maintenance Manuals

Submit six manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.12.2 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of 8 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

3.12.3 Installation (Fans)

Install units as shown on drawings, and according to manufacturer's installation instructions. On units provided with drain connection, install drain valve and cap discharge of drain. Verify lubrication of motor and fan bearings and lubricate properly in accordance with manufacturer's recommendation.

Provide fan inlet and outlet conditions that will not reduce the performance capacity of the fan per AMCA installation recommendations maintaining minimum straight duct inlet and outlet conditions.

Provide vibration isolation flexible duct materials that do not reduce the fan inlet or outlet dimensions.

General Contractor will install curbs furnished with fans unless otherwise indicated.

Perform field mechanical balancing, if necessary, to meet vibration tolerance as specified.

Smoke Control fans shall be provide with required design calculations and fan curves for the documentation procedures and shall be installed with methods and materials that are in accordance with the requirements of local building codes.

-- End of Section --

SECTION 23 03 00.00 20

BASIC MECHANICAL MATERIALS AND METHODS
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus

GREENGUARD ENVIRONMENTAL INSTITUTE (GEI)

GEI	Greenguard Standards for Low Emitting Products

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2012) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	Scientific Certification Systems (SCS)Indoor Advantage

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Certification

1.3 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 21, FIRE SUPPRESSION; 22, PLUMBING; and 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

Section 01 91 13 COMMISSIONING applies to the work and products specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.4 QUALITY ASSURANCE

1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.4.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.3 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.4.4 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.4.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4.5.3 Sustainable Design Certification

Product shall be third party certified by GEI Greenguard Indoor Air Quality Certified, SCS Scientific Certification Systems Indoor Advantage or equal. Certification shall be performed annually and shall be current.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors shall conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and shall have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work shall be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.7 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.7.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters (except starters/controllers which are indicated as part of a motor control center), control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors shall not be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, the motor control equipment forming a part of motor control centers, and the electrical power circuits shall be provided under

Division 26, except internal wiring for components of package equipment shall be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.7.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test,

the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. The cleaning process shall be done with environmentally friendly products that are all LEED compliant. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and degreasing with environmentally friendly products prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of 1 mil; and two coats of enamel applied to a minimum dry film thickness of 1 mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

-- End of Section --

SECTION 23 05 48.00 40

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S2.71	(1983; R 2006) Guide to the Evaluation of Human Exposure to Vibration in Buildings

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB PROCEDURAL STANDARDS	(2005) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

1.2 GENERAL REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section to the extent applicable.

Section 23 64 26 CHILLED, CHILLED HOT, AND CONDENSER WATER PIPING SYSTEMS applies to work specified in this section to the extent applicable.

Ensure all vibration-control apparatus is the product of a single manufacturing source, where possible. Human exposure levels should be considered using ASA S2.71 and NEBB PROCEDURAL STANDARDS.

Scheduled isolation mounting is in inches and is a minimum static deflection.

Spans referred to in Part 2, "Vibration-Isolation Systems Application," means longest bay dimension.

Determine exact mounting sizes and number of isolators by the isolator manufacturer based on equipment that will be installed. Check equipment revolutions per minute (rpm) and spring deflections to verify that resonance cannot occur.

Five working days prior to commencement of installation, submit installation drawings for vibration isolator systems including equipment and performance requirements.

Indicate within outline drawings for vibration isolator systems, overall physical features, dimensions, ratings, service requirements, and weights of equipment.

Within ten working days of Contract Award, submit equipment and performance data for vibration isolator systems including equipment base design; inertia-block mass relative to support equipment weight; spring

loads and free, operating, and solid heights of spring; spring diameters; nonmetallic isolator loading and deflection; disturbing frequency; natural frequency of mounts; deflection of working member; and anticipated amount of physical movement at the reference points.

Ensure data includes the following:

a. Mountings

b. Bases

c. Isolators

d. Floor-Mounted Piping

e. Vertical Piping

1.2.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings

Outline Drawings

SD-03 Product Data

Equipment and Performance Data; G

Isolators; G

SD-06 Test Reports

Type of Isolator

Type of Base

Allowable Deflection

Measured Deflection

PART 2 PRODUCTS

2.1 TYPE OF VIBRATION-ISOLATION PROVISIONS

Design for vibration isolation using NEBB PROCEDURAL STANDARDS

Submit test reports for testing vibration isolation for each type of isolator and each type of base, and meet referenced standards contained within this section. Include in test reports allowable deflection and measured deflection also meeting referenced standards within this section.

2.1.1 Materials

Ensure rubber is natural rubber and elastomeris chloroprene. Shore A durometer measurement of both materials and range between 40 and 60.

Inorganic materials such as precompressed, high-density, fibrous glass encased in a resilient moisture-impervious membrane may be used in lieu of specified natural rubber and elastomers. Where this substitution is made, ensure specified deflections are modified by the manufacturing source to accommodate physical characteristics of inorganic materials and to provide equal or better vibration isolation.

Ensure weather-exposed metal vibration-isolator parts are corrosion protected. Chloroprene coat springs.

2.1.2 Mountings

Provide the following mountings:

Type A: Composite pad, with 0.25-inch thick elastomer top and bottom layers, molded to contain a pattern with nonslip characteristics in all horizontal directions. Elastomer loading is not to exceed 40 pounds per square inch (psi). Ensure minimum overall thickness is 1 inch. Maximum deflections up to 0.25-inch are allowed.

Type B: Double rubber-in-shear with molded-in steel reinforcement in top and bottom. Maximum deflections up to 0.50 inch are allowed.

Type C: Free-standing laterally stable open-spring type for deflections over 0.50 inch, with built-in bearing and leveling provisions, 0.25-inch thick Type A base elastomer pads, and accessories. Ensure outside diameter of each spring is equal to or greater than 0.9 times the operating height of the spring under rated load.

Type D: Partially housed type, containing one or more vertically restrained springs with at least 0.50 inch clearance maintained around springs, with adjustable limit stops, 0.25-inch thick Type A base elastomer pads, and accessories.

Type E: Pendulum-suspension configuration with free-standing stable spring with resilient horizontal and vertical restraints to allow maximum movements of 0.25 inch in each direction, 0.25-inch thick Type A base elastomer pads.

Type F: Combination spring and rubber-in-shear steel framed for hanger-rod mounting, with minimum total static deflection of 1 inch.

Type G: Air spring with body constructed of reinforced elastomer specifically suitable for application environment. Select air spring to provide a natural frequency equal to 5 inches of deflection of conventional specified steel springs. Provide facilities for dead-level adjustment and height-control of supported equipment.

2.1.3 Bases

Provide the following bases:

Type U: Unit isolators without rails, structural-steel bases, or inertia blocks.

Type R: Rails, connected mill-rolled structural steel, of sufficient dimension to preclude deflection at midpoint of unsupported span in excess of 1/1,440th of the span between isolators, power transmission, component misalignment, and any overhung weight. Where Type R bases are specified and the equipment proposed requires additional base support, use a Type S base.

Type S: Structural-steel bases common to a supported assembly, made from welded-joint mill-rolled structural steel with closed-perimeter configuration, isolators attached to outrigger supports.

Ensure height of steel members is sufficient to provide stiffness required to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Ensure height of steel member does not result in member deflection at midpoint of unsupported span of more than 1/1,440th of the span between isolators. Minimum height is 5 inches.

Type CIB: Provide concrete inertia blocks common to the entire assembly, with welded-joint construction, mill-rolled structural-steel perimeters, welded-in No. 4 reinforcing bars 8 inches on center each way near the bottom of the block, outrigger-isolator mounting provisions, anchor bolts, and be filled with 3,000 psi cured-strength concrete.

Configure rectangular inertia bases to accommodate equipment supported.

Ensure minimum thickness of inertia base, in addition to providing suitable mass, is sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components, and is sufficient to result in base deflection at midpoint of unsupported span of not more than 1/1,440th of the span between isolators. Verify minimum thickness, the preceding requirements not withstanding, is 8 percent of the longest base dimension.

Ensure pumps with flexible couplings does not have inertia bases less than 8 inches thick, and the minimum mass of concrete inertia block is equal in weight to supported equipment.

2.2 VIBRATION-ISOLATION SYSTEMS APPLICATION

Vibration isolation design per NEBB PROCEDURAL STANDARDS

2.2.1 Centrifugal Pump Locations

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Close-couple through 5 hp	None	-R-0.35	C-S-1.0	C-S-1.0
Bedplate-mounted through 5 hp	None	C-CIB-1.0	C-CIB-1.5	C-CIB-1.75
7-1/2 hp	None	C-CIB-1.0	C-CIB-1.75	C-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.2 Low-Pressure Suspended Air-Handling Unit (AHU) Locations

Vibration-isolation provisions apply to ceiling-suspended Air Moving and Conditioning Association Class A packaged central-station units.

TYPE EQUIPMENT	20-FOOT ROOF-SPAN PROVISIONS*	30-FOOT ROOF-SPAN PROVISIONS*	40-FOOT ROOF-SPAN PROVISIONS*
Through 5 hp	F-U-1.0	F-U-1.0	F-U-1.0
7-1/2 hp and over 250 to 500 rpm	F-U-1.75	F-U-1.75	F-U-1.75
500 rpm and over	F-U-1.0	F-U-1.25	F-U-1.55

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.3 Low-Pressure AHU Locations

Vibration-isolation provisions apply to floor-mounted Air Moving and Conditioning Association Class A packaged central-station units.

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Through 5 hp	B-U-0.35	C-U-1.0	C-U-1.0	C-U-1.0
7-1/2 hp and over 250 to 500 rpm	B-U-0.35	C-U-1.75	C-U-1.75	C-U-1.75

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
500 rpm	B-U-0.35	C-U-1.0	C-U-1.5	

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.4 Medium- And High-Pressure AHU Locations

Vibration-isolation provisions apply to floor-mounted Air Moving and Conditioning Association Classes B and C packaged central-station units.

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Through 20 hp 250 to 300 rpm	B-U-0.35	C-U-2.5	C-U-2.5	C-U-3.5
300 to 500 rpm	B-U-0.35	C-U-1.75	C-U-1.75	C-U-2.5
500 rpm and over	B-U-0.35	C-U-1.0	C-U-1.0	C-U-1.75
Over 20 hp 250 to 300 rpm	B-U-0.35	C-U-2.5	C-CIB-3.5	C-CIB-3.5
300 to 500 rpm	B-U-0.35	C-U-2.5	C-CIB-2.5	C-CIB-3.5
500 rpm and over	B-U-0.35	C-U-1.0	C-CIB-1.75	C-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.5 Air-Moving Device Locations

Vibration-isolation provisions apply to housed, unhoused, or free-standing fans of any pressure rating, located in field-erected orfactory-fabricated central-station units, unhoused return-air or supply-air service.

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Through 20 hp 200 to				

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
300 rpm	B-U-0.35	C-S-2.5	C-S-2.5	C-S-3.5
300 to 500 rpm	B-U-0.35	C-S-1.75	C-S-1.75	C-S-2.5
500 rpm and over	B-U-0.35	C-S-1.0	C-S-1.5	C-S-1.75
Over 20 hp 250 to 300 rpm	B-U-0.35	C-S-2.75	C-CIB-3.5	C-CIB-5.0
300 to 500 rpm	B-U-0.35	C-S-1.75	C-CIB-2.5	C-CIB-3.5
500 rpm and over	B-U-0.35	C-S-1.0	C-CIB-1.75	C-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.3 PIPE AND DUCT VIBRATION ISOLATION

Type G: Provide isolators with in-series contained steel springs and preformed fibrous-glass or chloroprene-elastomer elements for connecting to building-structure attachments. Load devices by supported system during operating conditions to produce a minimum spring and elastomer static deflection of 1 inch and 3/8 inch, respectively.

Type H: Provide isolators with contained chloroprene-elastomer elements for connecting to building-structure attachments. Load devices by supported system during operating conditions to produce a minimum elastomer static deflection of 3/8 inch.

Type J: Provide isolators with elastomers mounted on floor-supported columns or directly on the floor. Load devices by supported system during operating conditions to produce a minimum elastomer static deflection of 3/8 inch.

2.3.1 Floor-Mounted Piping

Type K: Provide isolators with springs mounted on floor-supported columns or directly on the floor. Load devices by supported system during operating conditions to produce a minimum spring static deflection of 1 inch.

2.3.2 Vertical Piping

Type L: Provide isolators which are pipe base-support devices with one or more contained steel springs. Load devices by supported system during operating conditions to produce a minimum static deflection of 1 inch. Equip devices with precompression and vertical-limit features, as well as a minimum 1/4-inch thick elastomer sound pad and

isolation washers, for mounting to floor.

Type M: Provide isolators which are elastomer mounted baseplate and riser pipe-guide devices, with contained double acting elastomer elements which under rated load have a minimum static deflection of 3/8 inch. Size isolator to accommodate thermal insulation within the stationary guide ring.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

Ensure rails, structural steel bases, and concrete inertia blocks are raised not less than 1 inch above the floor and are level when equipment supported is under operating load.

Ensure vibration-isolation installation and deflection testing after equipment start-up is directed by a competent representative of the manufacturer.

3.2 TESTS AND REPORTS

Ensure vibration-isolation devices are deflection tested. Submit test reports in accordance with paragraph entitled, "Submittal Procedures," of this section, substantiating that all equipment has been isolated as specified and that minimum specified deflections have been met. Make all measurements in the presence of the Contracting Officer.

-- End of Section --

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC
08/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 203	(1990; R 2011) Field Performance Measurements of Fan Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2010; Errata 2011; INT 3 2012; INT 4 2012) Ventilation for Acceptable Indoor Air Quality

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(2002; 6th ed) National Standards for Total System Balance
AABC MN-4	(1996) Test and Balance Procedures

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV	(2006) Procedural Standards for Measurements and Assessment of Sound and Vibration
NEBB PROCEDURAL STANDARDS	(2005) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1143	(1985) HVAC Air Duct Leakage Test Manual, 1st Edition
SMACNA 1780	(2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition
SMACNA 1858	(2004) HVAC Sound And Vibration Manual - First Edition

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82 Protection of Stratospheric Ozone

1.1.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.2 DEFINITIONS

a. AABC: Associated Air Balance Council.

b. COTR: Contracting Officer's Technical Representative.

c. DALT: Duct air leakage test

d. DALT'd: Duct air leakage tested

e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling.

f. NEBB: National Environmental Balancing Bureau

g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means "a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction and sealant class.""a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING." When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."

h. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.

i. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.

j. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.

k. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

l. TAB: Testing, adjusting, and balancing (of HVAC systems).

m. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed.

n. TAB Agency: TAB Firm

o. TAB team field leader: TAB team field leader

p. TAB team supervisor: TAB team engineer.

q. TAB team technicians: TAB team assistants.

r. TABB: Testing Adjusting and Balancing Bureau.

1.2.1 Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems	International Standards for Environmental Systems Balance
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures	Field Readiness Check & Prelim. Field Procedures

1.3 WORK DESCRIPTION

The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air and water distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings, including records of existing conditions Also perform data center hot aisle temperature profile for all installed racks in the data center..

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1,

NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1143, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

1.3.1 Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. TAB scope shall include stair pressurization and elevator pressurization systems as described herein and required by applicable code.

1.3.2 Water Distribution Systems

TAB system in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to water distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. At Contractor's option and with Contracting Officer's written approval, the piping systems may be insulated before systems are TAB'd.

Terminate piping insulation immediately adjacent to each flow control valve, automatic control valve, or device. Seal the ends of pipe insulation and the space between ends of pipe insulation and piping, with waterproof vapor barrier coating.

After completion of work under this section, insulate the flow control valves and devices as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.3 TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.

2. Air quantities at air terminals.

3. Air quantities and temperatures in air handling unit schedules.

4. Water quantities and temperatures in thermal energy transfer equipment schedules.

5. Water quantities and heads in pump schedules.

6. Water flow measurement fittings and balancing fittings.

7. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications:

http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf

The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

Submit three copies of the TAB Schematic Drawings and Report Forms to the Contracting Officer, no later than 21 days prior to the start of TAB field measurements.

1.3.4 Related Requirements

Sections 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS, 23 31 13.00 40 METAL DUCTS and 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER SYSTEMS apply to work specified in this section.

Specific requirements relating to Reliability Centered Maintenance (RCM) principals and Predictive Testing and Inspection (PTI), by the construction contractor to detect latent manufacturing and installation defects must be followed as part of the Contractor's Quality Control program. Refer to the paragraph titled "Sustainability" for detailed requirements.

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Records of Existing Conditions; G

TAB Firm; G

Designation of TAB team assistants; G

Designation of TAB team engineer; G or TAB Specialist; G

Designation of TAB team field leader; G

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; G

SD-03 Product Data

Equipment and Performance Data; G

TAB Related HVAC Submittals; G

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB team engineer and assistant.

TAB Procedures; G

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

Calibration; G

Systems Readiness Check; G

TAB Execution; G

TAB Verification; G

SD-06 Test Reports

DALT and TAB Work Execution Schedule; G

DALT and TAB Procedures Summary; G

Design review report; G

Pre-Final DALT report; G

Final DALT report; G

TAB report for Season 1; G

TAB report for Season 2; G

SD-07 Certificates

Independent TAB agency and personnel qualifications; G

Prerequisite HVAC Work Check Out List; G

Advanced Notice For TAB Field Work; G

Advance notice of Pre-Final DALT field work; G

Completed Pre-Final DALT Work Checklist; G

Advance Notice of Season 1 TAB Field Work; G

Completed Season 1 Pre-TAB Work Checklist; G

Advance Notice of Season 2 TAB Field Work; G

Completed Season 2 Pre-TAB Work Checklist; G

TAB Firm; G

Independent TAB Agency and Personnel Qualifications; G

DALT and TAB Submittal and Work Schedule; G

Design review report; G

Pre-field DALT preliminary notification; G

Pre-field TAB engineering report; G

1.5 QUALITY ASSURANCE

1.5.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:

a. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

1.5.2 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.3 Sustainability

Contractor must submit the following as part of the Quality Control Plan for acceptance testing:

a. List all test equipment to be used, including its manufacturer,model number, calibration date, and serial number.

b. Certificates of test personnel qualifications and certifications. Provide certification of compliance with 40 CFR 82.

c. Proof of equivalency if the contractor desires to substitute a test requirement.

Perform the following PTI as an integral part of the TAB process per the most recent edition of the NASA RCBEA GUIDE:

Fans:
- a. Vibration Analysis
- b. Balance Test and Measurement
- c. Alignment (laser preferred)
- d. Lubricating Oil Test
- e. Thermodynamic Performance Test

Heat Exchangers (General):
- a. Hydrostatic Test
- b. Airborne Ultrasonic Test
- c. Thermodynamic Performance Test
- d. Infrared Thermography (optional)

Heat Exchangers (Condenser Air Cooled):
- a. Hydrostatic Test
- b. Thermodynamic Performance Test
- c. Airborne Ultrasonic Test (optional)
- d. Pulse Ultrasonic Test (optional)

e. Infrared Thermography (optional)

HVAC Ducts:
a. Operational Test
b. Ductwork Leak Testing (DALT); Pre-Final DALT report, Final DALT report

Piping Systems:
a. Vibration Analysis
b. Infrared Thermography

Valves:
a. Hydrostatic Test
b. Airborne Ultrasonic Test (optional)
c. Thermodynamic Performance Test (optional)
d. Infrared Thermography (optional)

1.5.4 Qualifications

1.5.4.1 TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems.

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

1.5.4.2 TAB Specialist

The TAB Specialist must be either a member of AABC,an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

1.5.4.3 TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process specified in Section 01 91 13 COMMISSIONING.

1.5.4.4 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.5 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in paragraph entitled "TAB Submittal and Work Schedule."

1.5.5.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in paragraph entitled "TAB Personnel Qualification Requirements."

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

(1) Contract drawings and specifications

(2) Approved submittal data for equipment

(3) Construction work schedule

(4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in paragraph entitled "TAB Submittal and Work Schedule," is met.

e. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the

DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

(1) HVAC system installations are fully complete.

(2) HVAC prerequisite checkout work lists specified in the paragraph "Pre-Field TAB Engineering Report" are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

(3) DALT field checks for all systems are completed.

(4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

i. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

j. Insulation work: For required DALT work , ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

1.5.5.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of paragraph entitled "Independent TAB Agency Personnel Qualifications". The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of

this specification section.

1.5.5.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Pre-DALT/TAB meeting: Attend meeting with Contractor.

c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.

e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.

f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.

g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

h. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of two 8 hour workdays duration.

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

(1) TAB field visit: At the midpoint of the Season 1 and Season 2 TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workdays duration. Review the TAB final report data and certify the TAB final report.

(2) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workday duration. Review the TAB final report data and certify the TAB final report.

k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise Season 1 and Season 2 TAB field check.

1.5.5.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, "Execution."

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

1.5.6 Test Reports

1.5.6.1 Data from DALT Field Work

Report the data for the Pre-final DALT Report and Certified Final DALT Report in compliance the following requirements:

a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1143. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.

b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition, provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.

c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.

d. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

1.5.6.2 Certified TAB Reports

Submit: TAB Report for Season 1 and TAB Report for Season 2 in the following manner:

a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.

b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

(1) Measure and compile data on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Measure and record data only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls must be fully operational a minimum of 24 hours in advance of commencing data compilation. Include the specified data in the Season I TAB Report and Season I and Season 2 TAB Report.

c. System Diagrams: Provide updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations. Use a key numbering system on the diagram which identifies each outlet contained in the outlet airflow report sheets.

d. Static Pressure Profiles: Report static pressure profiles for air duct systems. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. Include the following in the static pressure report data, in addition to AABC/NEBB/TABB required data:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit and also at the following locations:

Main Duct: Take readings at four locations along the full length of the main duct, 25 percent, 50 percent, 75 percent, and 100 percent of the total duct length.

Floor Branch Mains: Take readings at floor branch mains served by

a main duct vertical riser.

Branch Main Ducts: Take readings at branch main ducts.

VAV Terminals: Take readings at inlet static pressure at VAV terminal box primary air branch ducts.

Fan Coil Units: Take readings at fan inlet and discharge.

e. Duct Traverses: Report duct traverses for main and branch main supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane."

f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

g. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

h. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

1.6 SEQUENCING AND SCHEDULING

1.6.1 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section

1.6.2 DALT and TAB Submittal and Work Schedule

Submit this schedule,and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

Qualify TAB Personnel: Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

Pre-DALT/TAB Meeting: Within 30 calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

Design Review Report: Within 60 calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Contracting Officer in writing within 5 days after completion.

Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Contracting Officer.

Submit Final DALT Report: Within 15 calendar days after completion of successful DALT Work Field Check, submit TAB report.

Pre-Field TAB Engineering Report: Within 15 calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

Prerequisite HVAC Work Check Out List and Advanced Notice For TAB Field Work: At a minimum of 115 calendar days prior to CCD, submit prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of TAB field work.

TAB Field Work: At a minimum of 90 calendar days prior to CCD, accomplish TAB field work.

Submit TAB Report: Within 15 calendar days after completion of TAB field work, submit TAB report.

TAB Field Check: 30 calendar days after Season 1 TAB report is approved by the Contracting Officer, conduct field check.

Complete TAB Work: Prior to CCD, complete all TAB work .

1.6.2.1 Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

1.6.2.2 Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.

1.6.2.3 Pre-Field TAB Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.

At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System

Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

1.7 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section directly by the first tier subcontractor. No work may be performed by a second tier subcontractor.

1.8 WARRANTY

Furnish workmanship and performance warranty for the DALT and TAB system work performed for a period not less than 1 year from the date of Government acceptance of the work; issued directly to the Government. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time constitutes grounds for having the corrective action and repairs performed by others and the cost billed to the TAB firm. The Contractor must also provide a 1 year contractor installation warranty.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section as specified in Appendix A WORK DESCRIPTIONS OF PARTICIPANTS.

3.2 PRE-DALT/TAB MEETING

Meet with the Contracting Officer's technical representative (COTR)and the designing engineer of the HVAC systems to develop a mutual understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

3.3 DALT PROCEDURES

3.3.1 Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

3.3.2 Advance Notice of Pre-Final DALT Field Work

On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing prior to the COTR's duct selection field visit.

3.3.3 Ductwork To Be DALT'd

From each duct system indicated as subject to DALT, the COTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The percentage of the total measured linear footage of each duct system sections selected to be subject to DALT is identified in the "Duct Pressure Class, Material and Leakage" mechanical schedule. Sections of duct systems subject to DALT will include the percentage identified of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

It is acceptable for an entire duct system to be DALT'd instead of disassembling that system in order to DALT only the 20 percent portion specified above.

3.3.4 DALT Testing

Perform DALT on the HVAC duct sections of each system as selected by the COTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings and in the schedules, to comply with the procedures specified in SMACNA 1143.

In spite of specifications of SMACNA 1143 to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the COTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

3.3.5 Pre-final DALT Report

After completion of the DALT work, prepare a Pre-final DALT Report meeting the additional requirements specified in Appendix B REPORTS - DALT and TAB. Data required by those data report forms shall be furnished by the TAB team. Prepare the report neatly and legibly; the Pre-final DALT report shall provide the basis for the Final DALT Report.

TAB supervisor shall review, approve and sign the Pre-Final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-Final DALT Report data can commence.
After completion of the DALT work, prepare a Pre-final DALT Report using the reporting forms specified. TAB team to furnish data required by those data report forms . Prepare the report neatly and legibly; the Pre-final DALT report is the basis for the Final DALT Report. TAB supervisor must review and certify the Pre-final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-final DALT Report data can commence.

3.3.6 Quality Assurance - COTR DALT Field Acceptance Testing

In the presence of the COTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the COTR. For each duct system,

this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.

Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the presence of the COTR.

3.3.7 Additional COTR Field Acceptance Testing

If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the COTR.

3.3.8 Certified Final DALT Report
On successful completion of all field checks of the Pre-final DALT Report data for all systems, the TAB Supervisor is to assemble, review, certify and submit the Final DALT Report to the Contracting Officer for approval.

On successful completion of all field checks of the Pre-Final DALT Report data for all systems, the TAB Supervisor shall assemble, review, approve, sign and submit the Final DALT Report in compliance with Appendix B REPORTS - DALT and TAB to the Contracting Officer for approval.

3.3.9 Prerequisite for TAB Field Work

Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

3.4 TAB PROCEDURES

3.4.1 TAB Field Work

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

That is, comply with the requirements of AABC MN-1 and AABC MN-4, NEBB PROCEDURAL STANDARDS, NEBB MASV, or SMACNA 1780 (TABB) and SMACNA 1858 (TABB), except as supplemented and modified by this section.

Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section.

3.4.2 Preliminary Procedures

Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

3.4.3 TAB Air Distribution Systems

3.4.3.1 Units With Coils

Report heating and cooling performance capacity tests for hot water, and chilled water coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."

   Do not determine entering and leaving wet and dry bulb temperatures by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

   Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

   Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.3.2 Air Handling Units

Air handling unit systems including fans (air handling unit fans, exhaust fans and winter ventilation fans), coils, ducts, plenums, mixing boxes, terminal units, variable air volume boxes, and air distribution devices for supply air, return air, outside air, mixed air relief air, and makeup air.

3.4.3.3 Energy Recovery Units

Energy Recovery Unit systems including fans, filters, heat exchanger media, coil, or wheel, dampers.

3.4.3.4 Return Air Fans

Return air fan system including fan ducts, plenums, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed

air.

3.4.3.5 Fan Coils

Fan coil unit systems including fans, coils, ducts, plenums, and air distribution devices for supply air, return air, and outside air.

3.4.3.6 Exhaust Fans

Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.

3.4.4 Stairwell Pressurization Systems and Elevator Pressurization System

For stair and elevator pressurization fan systems, TAB contractor shall measure pressure differential across each stairway door with associated fan operating at minimum speed. TAB contractor shall increase fan speed via VFD to maintain a minimum of 0.15 inches and a maximum of 0.35 inches differential across each door with all doors closed. Record fan speed and coordinate with VFD manufacturer.

3.4.5 TAB Water Distribution Systems

3.4.5.1 Chilled Water (Including Chilled Beam Water)

Chilled water systems including chilled water converters (e.g., heat exchangers) pumps, coils, system balance valves and flow measuring devices.

3.4.5.2 Heating Hot Water

Heating hot water systems including pumps, coils, boilers, system balancing valves and flow measuring devices.

3.4.6 TAB Work on Performance Tests Without Seasonal Limitations

3.4.6.1 Performance Tests

In addition to the TAB proportionate balancing work on the air distribution systems and the water distribution systems, accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the heating systems and cooling systems.

3.4.6.2 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3.4.6.3 Coils

Report heating and cooling performance capacity tests for hot water, chilled water, for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units

and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing".

Entering and leaving wet and dry bulb temperatures are not determined by single point measurement, but the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.7 TAB Work on Performance Tests With Seasonal Limitations

3.4.7.1 Performance Tests

Accomplish proportionate balancing TAB work on the air distribution systems and water distribution systems, in other words, accomplish adjusting and balancing of the air flows and water flows, any time during the duration of this contract, subject to the limitations specified elsewhere in this section. However, accomplish, within the following seasonal limitations, TAB work on HVAC systems which directly transfer thermal energy.

3.4.7.2 Season Of Maximum Load

Visit the contract site for at least two TAB work sessions for TAB field measurements. Visit the contract site during the season of maximum heating load and visit the contract site during the season of maximum cooling load, the goal being to TAB the operational performance of the heating systems and cooling systems under their respective maximum outdoor environment-caused loading. During the seasonal limitations, TAB the operational performance of the heating systems and cooling systems.

3.4.7.3 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3.4.7.4 Coils

Report heating and cooling performance capacity tests for hot water, chilled water and chilled beam water for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."

   Entering and leaving wet and dry bulb temperatures are not determined by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

   Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

   Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.8 Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Contracting Officer for direction.

3.4.9 Deficiencies

Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph entitled "Workmanship," provide written notice as soon as possible to the Contractor and the Contracting Officer describing the deficiency and recommended correction.

Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

3.4.10 TAB Reports

Additional requirements for TAB Reports are specified in Appendix B REPORTS - DALT and TAB
After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and certification, using the reporting forms approved in the pre-field engineering report. Data required by those approved data

report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph entitled "Workmanship."

Prepare the report neatly and legibly; the pre-final TAB report is the final TAB report minus the TAB supervisor's review and certification. Obtain, at the contract site, the TAB supervisor's review and certification of the TAB report.

Verbally notify the COTR that the field check of the TAB report data can commence; give this verbal notice 48 hours in advance of field check commencement. Do not schedule field check of the TAB report until the specified workmanship requirements have been met or written approval of the deviations from the requirements have been received from the Contracting Officer.

3.4.11 Quality Assurance - COTR TAB Field Acceptance Testing

3.4.11.1 TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR and the Commissioning Agent, random selections of data (water, air quantities, air motion, sound level readings) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the COTR and coordinated with the Commissioning Agent. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

Group 1: All pumps, boilers, heat exchangers, supply fans, return fans, exhaust fans, air handling units, energy recovery units, fan coil units, chilled beams, and all associated automation controls.

Group 2: 25 percent of the VAV terminal boxes and associated diffusers and registers.

Group 3: 25 percent of the supply diffusers, registers, grilles associated with constant volume air handling units.

Group 4: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.

Further, if any data on the TAB Report for Groups 2 through 4 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

3.4.11.2 Additional COTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report.

Reschedule acceptance testing of the revised report data with the COTR. Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to be be found. This additional field testing is up and above the original 25 percent of the reported data entries to be field tested.

If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.

3.4.11.3 Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Contracting Officer approval of the TAB Report submitted.

3.5 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

3.6 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

3.7 APPENDICES

Appendix A WORK DESCRIPTIONS OF PARTICIPANTS
Appendix B REPORTS - DALT and TAB
Appendix C DALT AND TAB SUBMITTAL AND WORK SCHEDULE
(Note that Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING has been omitted from this specification section. Refer to the "Duct Pressure Class, Material and Leakage" schedule in the Mechanical Drawings for pertinent duct design information). Refer to Section 23 31 13.00 40 METAL DUCTS for specific duct leakage testing requirements for welded ducts.

Appendix A

WORK DESCRIPTIONS OF PARTICIPANTS

The Contractor is responsible for ensuring compliance with all requirements of this specification section. However, the following delineation of specific work items is provided to facilitate and co-ordinate execution of the various work efforts by personnel from separate organizations.

1. Contractor

a. HVAC documentation: Provide pertinent contract documentation to the TAB Firm, to include the following: the contract drawings and specifications; copies of the approved submittal data for all HVAC equipment, air distribution devices, and air/water measuring/balancing devices; the construction work schedule; and other applicable documents requested by the TAB Firm. Provide the TAB Firm copies of contract revisions and modifications as they occur.

b. Schedules: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Pre-DALT and TAB meeting: Arrange and conduct the Pre-DALT and TAB meeting. Ensure that a representative is present for the sheet metal contractor, the mechanical contractor, the electrical contractor, and the automatic temperature controls contractor.

d. Coordinate Support: Provide and coordinate support personnel required by the TAB Firm in order to accomplish the DALT and TAB field work. Support personnel may include factory representatives, HVAC controls installers, HVAC equipment mechanics, sheet metal workers, pipe fitters, and insulators. Ensure support personnel are present at the work site at the times required.

e. Correct Deficiencies: Ensure the notifications of Construction Deficiencies are provided as specified herein. Refer to the paragraph entitled "Construction Deficiencies." Correct each deficiency as soon as practical with the Contracting Officer, and submit revised schedules and other required documentation.

f. Pre-TAB Work Checklists: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as pre-TAB work checklist items, the deficiencies pointed out by the TAB team supervisor in the design review report.

Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's DALT and TAB Work Procedures Summary. Do not allow the TAB team to commence TAB field work until all of the following are completed.

g. Give Notice of Testing: Submit advance notice of TAB field work accompanied by completed prerequisite HVAC Work List

h. Insulation work: Ensure that no insulation is shall not be installed

on ducts to be DALT'd until DALT work on the subject ducts is complete.

Ensure the duct and piping systems are properly insulated and vapor sealed upon the successful completion and acceptance of the DALT and TAB work.

2. TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Schedule: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Submittals: Provide the submittals specified herein.

d. Pre-DALT/TAB meeting: Attend meeting with Contractor. Ensure TAB personnel that will be involved in the TAB work under this contract attend the meeting.

e. Design Review Report: Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

f. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the DALT and TAB Procedures Summary, the during the DALT or TAB field work.

Ensure the Contractor is properly notified and aware of all support personnel needed to perform the TAB work. Maintain communication with the Contractor regarding support personnel throughout the duration of the TAB field work, including the TAB field acceptance testing checking.

Ensure all inspections and verifications for the Pre-Final DALT and Pre-TAB Checklists are completely and successfully conducted before DALT and TAB field work is performed.

g. Advance Notice: Monitor the completion of the duct system installations and provide the Advance Notice for Pre-Final DALT field work as specified herein.

h. Technical Assistance: Provide technical assistance to the DALT and TAB field work.

i. Deficiencies Notification: Ensure the notifications of Construction Deficiencies are provided as specified herein. Comply with requirements of the paragraph entitled "Construction Deficiencies." Resolve each deficiency as soon as practical and submit revised schedules and other required documentation.

j. Procedures: Develop the required TAB procedures for systems or system components not covered in the TAB Standard.

3. TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, "Execution."

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC work list, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

Appendix B

REPORTS - DALT and TAB

All submitted documentation must be typed, neat, and organized. All reports must have a waterproof front and back cover, a title page, a certification page, sequentially numbered pages throughout, and a table of contents. Tables, lists, and diagrams must be titled. Generate and submit for approval the following documentation:

1. DALT and TAB Work Execution Schedule

Submit a detailed schedule indicating the anticipated calendar date for each submittal and each portion of work required under this section. For each work entry, indicate the support personnel (such as controls provider, HVAC mechanic, etc.) that are needed to accomplish the work. Arrange schedule entries chronologically.

2. DALT and TAB Procedures Summary

Submit a detailed narrative describing all aspects of the DALT and TAB field work to be performed. Clearly distinguish between DALT information and TAB information. Include the following:

a. A list of the intended procedural steps for the DALT and TAB field work from start to finish. Indicate how each type of data measurement will be obtained. Include what Contractor support personnel are required for each step, and the tasks they need to perform.

b. A list of the project's submittals that are needed by the TAB Firm in order to meet this Contract's requirements.

c. The schematic drawings to be used in the required reports, which may include building floor plans, mechanical room plans, duct system plans, and equipment elevations. Indicate intended TAB measurement locations, including where test ports need to be provided by the Contractor.

d. The data presentation forms to be used in the report, with the preliminary information and initial design values filled in.

e. A list of DALT and TAB instruments to be used, edited for this project, to include the instrument name and description, manufacturer, model number, scale range, published accuracy, most recent calibration date, and what the instrument will be used for on this project.

f. A thorough checklist of the work items and inspections that need to be accomplished before DALT field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Pre-Final DALT Work Checklist before DALT field work can be accomplished.

g. A thorough checklist of the work items and inspections that need to be accomplished before the Season 1 TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Season 1 Pre-TAB Work Checklist before the Season 1 TAB field work can be accomplished.

h. A thorough checklist of the work items and inspections that need to be accomplished before the Season 2 TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Season 2 Pre-TAB Work Checklist before the Season 2 TAB field work can be accomplished.

i. The checklists specified above shall be individually developed and tailored specifically for the work under this contract. Refer to NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under the paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" for examples of items to include in the checklists.

3. Design Review Report

Submit report containing the following information:

a. Review the contract specifications and drawings to verify that the TAB work can be successfully accomplished in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

b. Submit a typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the DALT work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. If no deficiencies are evident, state so in the report.

4. Pre-Final DALT Report for COTR DALT Field Checks

Report the data for the Pre-Final DALT Report meeting the following requirements:

a. Submit a copy of the approved DALT and TAB Procedures Summary: Provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit a comprehensive report for the DALT field work data using data presentation forms equivalent to the "Air Duct Leakage Test Summary Report Forms" located in the SMACNA 1143. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Node numbers shall be included in the completed report forms to identify each duct section.

c. Calculations: Include a copy of all calculations prepared in determining the duct surface area of each duct test section. Include in the DALT reports copy(s) of the calibration curve for each of the DALT test orifices used for testing.

d. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments are to be calibrated within one year of the date of use in the field; instrument calibration is to be traceable to the measuring standards of the National Institute of Standards and

Technology.

e. TAB Supervisor Approval: Include on the submitted report the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

5. Final DALT Report

On successful completion of all COTR field checks of the Pre-final DALT Report data for all systems, the TABS Supervisor shall assemble, review, sign and submit the Final DALT Report to the Contracting Officer for approval.

6. TAB Reports: Submit TAB Report for Season 1 and TAB Report for Season 2 in the following manner:

a. Procedure Summary: Submit a copy of the approved DALT and TAB Procedures Summary. When applicable, provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit the completed data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed, approved and signed by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data shall be typewritten. Handwritten report forms or report data are not acceptable.

c. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

(1) Data shall be measured and compiled on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Data shall be measured/recorded only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode. Provide a detailed explanation wherever a final measurement did not achieve the required value.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, the Contractor shall temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls shall have been fully operational a minimum of 24 hours in advance of commencing data compilation. The specified data shall be included in the Season I and Season 2 TAB Report.

d. Air System Diagrams: Provided updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations.

e. Air Static Pressure Profiles: Report static pressure profiles for air

duct systems including: AHU-1, AHU-2, AHU-3, AHU-4, AHU-5, AHU-6, AHU-7, AHU-7, AHU-9, AHU-10, SF-1, SF-2, SF-3, SF-4, SF-5, SF-6 SF-7, SF-8, EF-1, EF-2, EF-3, EF-4, EF-5, EF-6, FCU-1-1, FCU-1-2, FCU-1-3, FCU-1-4, FCU-1-5, FCU-1-6, FCU-1-7, FCU-1-8, FCU-2-1, FCU-2-2, FCU3-1, FCU-3-2, FCU- 4-1, FCU-4-2, FCU-5-1, FCU-5-2, FCU-5-3, FCU-6-1, FCU-6-2, FCU-6-3, FCU-6-4, FCU-7-1, FCU-7-2, FCU-8-1, FCU-8-2, ERU-1, ERU-2, B-1, and B-2. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. The static pressure report data shall include, in addition to AABC or NEBB or TABB required data, the following:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.

f. Duct Transverses: Report duct traverses for main and branch main supply, return, exhaust, relief and outside air ducts. This shall include all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency shall evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pitot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane".

g. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings shall

provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

h. Performance Curves: The TAB Supervisor shall include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor shall include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturis and flow orifices TAB'd on the job.

j. Data From TAB Field Work: After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and approval signature, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms shall be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report shall be considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph

entitled "Workmanship."

Appendix C

DALT AND TAB SUBMITTAL AND WORK SCHEDULE

Perform the following items of work in the order listed adhering to the dates schedule specified below.

Submit TAB Agency and TAB Personnel Qualifications: Within 42 calendar days after date of contract award.

Submit the DALT and TAB Work Execution Schedule: within 14 days after receipt of the TAB agency and TAB personnel qualifications approval. Revise and re-submit this schedule 28 days prior to commencement of DALT work and 28 days prior to the commencement of TAB Season 1 work and TAB Season 2 work.

Submit the DALT and TAB Work Procedures Summary: within 14 days after receipt of the initial approved DALT and TAB Work Execution Schedule.

Meet with the COTR at the Pre-DALT/TAB Meeting: Within 28 calendar days after receipt of the approved initial DALT/TAB Execution Schedule.

Submit Design Review Report: Within 56 calendar days after the receipt of the approved initial DALT and TAB Work Execution Schedule.

Conduct measurements and submit the Record of Existing Facility Conditions: within 28 days after receipt of approved DALT and TAB Work Procedures Summary.

Advance Notice of Pre-Final DALT Field Work: After the completed installation of the HVAC duct system to be DALT'd, submit to the Contracting Officer an Advance Notice of Pre-Final DALT Field Work accompanied by the completed Pre-Final DALT Work Checklist checklist for the subject duct system.

Ductwork Selected for DALT: Within 14 calendar days after receiving an acceptable completed Pre-Final DALT Work Checklist, the Contracting Officer's technical representative (COTR) will select the project ductwork sections to be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected project ductwork.

Submit Pre-Final DALT Report: Within two working days after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

Quality Assurance - COTR DALT Field Checks: Upon approval of the Pre-final DALT Report, the COTR's DALT field check work shall be scheduled with the Contracting Officer.

Submit Final DALT Report: Within 14 calendar days after completion of successful DALT Work Field Check, submit Season 1 TAB report.

Advance Notice of Season 1 TAB Field Work: At a minimum of 14 calendar days prior to Season 1 TAB Field Work, submit advance notice of TAB field work accompanied by completed Season 1 Pre-TAB Work Checklist.

Season 1 TAB Field Work: At a minimum of 84 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work.

Submit Season 1 TAB Report: Within 14 calendar days after completion of Season 1 TAB field work, submit initial Season 1 TAB report.

Season 1 Quality Assurance - COTR TAB Field Check: 30 calendar days after initial Season 1 TAB report is approved by the Contracting Officer, conduct Season 1 field check.

Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work and submit final.

Receive the approved TAB report: Within 21 calendar days, receive the report from Contracting Officer approved TAB report.

Advance Notice of Season 2 TAB Field Work: At a minimum of 126 calendar days after CCD, submit advance notice of Season 2 TAB field work accompanied by completed Season 2 Pre-TAB Work Checklist.

Season 2 TAB Field Work: Within 14 calendar days after date of advance notice of Season 2 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within 14 calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 Quality Assurance - COTR TAB Field Checks: 28 calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

Complete Season 2 TAB Work: Within 14 calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

Receive the approved TAB report: Within calendar 21 days, receive the report from Contracting Officer.

-- End of Section --

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2010; INT 1 2011; Errata 2011, Errata 2011; Errata 2011, INT 2-12 2011, Errata 2011; Addenda A, B, C, G, H, J, K, O, P, S, Y, Z, BZ, CG, CI, AND DS 2012; INT 13 2012; Errata 2012, Errata 2012, Errata 2012, Errata 2012) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2013a) Standard Specification for Stainless Steel Wire
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C1136	(2010) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C195	(2007) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C449	(2007) Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C534/C534M	(2011) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C795	(2008) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(1985; R 2007) Standard Specification for

	Adhesives for Duct Thermal Insulation
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM E2231	(2009) Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

GREENGUARD ENVIRONMENTAL INSTITUTE (GEI)

GEI	Greenguard Standards for Low Emitting Products

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1999) National Commercial & Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2012) Standard for the Installation of Warm Air Heating and Air Conditioning Systems

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	Scientific Certification Systems (SCS) Indoor Advantage

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-24179	(1969; Rev A; Am 2 1980; Notice 1 1987) Adhesive, Flexible Unicellular-Plastic Thermal Insulation
MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation

UNDERWRITERS LABORATORIES (UL)

UL 723	(2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials
UL 94	(1996; Reprint Jan 2012) Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 SYSTEM DESCRIPTION

1.2.1 General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Field applied insulation materials required for use on Government-furnished items shall be furnished and installed by the Contractor.

1.2.2 Surface Burning Characteristics

Unless otherwise specified, insulation shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flame spread, and smoke developed indexes, shall be determined by ASTM E84 or UL 723. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Test specimens shall be prepared and mounted according to ASTM E2231. Insulation materials located exterior to the building perimeter are not required to be fire rated.

1.2.3 Recycled Materials

Provide thermal insulation containing recycled materials to the extent practicable, provided that the materials meets all other requirements of this section. The minimum recycled material content of the following insulation are:

Rock Wool	75 percent slag of weight
Fiberglass	20-25 percent glass cullet by weight
Rigid Foam	9 percent recovered material

1.2.4 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation

identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submit the three SD types, SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time for each system.

SD-02 Shop Drawings

MICA Plates
Pipe Insulation Systems and Associated Accessories
Duct Insulation Systems and Associated Accessories
Equipment Insulation Systems and Associated Accessories
Insulation Systems; G

SD-03 Product Data

Certification
Pipe Insulation Systems; G
Duct Insulation Systems; G
Equipment Insulation Systems; G

SD-04 Samples

Thermal Insulation

SD-08 Manufacturer's Instructions

Pipe Insulation Systems
Duct Insulation Systems
Equipment Insulation Systems

1.4 QUALITY ASSURANCE

1.4.1 Installer Qualification

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.4.2 Sustainable Design Certification

Product shall be third party certified by GEI Greenguard Indoor Air Quality Certified, SCS Scientific Certification Systems Indoor Advantage or equal. Certification shall be performed annually and shall be current.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material. Insulation packages and containers shall be asbestos free.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. Materials furnished under this section shall be submitted together in a booklet and in conjunction with the MICA plates booklet (SD-02). Annotate the product data to indicate which MICA plate is applicable. Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems which are located within, on, under, and adjacent to buildings; and for plumbing systems. Insulation shall be CFC and HCFC free.

2.2 MATERIALS

Provide insulation that meets or exceed the requirements of ASHRAE 90.1 - IP. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C795 requirements. Calcium silicate shall not be used on chilled or cold water systems. Materials shall be asbestos free and conform to the following:Flexible Elastomeric: Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive. Comply with ASTM C534/C534M, Type I, Grade 1, for tubular materials and Type II, Grade 1, for sheet materials. Provide product recognized under UL 94 and listed in FM APP GUIDE.

2.2.1 Adhesives

2.2.1.1 General

Products shall be compatible with surfaces and materials on which they are applied, and shall be suitable for use at operating temperatures of systems to which they are applied.

Products shall be fire retardant, moisture resistant and mildew resistant and vermin proof.

Adhesives, mastic, sealants, and protective finishes shall be as recommended by insulation manufacturer for specified application.

Glass fiber fabric reinforcing shall be 10 by 10 or 20 by 10 mesh.

Wire mesh reinforcing shall be 22 ga, 1 inch galvanized.

Insulation cement shall be ANSI/ASTM C195, hydraulic setting mineral wool.

Finishing cement shall be ASTM C449.

Butt joint and longitudinal joint adhesive for Type A insulation shall be Armstrong 520, Rubatex 373, Manville 57, or approved equal.

Weather-resistant protective finish for Type A insulation shall be Armstrong WB Armaflex finish or approved equal.

2.2.1.2 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C916, Type I.

2.2.1.3 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C195.

2.2.1.4 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Adhesive shall be MIL-A-3316, Class 1, pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations for pipe and duct insulation. Submit and display, after approval of materials, actual sections of installed systems, properly insulated in accordance with the specification requirements. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. The Contracting Officer will inspect display sample sections at the jobsite. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

a. Pipe Insulation Display Sections: Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric waterways and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

b. Duct Insulation Display Sections: Display sample sections for rigid and flexible duct insulation used on the job. A temporary covering shall be used to enclose and protect display sections for duct insulation exposed to weather.

2.2.2 Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation shall be used to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product recognized under UL 94 and listed in FM APP GUIDE.

2.2.3 Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

2.2.4 Corner Angles

2.2.4.1 General

Nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum shall be ASTM B209, Alloy 3003, 3105, or 5005.

2.2.4.2 Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor).

2.2.5 Finishing Cement

ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with ASTM C795.

2.2.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth, with 20X20 maximum mesh size, and glass tape shall have maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces/square yard. Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.

2.2.7 Staples

Outward clinching type monel.

2.2.8 Jackets - Insulation jacket materials shall conform to Table 1 for pipe systems and Table 2 for duct systems.

Jacket puncture resistances shall be based on ASTM D-781 test methods. Vapor barrier permeance ratings shall be based on ASTM E-96 Procedure A

Type A-1 Jacket (Protective Insulation Shield):

Factory fabricated .016" thick, ASTM B209, Type 3003 or 1100, stucco embossed aluminum jacket with integrally bonded polykraft moisture barrier, complete with integral longitudinal Pittsburgh Z-Lock seam.

Fitting covers shall be factory fabricated from not lighter than 0.024" thick, Type 3003 or 1100 aluminum.

Jacketing system shall be Childers Lock-On or approved equal.

Type D-1 Jacket:

Heavy-duty, fire retardant material with glass fiber reinforcing. Jackets shall have neat, white Kraft finish suitable for painting, with beach puncture resistance of 50 units minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ", Johns Manville "AP" or approved equal.

Type D-2 Jacket:

Glass fiber reinforced foil Kraft laminate with permeance not exceeding 0.02 perm and beach puncture resistance 25 units minimum. Owens Corning "FRK", Johns Manville "FSK", or approved equal.

Type D-3 Jacket:

Self-adhering, multiple laminated waterproofing material with reflective aluminum foil, high density polymer films and minimum 40 mil rubberized asphalt waterproofing compound, similar to Peel and Seal or Flex Clad 400 by MFM Building Products Corp., Alumaguard 60 by Polyguard, or approved equal. Products shall carry minimum 10 yr manufacturer's warranty.

Venture Clad 1577 CW may be used.

a. Jackets shall be minimum 5 ply laminated, weather proofing material with acrylic adhesive capable of installation with no additional mechanical attachments, 0.00 water vapor permeance rating per ASTM E-96, mold inhibitors incorporated and UV stable.

b. Jackets shall have an aluminum finish.

Products shall carry minimum 10 yr manufacturer's warranty.

Type E-1 Jacket:

Glass fiber reinforcing fabric imbedded in weather barrier mastic as

per manufacturer's recommended procedure for 2 coat application.

Type E-2 Jacket:

Heat sealable, multi-ply laminate consisting of layer of asphalt, glass fiber reinforcement, second layer of asphalt, aluminum foil layer, third layer of asphalt, and polyester outer film. Pittsburgh Corning Pittwrap or approved equal. Minimum total thickness shall be 125 mils.

Self-sealing, non-metallic sheet consisting of special bituminous resin reinforced with woven glass fabric and 1 mil thick aluminum film. Pittsburgh Corning Pittwrap SS or approved equal. Minimum total thickness shall be 70 mils.

Type E-3, Jacket

Self-sealing, modified bituminous membrane reinforced with glass fabric and 1 mil thick aluminum film. Pittsburgh Corning Pittwrap CW Plus or approved equal. Minimum total thickness shall be 50 mils.

Type P-1 Jackets:

Heavy-duty, fire retardant material with glass fiber reinforcing and self-sealing lap. Jacket shall have neat, white Kraft finish suitable for painting, with beach puncture resistance of 50 units minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ-SSL", Johns Manville flame-safe "AP-T" or approved equal.

Jacketing system shall be Johns Manville Zeston/Perma-Weld System, Speedline Smoke Safe, or approved equal. Similar product by PROTO will be acceptable.

2.2.9 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 gauge.

2.2.10 Insulation Bands

Insulation bands shall be 1/2 inch or 3/4 inchwide; 26 gauge stainless steel.

2.2.11 Sealants

Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum moisture vapor transmission of 0.02 perms, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3 INSULATION SYSTEMS

Insulation materials and thickness shall conform to Table 1 for pipe systems and Table 2 for duct systems. Insulation thickness shall meet or exceed the requirements of ASHRAE 90.1 - IP. . Comply with EPA requirements in accordance with Section 01 33 29 LEED(TM) DOCUMENTATION. Pipe insulation materials shall be limited to those listed herein and

shall meet the following requirements:

Insulation materials shall be fire retardant, moisture and mildew resistant, vermin proof and suitable to receive jackets, adhesives and coatings as indicated.

Glass fiber insulation shall be of inert inorganic material, non-corrosive to mechanical surfaces.

Insulating cement shall be Quick-Cote by PK Insulation Mfg. Co., Ryder GP, or approved equal with dry density of no more than 38 lb/ft3, thermal conductivity of 0.96 at 400 degrees F mean temperature, and service temperature to 1200 degrees F.

Filling and finishing cement shall be Super-Stik by PK Insulation Mfg. Co., Ryder MW, or approved equal with dry density of no more than 24 lb/ft3 thermal conductivity of 0.74 at 500 degrees F mean temperature, and service temperature to 1900 degrees F.

Type A Insulation (Closed Cell Elastomeric Thermal Insulation):

a. Minimum nominal density of 6 lb/ft3 thermal conductivity not more than 0.28 at 75 degrees F mean temperature, maximum water vapor transmission of 0.08 perm-inch and suitable for temperatures from -70 to 220 degrees F, Armacell Model AP/Armaflex, K-Flex USA, Aeroflex Model Aerocel, or approved equal.

Type F Insulation (Flexible Glass Fiber):

a. Minimum density of 0.75 lb/ft3 with thermal conductivity of not more than 0.29 at 75 degrees F mean temperature, and suitable for temperatures to 250 degrees F. Owens Corning "All Service Duct Wrap", Johns Manville Microlite, or approved equal.

Type FR Insulation (Fire Resistive Duct Wrap):

a. Wrap material shall have fire resistive rating of 2 h and shall be Fire Master Fast Wrap XL duct wrap by Thermal Ceramics, similar products by Unifrax or 3M, or approved equal. Wrap shall be 1-1/2 inches thick, service range up to 2000 degrees F and R-value per ASTM C518, 4.15 per inch at 70 degrees F.

b. Wrap shall have the following requirements:

(1) Through-penetration firestop systems for air ducts, ASTM E814, 2-hour F and T Ratings.

(2) Non-combustibility, ASTM E136.

(3) ISO-6944, Fire Resistance Tests - Ventilation Ducts.

Type G Insulation (Cellular Glass):

a. 100 percent cellular glass cells with no organic material, noncombustible, 0.00 perm-inch permeability, 7.5 lb/ft3 average density, compression strength 90 psi, thermal conductivity of not more than 0.31 at 50 degrees F mean temperature and service temperature of 900 degrees F. Pittsburgh Corning Foamglas or approved equal.

Type R Insulation (Rigid Glass Fiber):

a. Minimum nominal density of 3 lb/ft3 with thermal conductivity of not more than 0.23 at 75 degrees F mean temperature. Minimum compressive strength at 10 percent deformation shall be 25 lb/ft2.

b. Pipe insulation shall be suitable for temperatures to 850 degrees F. Johns Manville Micro-Lok 850, Owens Corning Fiberglas ASJ/SSL-II, or approved equal.

c. Duct and equipment insulation shall be suitable for temperatures to 450 degrees F. Johns Manville Spin-Glas Type 814, Owens Corning Type 703, or approved equal.

d. Pipe and tank wrap faced with specified jacket may be used for equipment and round ducts insulation, provided that it meets all insulation characteristics requirements stated above and maintains same R-value as specified. Knauf Pipe and Tank Insulation or approved equal.

Type RR Insulation (Rigid Glass Fiber):

a. Minimum nominal density of 6 lb/ft3 with thermal conductivity of not more than 0.22 at 75 degrees F mean temperature. Insulation shall be suitable for temperatures to 450 degrees F. Minimum compressive strength at 10 percent deformation shall be 200 lb/ft2, Johns Manville Spin-Glas Type 817 or Owens Corning 705, or approved equal.

b. TUFF-R Polyisocyanurate Insulation by Celotex may be used for Type RR insulation specified for exterior rectangular ductwork, provided minimum thickness is 3/4 inches and R-value is not less than R-value specified.

c. Pipe and tank wrap faced with specified jacket may be used for equipment and round duct insulation, provided that it meets all insulation characteristics requirements stated above and maintains same R-value as specified.

Type KG Insulation (Kitchen Grease Duct Wrap):

a. Wrap material shall be suitable for kitchen grease duct wrap meeting IMC 2006 and shall be Fire Master Fast Wrap XL by Thermal Ceramics or similar products by Unifrax or 3M. Wrap shall be two layers, each 2 inches thick maximum, service range up to 2000 degrees F and R-value per ASTM C518, 4.15 per inch at 70 degrees F.

b. Wrap shall have the following requirements:

(1) Through-penetration firestop systems for air ducts, ASTM E814, 2-hour F and T Ratings.

(2) Passes ASTM E2336 test standard, shall have ICC ESR.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.

3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

3.1.2 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING. The protection of ducts at point of passage through firewalls must be in accordance with NFPA 90A and/or NFPA 90B. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a NRTL.

3.1.3 Painting and Finishing

Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1.4 Installation of Flexible Elastomeric Cellular Insulation

Flexible elastomeric cellular insulation shall be installed with seams and joints sealed with rubberized contact adhesive. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 220 degrees F. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish or PVC or metal jacketing as recommended by the manufacturer after the adhesive is dry and cured. A brush coating of adhesive shall be applied to both butt ends to be joined and to both slit surfaces to be sealed. The adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be

pulled apart one hour after installation shall be replaced.

3.1.5 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.6 Pipes/Ducts/Equipment which Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items, as specified.

3.2 PIPE INSULATION SYSTEMS INSTALLATION

When used in this section, the term Chilled Water shall include Chilled Beam Water as well as chilled water.

Install pipe insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards published by MICA (Midwest Insulation Contractors Association) and manufacturer's installation instructions, except as modified in this Section of specifications.

Install products with good workmanship, with smooth and even surfaces. Use full-length factory-furnished material where possible. Do not use scrap pieces.

Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed. Do not insulate any section of system that must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects prior to end of guarantee period shall be accomplished at no expense to Owner.

Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required, and to allow for expansion.

Where possible longitudinal joints in jackets shall face toward wall or ceiling.

Apply insulation to each pipe or duct individually. Common insulation applied to adjacent pipes or ducts will not be accepted.

Unless otherwise indicated, pipe and duct insulation shall be continuous through walls and floors.

Where multiple layers of insulation are used, stagger and secure each layer with metal bands.

Where penetrations occur through fire-rated walls, partitions, or floors, provide fire seal as specified.

Insulate water piping within casework up to penetration of casework pipe

chase at fixture stop. Insulate water piping within walls up to pipe penetration through the wall at fixture stop when serving wall-mounted fixtures. Termination of insulation shall be in neat and workman like manner with insulation jacket cap.

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder/barrier, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used.

Apply insulation to pipe, unions, flanges, fittings, valves and piping specialties with butt joints and longitudinal seams closed tightly. Valve insulation shall cover entire valve body including bonnets and packing nuts.

Laps on factory-applied jackets shall be 2" minimum width firmly cemented with lap adhesive, or shall be pressure sealing type lap.

Cover joints with factory furnished tape (3" minimum width) to match jacket. Cement firmly with lap adhesive.

Secure insulation, except insulation covered with vinyl jackets, additionally with staples.

Where staples are used, they shall be on 6" maximum centers. When used for systems requiring vapor barrier, cover lap and staples with finish coat of lagging adhesive.

Built-up insulation for fittings and valves shall be made with sectional insulation, wrapped firmly to thickness of adjoining pipe insulation, and bound with jute twine, or built up with insulating cement, and finished to smooth hard surface, and covered with minimum of 9 oz per sq yd rewettable glass cloth similar to Clairmont Diplag 60.

For valves and fittings requiring vapor barrier, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric after application of insulating cement. For valves and fittings not requiring vapor barrier, apply 2 coats of weatherproof mastic with glass fiber reinforcing fabric after application of insulating cement. Apply coating in accordance with manufacturer's recommended procedure.

For finishing of insulated pipe fittings and valves where surface temperature of insulation is not higher than 125°F, one piece PVC fitting covers, minimum thickness of 20 mil, may be used. Fitting covers located in mechanical rooms within 8 ft above floor shall be 30 mil thickness. Johns Manville Zeston 2000 PVC, PROTO Fitting Covers, or similar by other manufacturers listed. Where fitting and valve insulation requires vapor barrier, seal joints of PVC covers with vapor barrier adhesives. Insulation type, R-value and density of insulation used at fittings shall match those of adjacent piping. Install insulation at pipe fittings and valves completely prior to applying PVC covers.

Where terminations of pipe insulation are required, insulation shall have

tapered ends, built up and finished as specified for fittings.

For pipes 1-1/2" and smaller, install specified pipe insulation and jacket continuous through hanger or support locations. Install insulation protection shields to protect insulation from compressing.

For pipes 2" and larger, where manufactured pre-insulated pipe supports are used at hanger or support locations, extend insulation to insulated pipe supports. Where vapor barrier is required, this Contractor shall be responsible for continuity of vapor barrier at insulated pipe supports. Use 3" wide vapor barrier tape on hot and cold systems at pipe supports.

For pre-insulated pipe supports and insulation protection shields, refer to this section.

For Contractor-fabricated anchors, secure insulation directly to pipe surface and extend insulation up anchor for distance of 4 times insulation thickness. For pre-insulated anchors, cover entire surface of anchors with Type A insulation. Where applicable, take special care to assure vapor seal at anchor.

Pipe insulation shall be omitted on the following:

a. Air chambers.

b. Adjacent insulation.

c. ASME stamps.

d. Access plates of fan housings.

e. Cleanouts or handholes.

f. Control valves and balancing valves for heating terminal devices.

g. Valves furnished with removable insulation/jacket.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

a. Pipe insulation shall be continuous through the sleeve.

b. An aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 ply standard grade, silver, white, black and embossed with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.

c. Where pipes penetrate interior walls, the aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 plies standard grade, silver, white, black and embossed shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.

d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.

f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.

g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor retarder coating. The insulation for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.

h. For hot water pipes supplying lavatories or other similar heated service that requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Glass tape seams shall overlap 1 inch. The annular space between the pipe and wall penetration shall be caulked with approved fire stop material. The pipe and wall penetration shall be covered with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inches.

i. For domestic cold water pipes supplying lavatories or other similar cooling service that requires insulation, the insulation shall be terminated on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. The annular space between the outer surface of the pipe insulation and the wall penetration shall be caulked with an approved fire stop material having vapor retarder properties. The pipe and wall penetration shall be covered with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inches.

3.2.1.3 Pipes Passing Through Hangers

a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed, or factory insulated hangers (designed with a load bearing core) can be used.

b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69, and Section 22 00 00 PLUMBING, GENERAL PURPOSE.

c. Horizontal pipes larger than 2 inches and below 60 degrees F shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass, prefabricated insulation pipe hangers, perlite above 80 degrees F), or the necessary strength polyisocyanurate shall be installed above each shield. The insert shall cover not less than the bottom 180-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.

d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360-degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Grade 1, Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, the insulation shall be adhered directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.1.5 Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum or flexible laminate cladding (comprised of elastomeric, plastic or metal foil laminate) laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket, - less than 0.0000 permeability; (greater than 3 ply, standard grade, silver, white, black and embossed) aluminum jackets shall be utilized. Pipe insulation to the 6 foot level shall be protected.

3.2.1.6 Pipe Insulation Material and Thickness

TABLE 1

Provide insulation and jackets as indicated in the following table (Note that insulation of plumbing pipe systems is specified in section 22 07 19.00 40 PLUMBING PIPING INSULATION). The table applies to both exposed and concealed applications unless noted otherwise:

Table 1 - Piping System							
Service	Jacket Type	Insulation Type	Insulation Thickness According to Pipe Size				
			3/4" and less	1" - 1-1/4"	1-1/2" - 3"	4" - 6"	8" and Larger
Heating Hot Water (105-140F)	P-1	R	1"	1"	1"	1-1/2"	1-1/2"
Chilled Water (Interior)	P-1	G	1"	1-1/2"	2"	2"	2-1/2"
Chilled Water (Exterior)	P-1 & A-1	G	1"	1-1/2"	1-1/2"	2"	2"
Chilled Water (Undergrou - direct buried)	E-3	G	1-1/2"	1-1/2"	2"	2"	2-1/2"
Refrigeran Suction Lines and Hot Gas By-pass Line if Used	-	A	1"	1-1/2"	1-1/2"	1-1/2"	2"
Provide protective coating paint for exterior piping as recommended by Insulation Manufacturer							

Table 1 - Piping System							
Cooling Coil Condensate Drain	P-1	R	1"	1"	1"	1"	1"
Type A 3/4" thick insulation may be used.							
Insulation thickness shall be the greater thickness specified for piping system or thickness specified above.							
Insulated Exterior Piping	Unless otherwise indicated, provide protective insulation shield (Type A-1 jacket) in addition to pipe insulation and jacket specified in this schedule.						
Insulated Piping in Air Handling Unit Housing	Provide V-1 jacket in addition to insulation jacket specified in this schedule.						
Insulated Piping Subject to Abuse as Indicated on Drawings	Provide Type H insulation with E-1 jacket in lieu of specified insulation/jacket with same insulation thickness.						

Air Separators & Water Filters (Chilled Water)	E-1	R	1-1/2"
Chilled Water Storage Tank	E-1	R	2"
Storage Tanks	E-1	R	2"
Chiller Evaporator Shell	--	A	1-1/2"
Chilled Water Expansion Tanks	--	A	3/4"

When used in this section, the term Chilled Water shall include Chilled Beam Water as well as chilled water.

3.2.2 Aboveground Cold Pipelines

The following cold pipelines for minus 30 to plus 60 degrees F, shall be insulated in accordance with Table 1 except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted (Note that insulation of plumbing pipe systems is specified in section 22 07 19.00 40 PLUMBING PIPING INSULATION). This includes but is not limited to the following:

a. Chilled water (including Chilled Beam Water).

b. Cooling Coil condensate drains.

3.2.2.1 Insulation Material and Thickness

Insulation thickness for cold pipelines shall be determined using Table 2.

3.2.2.2 Factory or Field applied Jacket

Insulation shall be covered with a factory applied vapor retarder jacket/vapor barrier or field applied seal welded PVC jacket or greater than 3 ply laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, standard grade, sliver, white, black and embossed for use with Mineral Cellular Glass Insulated Pipe. Insulation inside the building, to be protected with an aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, Embossed Silver, White & Black, shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, White & Black, shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, white & black, shall be provided for pipe insulation to the 6 ft level.

3.2.2.3 Installing Insulation for Straight Runs Hot and Cold Pipe

a. Insulation shall be applied to the pipe with joints tightly butted. All butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating, greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or PVDC adhesive tape.

b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. If staples are used, they shall be sealed in accordance with item "e." below. Note that staples are not required with cellular glass systems.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. The patch shall extend not less than 1-1/2 inches past the break.

g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

h. Installation of flexible elastomeric cellular pipe insulation shall be by slitting the tubular sections and applying them onto the piping or tubing. Alternately, whenever possible slide un-slit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used. Grade 1, Type II sheet insulation when used on pipe larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow'. Submit a booklet containing completed MICA Insulation Stds plates detailing each insulating system for each pipe, duct, or equipment insulating system, after approval of materials and prior to applying insulation.

(1) The MICA plates shall detail the materials to be installed and the specific insulation application. Submit all MICA plates required showing the entire insulating system, including plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. The MICA plates shall present all variations of insulation systems including locations, materials, vapor proofing, jackets and insulation

accessories.

(2) If the Contractor elects to submit detailed drawings instead of edited MICA Plates, the detail drawings shall be technically equivalent to the edited MICA Plate submittal.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with PVDC or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with either greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape, standard grade, silver, white, black and embossed or PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

e. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.2.6 Aboveground Hot Pipelines

3.2.2.6.1 General Requirements

All hot pipe lines above 60 degrees F, except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted, shall be insulated in accordance with Table 2. This includes but is not limited to the following:

a. Hot water heating.

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied jacket or field applied aluminum where required or seal welded PVC.

3.2.2.6.2 Insulation for Fittings and Accessories

a. General. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant. Insulation shall be marked showing the location of unions, strainers, check valves and other components that would otherwise be hidden from view by the insulation.

b. Precut or Preformed. Precut or preformed insulation shall be placed around all fittings and accessories. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity.

c. Rigid Preformed. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

3.2.3 Below Ground Pipe Insulation

Below ground pipes shall be insulated in accordance with Table 1. This includes, but is not limited to the following:

a. Chilled Water.

3.2.3.1 Type of Insulation

Below ground pipe shall be insulated with Cellular Glass insulation in accordance with manufacturer's instructions for application with thickness as determined from Table 1 (whichever is the most restrictive).

3.2.3.2 Installation of Below ground Pipe Insulation

a. Bore surfaces of the insulation shall be coated with a thin coat of gypsum cement of a type recommended by the insulation manufacturer. Coating thickness shall be sufficient to fill surface cells of insulation. Mastic type materials shall not be used for this coating. Note that unless this is for a cyclic application (i.e., one that fluctuates between high and low temperature on a daily process basis) there is no need to bore coat the material.

b. Stainless steel bands, 3/4 inch wide by 0.020 inch thick shall be used to secure insulation in place. A minimum of two bands per section of insulation shall be applied. As an alternate, fiberglass reinforced tape may be used to secure insulation on piping up to 12 inches in diameter. A minimum of two bands per section of insulation shall be applied.

c. Insulation shall terminate at anchor blocks but shall be continuous through sleeves and manholes.

d. At point of entry to buildings, underground insulation shall be terminated 2 inches inside the wall or floor, shall butt tightly against the aboveground insulation and the butt joint shall be sealed with high temperature silicone sealant and covered with fibrous glass tape.

e. Provision for expansion and contraction of the insulation system shall be made in accordance with the insulation manufacturer's recommendations.

f. Flanges, couplings, valves, and fittings shall be insulated with factory pre-molded, prefabricated, or field-fabricated sections of insulation of the same material and thickness as the adjoining pipe insulation. Insulation sections shall be secured as recommended by the manufacturer.

g. Insulation, including fittings, shall be finished with three coats of asphaltic mastic, with 6 by 5.5 mesh synthetic reinforcing fabric embedded between coats. Fabric shall be overlapped a minimum of 2 inches at joints. Total film thickness shall be a minimum of 3/16 inch. As an alternate, a prefabricated bituminous laminated jacket, reinforced with internal reinforcement mesh, shall be applied to the insulation. Jacketing material and application procedures shall match manufacturer's written instructions. Vapor barrier - less than 0.0000 permeability self adhesive (minimum 2 mils adhesive, 3 mils embossed) jacket greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive), heavy duty, white or natural). Application procedures shall match the manufacturer's written instructions.

(1) Apply insulation to pipe and fittings with joints tightly fitted. Hold each section of insulation in place with minimum 2 stainless steel wires.

(2) Apply insulation with joints fitted to eliminate voids. Eliminate voids by refitting or replacing insulation. Do not fill voids with joint sealer.

(3) Finish underground insulation with Type E-3 jacket and install in accordance with Pittsburgh Corning Bulletin FI-213, "Foamglass Insulation Systems for Underground Direct Burial Applications" and Product Data Sheets, FI-234, and FI-155, "Pittwrap SS Primer".

h. At termination points, other than building entrances, the mastic and cloth or tape shall cover the ends of insulation and extend 2 inches along the bare pipe.

3.3 DUCT INSULATION SYSTEMS INSTALLATION

Install duct insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

3.3.1 Duct Insulation Thickness

Table 2

Provide insulation and jackets as indicated in the following schedule. The schedule applies to both exposed and concealed applications unless noted otherwise:

TABLE 2 - Ductwork/Equipment System			
Service	Jacket Type	Insulation Type	Insulation Thickness
OA Ducts & Plenum	D-1 or D-2	R	2"
OA Ducts & Plenum	D-2	R	2"
Mixed Air (Outside Air & Return Air Ducts & Plenum)	D-1	R	1-1/2"
Supply Ducts Exposed	D-1	R	2"
Supply Ducts Concealed	D-2	F	2"
Smoke Control, Exhaust or Relief Ducts & Plenum from Control or BD Damper to Outside Wall or Roof	D-1	R	1-1/2"
Return and Relief Ducts in Equipment Rooms	D-1	R	1-1/2"
Return Ducts in specific areas identified in the duct plans	D-2	F	1-1/2"
All Exterior Ducts	D-2 & D-3	RR	2"
Kitchen Exhaust Ducts (Concealed)	--	KG	(Refer to Part 2)
Ductwork Covered with 2 Hr Rated Wrap	--	FR	(Refer to Part 2)

Type F insulation with Type D-2 jacket may be used in lieu of Type R insulation with Type D-1 jacket for ductwork located 6 ft or higher above floor in mechanical equipment rooms. Horizontal ducts that are not completely 6 ft above floor shall be insulated with Type R insulation as specified for its entirety.

Provide insulated duct supports as shown and specified in the Insulated Duct Supports details in the mechanical drawings.

3.3.2 Insulation and Vapor Retarder/Vapor Barrier for Cold Air Duct

Insulation and vapor retarder/vapor barrier shall be provided for the following cold air ducts and associated equipment.

a. Supply ducts.

b. All duct systems in the mechanical penthouse.

c. Flexible run-outs (field-insulated).

d. Plenums (intake and exhaust).

e. Duct-mounted coil casings.

f. Coil headers and return bends.

g. Coil casings.

h. Fresh air intake ducts.

i. Filter boxes.

j. Mixing boxes (field-insulated).

k. Supply fans (field-insulated).

l. Site-erected air conditioner casings.

m. Ducts exposed to weather.

Duct insulation shall be continuous through sleeves and prepared openings except firewall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder/vapor barrier shall cover the collar, neck, and any un-insulated surfaces of diffusers, registers and grills. Vapor retarder/vapor barrier materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with Section 23 31 13.00 40 METAL DUCTS.

Where insulated exposed supply ducts, fittings, accessories and diffusers are shown to be painted, coordinate the painting system and color to be used with the architect. All exposed duct systems are to be provided with an ASJ jackect and be sealed with fabric and mastic. All joints and seams are to be sealed completely and neatly prepared for painting.

3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, flexible insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.

e. Where mechanical fasteners are used, self-locking washers shall be installed and the pin trimmed and bent over.

f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating or PVDC adhesive tape greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.2.2 Concealed Kitchen Exhaust Ducts:

Insulate kitchen exhaust ducts except those exposed in kitchen. Impale insulation over weld pins on 12" centers longitudinally and 9" centers in transverse direction. Fasten with steel speed washers 0.019" x 2-1/2" x 2-1/2". Butt insulation edges tightly together and seal joints with 3" tape adhered and stapled with flare type staples on 4" centers. Install the kitchen exhaust duct insulation per manufacturer's instructions in meeting all UL and code requirements.

3.3.3 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.3.4 Duct Exposed to Weather

3.3.4.1 Installation

Ducts exposed to weather shall be insulated and finished as specified for the applicable service for exposed duct inside the building. After the above is accomplished, the insulation shall then be further finished as detailed in the following subparagraphs.

3.3.4.2 Round Duct

Laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - Less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply, heavy duty, white and natural) membrane shall be applied overlapping material by 3 inches no bands or caulking needed - see manufacturer's recommended installation instructions. Aluminum jacket with factory applied moisture retarder shall be applied with the joints lapped not less than 3 inches and secured with bands located at circumferential laps and at not more than 12 inch intervals throughout. Horizontal joints shall lap down to shed water and located at 4 or 8 o'clock position. Joints shall be sealed with caulking to prevent moisture penetration. Where jacketing abuts an un-insulated surface, joints shall be sealed with caulking.

3.3.4.3 Fittings

Fittings and other irregular shapes shall be finished as specified for rectangular ducts.

3.3.4.4 Rectangular Ducts

Two coats of weather barrier mastic reinforced with fabric or mesh for outdoor application shall be applied to the entire surface. Each coat of weatherproof mastic shall be 1/16 inch minimum thickness. The exterior shall be a metal jacketing applied for mechanical abuse and weather protection, and secured with screws.

3.4 EQUIPMENT INSULATION SYSTEMS INSTALLATION

Install equipment insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

a. Hand-holes.

c. Cleanouts.

d. ASME stamps.

f. Duct Test/Balance Test Holes.

3.4.2 Insulation for Cold Equipment

Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:

a. Pumps.

b. Refrigeration equipment parts that are not factory insulated.

c. Drip pans under chilled equipment.

d. Chilled water heat exchangers.

e. Duct mounted coils.

f. Cold and chilled water pumps.

h. Air handling equipment parts that are not factory insulated.

i. Expansion and air separation tanks.

3.4.2.1 Pump Insulation

a. Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. The box shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible elastomeric cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.

b. Exposed insulation corners shall be protected with corner angles.

c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

3.4.2.2 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible elastomeric cellular which shall be adhered with contact adhesive. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. Phenolic foam insulation shall be set in a coating of bedding compound and joints shall be sealed with bedding compound as recommended by the

manufacturer. Cellular glass shall be installed in accordance with manufacturer's instructions. Joints and ends shall be sealed with joint sealant, and sealed with a vapor retarder coating.

d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.

e. Exposed insulation corners shall be protected with corner angles.

f. Insulation on equipment with ribs shall be applied over 6 by 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inches washers or shall be securely banded or wired in place on 12 inch centers.

3.4.2.3 Vapor Retarder/Vapor Barrier

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating or vapor barrier jacket shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking or vapor barrier tape shall be applied to parting line between equipment and removable section insulation.

-- End of Section --

SECTION 23 09 23.13 20

PROGRAMMABLE LOGIC CONTROL (PLC) SYSTEMS FOR HVAC
08/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B16.10	(2009) Face-to-Face and End-to-End Dimensions of Valves
ASME B31.1	(2012; INT 2-6, 8-10, 13, 15, 17-25, 27-31 and 42-46) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A216/A216M	(2012) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM B 117	(2009) Standing Practice for Operating Salt Spray (Fog) Apparatus

FLUID CONTROLS INSTITUTE (FCI)

FCI 70-2	(2013) Control Valve Seat Leakage

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 508	(1999; Reprint Apr 2010) Industrial Control Equipment
UL 508A	(2001; R 2003 thru 2009) Standard for Industrial Control Panels

1.2 DEFINITIONS

1.2.1 Bridge

Network hardware that connects two or more network segments at the physical and data link layers. A bridge may also filter messages.

1.2.2 Broadcast

A message sent to all devices on a network segment.

1.2.3 Cablefast Terminal Block (Fastblock)

A pre-wired multi-cable connector between a PLC I/O card and the I/O signal wiring consisting of a multi-pin plug for connection to the I/O card at one end and a din-rail mount terminal block at the other.

1.2.4 Central Processing Unit (CPU) Module

Digital high speed processor modules designed for in-rack mounting with internal battery backed internal RAM, LED status lights and built-in communication ports.

1.2.5 Communications Module

Ethernet TCP/IP and modbus TCP-based module designed for in-rack mounting, 10/100 Mbps data transfer rate with either copper or fiber optic conductor.

1.2.6 Device

Any control system component.

1.2.7 Ethernet

A family of local-area-network technologies providing high-speed networking features over various media.

1.2.8 Firmware

Software programmed into read only memory (ROM), flash memory, electrically erasable programmable read only memory (EEPROM), or erasable programmable read only memory (EPROM) chips.

1.2.9 Functional Test

Functional Test (FT): Test of individual components/elements of the control system to make sure the wiring is completed, setpoints and similar parameters are fully defined and acceptable, individual points are operational in all modes and the OWS/HMI graphical interfaces are functioning. The Cx A shall write and refine the FT's. CxA shall witness all FT's. The Contractor performs the FT's.

1.2.10 Gateway

Communication hardware connecting two or more different protocols, similar to human language translators. The Gateway translates one protocol into equivalent concepts for the other protocol. In PLC applications, a gateway has Modbus on one side and non-Modbus (usually proprietary) protocols on the other side.

1.2.11 Human Machine Interface (HMI)

A device that allows for system interrogation, monitoring and access to system operating parameters generally at the "floor" level (i.e. on the PLC).

1.2.12 Hub

A common connection point for devices on a network.

1.2.13 Internet Protocol (IP, TCP/IP, UDP/IP)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.2.14 Input/Output (I/O)

Physical inputs and outputs to and from a device, although the term sometimes describes software, or "virtual" I/O. See also "Points". PLC I/O reside in discrete modules which plug into slots on racks. Remote I/O refers to input/output modules located in racks without an integral CPU, but are interconnected to racks with a CPU.

1.2.15 IP subnet

Internet protocol (IP) identifies individual devices with a 32-bit number divided into four groups from 0 to 255. Devices are often grouped and share some portion of this number. For example, one device has IP address 209.185.47.68 and another device has IP address 209.185.47.82. These two devices share Class C subnet 209.185.47.00

1.2.16 Local-Area Network (LAN)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.2.17 Modbus

A communication protocol for use with PLC-based controllers available in different versions including RTU (serial), ASCII (serial), TCP/IP and Plus versions.

1.2.18 Network

Communication technology for data communications. Approved network types are Ethernet TCP/IP, Modbus TCP and other Modbus protocols.

1.2.19 Peer-to-Peer

Peer-to-peer refers to devices where any device can initiate and respond to communication with other devices.

1.2.20 PID

Proportional, integral, and derivative control; three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.2.21 Programmable Logic Controller

An electronic digital controller, consisting of power, communications, processor and input/output modules with internal programming logic, which performs control functions.

1.2.22 PLC System

A network of programmable logic controllers, communication architecture, and user interfaces. A PLC system may include programming, sensors, actuators, switches, relays, factory controls, operator workstations, human machine interface, and various other devices, components, and attributes.

1.2.23 Power Supplies

Modular components for PLC racks, provide power for the system rack components (CPU, communications and I/O modules) and provide for adequate shutdown time upon a loss of power.

Panel power supplies provide conversion of 120 volt AC input power to regulated 24 VDC output for powering PLC power and supplies and control panel devices/circuits.

1.2.24 Points

Physical and virtual inputs and outputs. See also "Input/Output".

1.2.25 Rack

A physical piece of hardware with a specific number of slots which accepts PLC automation platform modules such as power supplies, CPU's, communication network, and discrete input/output modules. It distributes the power and provides communication to all modules located in the rack, also referred to as a chassis or backplane.

1.2.26 Repeater

A network component that connects two or more physical segments at the physical layer.

1.2.27 Router

A router is a component that joins together two or more networks using different LAN technologies.

1.2.28 Signal Wiring

Signal and/or device wiring is wiring between controllers and end devices (input/output devices). It includes multi-conductor cabling and wiring between devices such as switches, indicators, displays, relays and similar items.

1.2.29 Wiring

The term wiring is inclusive of all types of wiring and cabling, inclusive of power, communication, and signal systems, and includes associated conduit and raceway systems.

1.3 PLC SYSTEMS FOR CHILLED WATER ENTRANCE DESCRIPTION

a. Provide PLC based controls including but not by way of limitation, racks, processors, power supplies, input/output modules, HMI's, enclosures, communications, signal and power wiring/conduit,

transducers, devices and accessories. Connect the PLC to the IACP network via the GFE switch in the PLC rack.

b. All control points for a system shown on workstation points list shall be wired to one control cabinet. If expansion modules are required they will be connected to the main controller via a sub-network.

1.3.1 Design Requirements

The Contractor is solely responsible for the detailed field verification, design, installation, programming, graphics, performance verification testing, commissioning, and training associated with providing a complete, fully functional replacement PLC-based control system which meets the requirements of the design documents and the sequences of operation. Approval of individual components and drawings shall not relieve the Contractor of the responsibility to provide all necessary engineering, components, programming, testing, verification and calibration.

The design of the new panels inclusive of determining and sizing power supplies, heat dissipation considerations, the type and quantity of PLC components and accessories, layout configuration and mounting is the exclusive responsibility of the Contractor.

All necessary wiring within panels and between panels and input/output devices shall be provided; this wiring is not shown on the documents. All wiring including extension of power wiring to input/output devices is the responsibility of the contractor.

1.3.1.1 Control System Drawings Title Sheet

Provide a title sheet for the control system drawing set. Include the project title, project location, contract number, the controls contractor preparing the drawings, an index of the control drawings in the set, and a legend of the symbols and abbreviations used throughout the control system drawings.

1.3.1.2 List of I/O Points

Also known as a Point Schedule: point name, point description, point type (Analog Output (AO), Analog Input (AI), Binary (discrete) Output (BO/DO), Binary (discrete) Input (BI/DI)), point sensor range, point actuator range, point address, and point connection terminal number. Unique schedules for each PLC shall be provided. Where remote I/O is used, provide a unique schedule for each grouping (rack) of I/O points.

1.3.1.3 Control System Components List

Provide a complete list of control system components installed on this project. Include for each controller and device: control system schematic name, control system schematic designation, device description, manufacturer, and manufacturer part number. For sensors, include point name, sensor range, and operating limits. For valves, include body style, Cv, design flow rate, pressure drop, valve characteristic (linear or equal percentage), and pipe connection size. For actuators, include point name, spring or non-spring return, modulating or two-position action, normal (power fail) position, nominal control signal operating range (0-10 volts DC or 4-20 milliamps), and operating limits.

1.3.1.4 Control System Schematics

Provide control system schematics. Unique schematics for each PLC and remote I/O panel, manual panel shall be provided. Include the following:

a. Building floor plan showing location of each input and output device, controlled equipment, controllers, starter, variable frequency drive, PLC and remote I/O cabinets, and networking devices coordinated with nomenclature used for the component wiring diagrams and PLC communication architecture schematic. The intent of this drawing is to provide the physical location of all components, shown in the component wiring diagram and PLC communication architecture schematic.

b. Flow diagram for each system illustrating the Chilled water equipment and I/O sensors/devices

c. Name or symbol for each control system component, such as V-1 for a valve

d. Setpoints, with differential or proportional band values

e. Written sequence of operation for the Chilled water entrance equipment and I/O sensor/devices

f. Valve Schedules, with normal (power fail) position

g. Complete parts list with description, manufacturer, model number and quantity.

1.3.1.5 Component Wiring Diagrams

Point-to-point wiring diagrams shall be provided for the SCADA/PLC control system inclusive of communications networking, power sources and I/O points. The diagram(s) shall be comprehensive and include wiring being installed under this contract.

Provide a wiring diagram for each type of input device and output device typical schematics for identical equipment is not allowed. Indicate how each device is wired and powered; showing typical connections at the digital controller and power supply. Show for all field connected devices such as control relays, motor starters, variable frequency drives, actuators, sensors, and transmitters.

1.3.1.6 Terminal Strip Diagrams

Provide a diagram of each terminal strip and cable fast block. Indicate the terminal strip and cable fast blocks location, termination numbers, wire color, wire tag designation and associated point names. These diagrams may be contained within the component wiring diagrams.

1.3.1.7 Communication Architecture Schematic

Provide a schematic showing the project's entire Ethernet communication network, including addressing used for LANs.

1.3.1.8 Software

On the communication architecture schematic provide a listing of all of

the software including the version number installed on each device. Provide a summary table/legend with a numeric-alphabetic identifier for each type of software and mark each device with the appropriate software identifier(s).

1.3.1.9 PLC Rack Layout

Refer to detail on drawing.

1.4 SUBMITTALS

Submit detailed and annotated manufacturer's data, drawings, and specification sheets for each item listed, that clearly show compliance with the project specifications.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only.

SD-02 Shop Drawings

Shop drawings shall be produced in AutoCAD Version 2009 or later; graphics shall be produced in AutoCAD Version 2009, Visio or other protocol as approved by the Contracting Officer.

Include the following in the project's control system drawing set:

Control system drawings title sheet; G

List of I/O Points; G

Control System Components List; G

Control system schematics; G

Sensor location summary; G

Point-to-point wiring diagrams; G

Component wiring diagrams; G

PLC panel layout drawings; G

Terminal strip diagrams; G

Communication architecture schematic; G

Software 10%; G Provide an initial software submittal including an overview of the proposed system architecture, identifying program locations, purpose, language and rudimentary logical flow charts showing the interaction between sub-systems. Initiate an I/O point description listing showing each point, it's naming convention, units of measure, properties, range, alarm value(s), failed state, and password level accessibility. Identify areas/fields where government input is needed to provide clarification or establish requirements. Provide specific examples of programming and text-based commentary defining variables, the program purpose, SOO and purpose. The intent of this submittal is for the Contractor to provide a high level overview of the proposed system, as well as seek input from the

Government to enable the Contractor to proceed with software development in an effort to minimize rework effort on the part of the Contractor.

Software 50%; G Build upon the information presented in the 10% submittal. Submit documentation for PLC and Citect Cicode programming in both hard copy and electronic copy in the application program format. Include an on-site meeting to review the submitted information with the Contracting Officer's representative.

Software 90%; G Submit documentation incorporating 50% submittal comments for PLC and Citect Cicode programming in both hard copy and electronic copy in the application program format. Include an on-site meeting to review the submitted information with the Contracting Officer's representative.

Graphics 10%; G Provide an initial graphics submittal identifying the number, type and format of the graphic screens to be provided, and the "look and feel" of the graphics interface for both the PLC HMI's and the operators workstation located at IACP. Identify areas where additional information is needed from the Government for further graphic development. Provide a color hard copy and arrange for an on-site follow-up meeting to present the graphics on a PC in a dynamic format.

Graphics 50%; G

Submit documentation for each graphical screen (data and pictorial) for each PLC mounted HMI and for the CITECT Operators Workstation, as well as PLC programming. Provide a color hard copy and arrange for an on-site follow-up meeting where the graphics can be presented on a PC in a dynamic format.

Graphics 90%; G

Submit documentation for each graphical screen (data and pictorial) for each PLC mounted HMI and for the CITECT Operators Workstation, fully incorporating the 50% review comments. Provide a color hard copy and arrange for an on-site follow-up meeting where the graphics can be presented on a PC in a dynamic format.

SD-03 Product Data

Programmable Logic Controllers; G

Include PLC components including modules (CPU's, power supplies, communications/network, input/output cards, remote input/output cards), racks, display units/terminals, HMI's and modular wiring connectors.

PLC and System Software; G

HMI Configuration Software; G

Sensors and Input Hardware; G

Output Hardware; G

Surge and transient protection; G

Electrical Devices; G

Programmable Logic Controller Network; G

Cabinets; G

Cable Management Systems; G

Cable Identification; G

Power Supplies; G

Cablefast Terminal Block; G

SD-05 Design Data

Functional Testing Plan; G

calibration report; G

Pre-Functional Testing Checklist; G

SD-06 Test Reports

PLC Panel Test; G

Functional Testing Report; G

SD-07 Certificates

Contractor's Qualifications; G CITECT training

Contractor's Qualifications; G Modicon Concept

Contractor's Qualifications; G Echelon training

SD-09 Manufacturer's Field Reports

Pre-Functional Test Checklist; G

SD-10 Operation and Maintenance Data

Controls System Operators Manuals, Data Package 4; G

SD-11 Closeout Submittals

Training documentation; G

Software documentation and licenses; G

1.5 QUALITY ASSURANCE

1.5.1 Standard Products

Provide material and equipment that are standard manufacturer's products currently in production and supported by a local service organization.

1.5.2 Delivery, Storage, and Handling

Handle, store, and protect equipment and materials to prevent damage before and during installation according to manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5.3 Operating Environment

Protect components from humidity and temperature variation, dust, and contaminants. If components are stored before installation, keep them within the manufacturer's limits.

1.5.4 Finish of New Equipment

New equipment finishing shall be factory provided. Manufacturer's standard factory finishing shall be proven to withstand 125 hours in a salt-spray fog test. Equipment located outdoors shall be proven to withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be according to ASTM B 117, with acceptance criteria as follows: immediately after completion of the test, the finish shall show no signs of degradation or loss of adhesion beyond 0.125 inch on either side of the scratch mark.

1.5.5 Verification of Dimensions

The contractor shall verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing work. The control panel designer shall verify available cabinet space, minimum clearances between components and is solely responsible for sizing of cable management systems.

1.5.6 Contractor's Qualifications

Submit documentation certifying the controls Contractor performing the work has completed at least three PLC systems installations utilizing Schnider Electric "Quantum" PLC's, with at least as many points, and programmed sequences of operation.

The Contractor shall have at least 1 individual proficient in the use of CITECT SCADA software. Proficiency will be exhibited by satisfactory completion of not less than 3 projects utilizing CITECT, and authorized CITECT training including "Cicode Fundamentals" and "CITECT HMI/SCADA Configuration".

1.5.7 Modification of References

The advisory provisions in ASME B31.1 and NFPA 70 are mandatory. Substitute "shall" for "should" wherever it appears and interpret all references to the "authority having jurisdiction" and "owner" to mean the Contracting Officer.

1.5.8 Project Sequence

The control system work for this project shall be performed in phases and proceed in the following order:

a. Submit and receive approval on the Shop Drawings, Product Data, and

Certificates specified under the paragraph entitled "SUBMITTALS."

b. Fabricate PLC/RIO/manual panels and perform factory testing,

c. Perform the control system installation work, including all field check-outs and tuning.

d. Submit and receive approval of the Functional Testing Plan and the Pre-Functional Test Checklist as specified under the paragraph "FUNCTIONAL TESTING." Calibrate all devices and submit calibration report.

e. Complete the Pre-Functional testing checklist and submit for approval. Once approved, perform the Functional Testing for each project phase.

f. Submit and receive approval on the Functional Testing Report. Participate in system commissioning.

g. Submit and receive approval on the Training Documentation specified under the paragraph "INSTRUCTION TO GOVERNMENT PERSONNEL". Submit at least 30 days before training.

h. Submit and receive approval of the Controls System Operators Manual specified under the paragraph "CONTROLS SYSTEM OPERATORS MANUALS."

i. Deliver the final Controls System Operators Manuals.

j. Conduct the Training.

k. Submit and receive approval of Closeout Submittals.

PART 2 PRODUCTS

2.1 PLC SYSTEM

a. Provide a networked PLC system for stand-alone control. Include all programming, objects, and services required to meet the sequences of operation. Provide Ethernet communication between the PLC system and the government pointed ethernet switch. PLC equipment, software and HMI's shall be of the same manufacturer to ensure compatibility.

2.1.1 Programmable Logic Controllers

Programmable logic controllers shall be UL 508 rated, and shall be as manufactured by Schneider Electric, Modicon Quantum. PLC's shall be of customizable modular construction including racks, CPU's, power supplies, networking/communications and input/output modules and related components.

Provide PLC panel layout drawings submittal.

2.1.1.1 Racks

Racks shall include a metal frame connectors for module/rack connection, tapped module mounting holes, rack mounting holes and grounding terminals. Racks shall have between 3 - 16 slots as required for the application. Racks shall include internal bus for distribution of power and controls signals, slots shall be universal/unassigned type with no assigned or reserved slots and shall be capable of use as local I/O,

remote I/O and distributed I/O. Accessories shall be provided as required for the hardware configuration including rack extension modules, cables for extension racks and rail type mounting brackets.

2.1.1.2 Environmental Limits

PLC modules shall be suitable for, or placed in protective enclosures suitable for the environment (temperature, humidity, dust, and vibration) where they are located.

Store PLCs according to manufacturer's requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect PLCs from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect the PLC from all forms of electrical and magnetic energy that could reasonably cause damage.

2.1.1.3 Central Processing Units

CPU modules shall be microprocessor-based computational processors designed and selected to support the processing, input/output, memory and logic programming requirements. Integral Modbus and Modbus plus communication ports shall be provided. Modules shall include lithium battery memory back-up. Programming languages shall include sequential functional chart, functional block, ladder logic, structured text, and instruction list. Modules shall be identified with the model number and color code, include a LED status array, removable hinged door with customizable identification label, battery slot, slide switches for memory write protection and start-up communications parameters and communications port. Provide sufficient memory to store programs in the CPU, as well as data as required by the system architecture. The CPU shall be compatible with Concept Version 2.6, and be provided with the latest firmware revision.

2.1.1.3.1 Internal Clock

Provide integral internal clocks for all CPU modules. Automatically synchronize system clocks daily. Store time of day information in addresses 4:1 through 4:8, with automatic time synchronization provided through the SCADA system via KCCS referenced to local eastern standard time, with automatic connection for daylight savings time.

2.1.1.3.2 Memory

Provide sufficient memory for each CPU to support the required control, communication, and programming documentation to allow the control programs to be stored for future upload to a laptop. Protect programs residing in memory with EEPROM, flash memory, or internal battery with a minimum service life of 8 years.

2.1.1.4 Power Supply Modules

Power supply modules shall be of the standalone, summable or redundant type as indicated or as required. Power supplies shall provide power to the system rack modules and protect the system from noise and voltage swings. Power supplies shall accept 24VDC input power and provide to +5 volts DC for the requirements of the CPU, the communication and I/O modules. Power supplies shall be selected to power the rack modules inclusive of anticipated power demand of empty slots.

Control panel designer shall provide independent line fuses or circuit breakers, per the manufacturer's recommendation, for each power Supply, Input Module, Output Module, and other modules with separately derived power requirements.

Control panel designer shall insure that communication signals, 4-20mA signals, embedded HART signals, etc. are properly conditioned for the PLC and protected from all sources of radiated energy or harmonics.

2.1.1.5 Wiring Terminations

Use screw terminal wiring terminations for all field-installed devices. Use cable fast terminal block (fastblock) wiring systems consisting of DIN rail mounted terminal blocks, multi-conductor cables with "D" pin terminal block connectors, between I/O modules and terminals.

2.1.1.6 Input and Output Modules

Provide UL 508 listed input and output modules for all PLC's as follows:

a. Provide discrete input/output modules as required to satisfy the points lists indicated on the drawings. Size modules to provide the larger of 10-percent spare of each type, or 2 spares.

b. Binary Input Modules: Binary input modules shall have up to 32 24-volt inputs.

c. Analog Input Modules: Analog input modules shall provide up to 8 inputs and monitor low-voltage (0-10 VDC), current (4-20 mA), or resistance (thermistor or RTD) signals.

d. Binary Output Modules: Binary output modules shall have up to 32 24-volt outputs or up to 8 relay outputs.

e. Analog Output Modules: Analog output modules shall send up to 8 modulating 0-10 VDC or 4-20 mA signals to control output devices.

f. Modules shall be identified on the front with the model number and color-coded, have status indicating LED lights and a removable hinged door with customizable identification label.

g. Provide accessory items required to interface modules to wiring systems including screw terminal blocks, jumpers, and fast block connector cables.

2.1.1.7 Programmable Logic Controller Network

See network architecture diagram for network connectivity.

2.1.1.8 Communication Modules

Single format Ethernet network modules for rack mounting, accepting twisted pair or optical medium, 10/100 Mbps data rate, 10 Base-T/100 Base-TX (RJ45) or 100 Base-FX (MT/RJ) physical interface, factory cast configurable web server with web page editor and page hosting, provide with the latest firmware revision.

2.1.1.9 Human Machine Interface

2.1.1.9.1 PLC Enclosure Panels

Provide backlit color STN LCD touch screen, 7.5 inches diagonal screen, 32 MB flash EPROM, screw clamp fastened, flush mounted on each PLC panel , with a serial link type interconnecting cable to PLC. HMI shall be Magelis XBT GT4230.

2.1.1.10 Cabinets

Provide each PLC, remote I/O and the manual panel in a factory fabricated cabinet enclosure. Cabinets located indoors shall protect against dust and have a minimum NEMA 12 rating, except where indicated otherwise and be UL 508A listed. Cabinets shall be of the free-standing floor or wall mount type as indicated. Cabinet shall be of the general size and arrangement indicated; size and style shown on the documents are conceptual. Floor mount cabinets shall be manufactured from not less than 12-gauge steel, wall mount cabinets shall be manufactured from not less than 16-gauge steel; all seams continuously welded and ground smooth, have integral lifting eyes, 3-point latches, latch rod rollers, oil resistant door gasket, continuous door hinge, and a thermoplastic data pocket shall be included on the inside of the front door. Cabinet shall include internal mounting channels affixed by welding to the top center and bottom of side and rear panels with rear and side solid interior panels provided. Wall mounted cabinets shall be provided with the manufacturers wall mount brackets. Exterior finish for all cabinets and enclosures shall be polyester powder paint, light blue color S020 with a white interior; interior panels shall have a white enamel finish. Provide custom cutout for front door flush mounting of the HMI. Cabinets shall have a hinged lockable door and an offset removable metal back plate. Provide like-keyed locks for all hinged panels provided and a set of two keys at each panel, with one key inserted in the lock. Provide a signal splitter to the PLC for CHW supply temperature. Route this signals to the communications room for connection to IACP.

2.1.1.11 Cable Management Systems

Provide pre-manufactured PVC cable management/wire duct systems for organizing, routing, and managing cable/wiring within panels. Troughs shall be 4-sided with slotted sides, solid cover and back and include all mounting hardware as required for screw mounting to the back or side plane; double back tape and/or adhesive systems shall not be used.

Size to provide no more than 50-percent fill.

2.1.1.12 Cable Identification

Each cable or wire within a panel shall be uniquely identified using a heat shrink laser printable radiation cross-linked polyolefin material, with a shrink ratio of 3 to 1, suitable for both indoor and outdoor use. Identification labels shall be rated for use from -67 - 275 degrees F, be 0.53 mil wall thickness sleeve length to suit identification text field.

2.1.1.13 Main Power Switch and Receptacle

Provide each control cabinet with a main external power circuit breaker located inside the cabinet. Also provide each cabinet with a separate 120 VAC power strip with a minimum of 4 receptacles.

2.1.2 PLC and System Software

Except where the Government has site licensed versions of software, provide not less than 2 licensed copies of all software, configuration and installation tools, plug-ins, service tools and databases necessary to configure the PLC system. Software documentation and licenses are to be turned over at the end of construction. The Government has licensed copies of Concept XL version 2.6 SR7 and Citect 7.2 SP4.

2.1.2.1 Programming

Provide programming to execute the sequence of operation indicated. Provide all programming to configure and program all programmable logic controllers, human/machine interface (HMI) and operators workstations. Provide programming routines in simple, easy-to-follow logic with detailed text comments describing what the logic does and how it corresponds to the project's written sequence of operation. All PLC platforms shall be programmed using the same programming software. Programmable/set-up of PLC's will utilize the manufacturers programming software "Concept XL" Version 2.6 SR7, including specialist tools, function block libraries, and maintenance and diagnostic packages as required to configure, test, and diagnose the controllers to accomplish the specified sequences of operation. HMI configuration software for PLC cabinet screen shall be "vijeo designer". Provide HMI Configuration Software submittal.

a. To the maximum extent possible, PLC graphic-based programming shall be used consisting of a library of function blocks made from pre-programmed code suitable for PLC control. Function blocks shall be assembled with interconnecting lines, depicting the control sequence in a flowchart. Graphic programs shall be viewable in real time showing present values and logical results from each function block. Other programming languages are acceptable on a case-by-case basis but must be specifically reviewed and approved by the Contracting Officer prior to deployment.

b. Menu-based programming shall be done by entering parameters, definitions, conditions, requirements, and constraints.

c. For line-by-line instruction list and structured text-based programming, provide initial commentary as to the programs purpose referencing the SOO, declare variable types (local, global, real, integer, etc.) at the beginning of the program. Use descriptive comments frequently to describe the programming and operations being performed within each program and sub-program.

d. For ladder logic programs, utilize contacts, coils, compares timers, special blocks and similar devices represented diagrammatically.

e. Software programming shall be successfully factory tested by the Contractor prior to delivery of Contractor fabricated/configured PLC control cabinets to the project site. Testing shall include simulated I/O to demonstrate the specified sequences, including but not limited to, control actions, modes of operation, alarms, safeties, failures, trending, HMI's and graphic displays. The Contractor is responsible for providing all services and hardware/software necessary for testing at the panel fabrication site. Each fabricated and assembled control panel shall be successfully tested with a PLC panel test affidavit provided attesting to the full functionality of the panel. At the

Governments option, testing may be witnessed in-person by at least 6 Government representatives at the place of fabrication/testing. Provide not less than 14 days notice of each test to the Contracting Officer.

f. Provide Software 10%, Software 50% and Software 90% submittals. Provide separate submittals for the building (1 submittal) and the IACP (1 submittal for the plant). Provide hard copy submittals and schedule a live demonstration for 90% to be performed at KSC within 10 days of the submittal. Approval of the submittal allows for further development and submittal of the next specified level. Non-approval will necessitate a resubmittal and follow-up demonstration on-site.

2.1.2.2 Parameter Modification

Parameter setpoints (time delays, set points, minimums, maximums, PID loop tuning parameters, etc.) shall not be embedded in programs, they shall be adjustable at the PLC HMI and at operator's workstation. Setpoint access and allowable range of adjustment shall be restricted through the use of password protection.

2.1.2.3 Short Cycling Prevention/System Protection

Provide adjustable setpoint differentials, min/max positions, and minimum on/off times to prevent equipment short cycling, and to protect systems from low/high pressure/flow conditions. Configure systems such that if control variable information fails or is otherwise unavailable, the system reverts to a safe condition or freezes in-place as appropriate.

2.1.2.4 Equipment Status Delay

Provide an adjustable delay from when equipment is commanded on or off and when the control program looks to the status input for confirmation.

2.1.2.5 Run Time Accumulation

Use the Elapsed Time Property to provide re-settable run time accumulation for each Binary Output Object connected to mechanical loads greater than 1 HP, electrical loads greater than 10 KW, or wherever else specified. Accumulate run-hours in the PLC memory.

2.1.2.6 Time Synchronization

Provide time synchronization, including ability for operator time adjustments.

2.1.2.7 Object Property Override

Allow writeable object property values to accept overrides to any valid value. Where specified or required for the sequence of control, the Out_Of_Service property of Objects shall be modifiable. When documented, exceptions to these requirement are allowed for life, machine, and process safeties.

2.1.2.8 Alarms and Events

Alarms and events shall be capable of having programmed time delays and high-low limits. Generally alarms will be generated at the PLC level; critical alarms shall be generated at the PLC. Alarms/events shall report

to the local HMI screen, as well as the operator workstation computer, and based on the SCADA software, be displayed and optionally printed, as defined at the workstation and be stored on the server. Where the communications network is inoperable, alarms/events shall be stored within a device on the PLC network until connected to a user interface device or the network restored. Provide alarms/events in agreement with the point schedule, and sequence of operation. At a minimum, provide programming to initiate alarms/events any time a piece of equipment fails to operate, a control point is outside normal range or condition, communication to a device is lost, a device has failed, or a controller has lost its memory.

2.1.2.9 Trending/Graphing

Trend data collected by the PLC shall be broadcast over the network and stored in the server. Trends shall be viewable at the OWS.

2.1.2.10 Device Diagnostics

Each controller shall have diagnostic LEDs for power, communication, and device fault condition. The PLC system shall recognize and report a non-responsive controller.

2.1.2.11 Power Loss

Upon restoration of power, the PLC system shall perform an orderly restart and restoration of control.

2.1.3 Operator Workstation

The existing Industrial Area Chiller Plant workstation shall run the SCADA software, be capable of accessing all PLC system devices and communicate using the Ethernet TCP/IP protocol. The workstation shall be capable of displaying, modifying, creating, archiving, and deleting (as applicable): all points, objects, object properties, programming, alarms, trends, messages, schedules, and reports.

2.1.3.1 Password Protection

Provide at least 3 levels of password protection for the HMI. The lowest level, manager, only allows viewing graphics. The second level, operator, allows viewing graphics, creating trend logs/graphs, commanding equipment on/off, acknowledging alarms, assigning maintenance status and changing selected setpoints and alarm values. The highest level, system administrator, provides all administrator rights and allows full access to all programming, including setting new passwords and access levels. Provide automatic log out if no keyboard or mouse activity is detected after a user-defined time delay.

2.1.3.2 SCADA Software

The existing workstation software shall permit complete monitoring, modification, and troubleshooting interface with the PLC system. The operator interface with the software shall be menu-driven with appropriate displays and menu commands to manipulate the PLC system's objects, point data, operating schedules, control routines, system configuration, trends, alarms, messages, graphics, and reports. Trends shall be capable of graphic display in real time, with multiple variables plotted as functions of time. Each alarmed point shall be capable of displaying its alarm history, showing when it went into alarm, if and when it was acknowledged,

and when it went out of alarm. The modification of PLC system parameters and object properties shall be accomplished with "fill in the blank" and/or "point and drag" methods. Modifications shall download to the appropriate controllers at the operator's request.

2.1.3.3 Graphics Software

Graphics Display in the form of tabular data on multiple screens shall be provided at both HMI touch screens and the OWS. The system and equipment shall be monitored and a real time graphical display of the status and value of the points, alarm status and mode of operation as well as the building manual/off/auto status shall be displayed. Pump state shall be displayed (on/off), speed output/input, staging number, building chilled water pressure set point and active reading of the pressure sensor, the active control mode of staging (run time or operator selected), pump maintenance status and VFD fault status shall also be displayed. In addition the loop and building chilled water supply and return temperatures, building summed flow meters and loop chilled water flow rates, loop valve position (output and input signals), differential pressure and end switch status shall be displayed. A graph of the instantaneous energy consumption (MBTUH) verses hour of the day shall be displayed, and the current days ton-hours, ton-hours for the previous day and average daily ton-hours for the previous 30 days.

Use the existing HMI and OWS graphics that have been developed for the existing HQ building as the basis for new graphic development.

Graphics software at the OWS shall be configured to allow for display of both tabularized data and pictorial graphics; for the PLC cabinet mounted HMI's only tabularized data shall be displayed. The present value/status of all points shall be captured both in tabular and pictorial formats. At a minimum provide separate graphic screens for the following: overall system, chilled water entrance, pumps, and mode of operation.

Provide Graphics 10% submittal, Graphics 50% submittal and Graphics 90% submittals.

2.2 SENSORS AND INPUT HARDWARE

Submit a sensor location summary documenting the following information:

For temperature sensor; the well location, material of construction, bore size, bore depth and process connection size.

For flow meters; the tap location, diameters of upstream and downstream piping provided, diameter of the pipe and size of the ball valve.

For pressure sensors; the tap location, and the isolation valve size.

2.2.1 Field-Installed Temperature Sensors

Provide the same sensor type throughout the project, unless otherwise approved by the Contracting Officer.

2.2.1.1 Resistance Temperature Detectors (RTDs)

Provide 1000 ohm platinum 4-wire RTD sensors with matched transmitters with a range of -328 to 608 degrees F with an accuracy of +/- 0.18 degrees F or better. Sensors shall have hermetically sealed teflon insulated lead

wires, 316 stainless steel sheath, response time less than 5 seconds to 63.2-percent temperature change with a stability of 0.2 degrees C after 10,000 hours. Transmitters shall be of the Smart HART programmable loop powered type which converts the RTD signal to an isolated, scaleable 4 20 mA, includes an LCD display with not less than 2 rows of five alphanumeric characters at least 1 row shall be 0.4 inches tall, the second 0.22 inches, NEMA 4X, explosion-proof enclosure with 2, 1/2-inch entry points and clear glass cover. Basis of design is Moore Industries Model TDZ2.

Provide and turn over to the Government 2 hand-held portable modular SMART HART calibration/communicator tool with LCD display, NIST traceable accuracy of +/-0.025% for pressure and current/voltage equal to Yokogawa Model YPC4000.

Where documents indicate direct connection of RTD sensors to PLC's, transmitters are not required; provide PLC RTD input modules to accept inputs.

2.2.1.2 Temperature Sensor Details

For new sensors provide minimum three-inch immersion. Provide each new sensor with a corresponding pipe-mounted sensor well. Sensor wells shall be stainless steel when used in steel piping, and brass when used in copper piping. Provide the sensor well (new and existing) with a heat-sensitive zinc oxide transfer agent between the sensor and the well interior.

2.2.2 Pressure Transmitter

Pressure transmitter shall be of the thin-film strain gauge bridge and stainless steel diaphragm type, range of 0 - 100 psi, watertight stainless steel housing, accuracy of +/- 1 percent of full scale or better, 4-20 mA output, overpressure rating of not less than 200-percent of range, operating temperature between -40 to 200 degrees F. Basis of design is Kele PTX1 Series. Provide with a porous metal disk type pressure snubber suitable for use with water media with a capacity of 3 cubic feet per hour at 1 psi pressure differential.

Configure with separate isolation and calibration ball valve.

2.2.3 Differential Pressure Sensors

Shall be of the industrial grade microprocessor based capacitance cell type, minimum of 30 to 1 range ability, with plus or minus 0.075 percent accuracy and user selectable linear or square root output. The capacitance cell shall be isolated mechanically, electrically, and thermally from the process medium. An electronic transmitter module shall convert the digital output to a 4-20 mA output and have an integral LCD output in conventional engineering units (psi or feet of water). Housing shall be aluminum. Transmitter shall be factory calibrated to provide a 4-20 mA output over the required range. Basis of design shall be Rosemount Model 3051CD or approved equal.

2.2.4 Water Flow Measurement Stations

2.2.4.1 Magnetic

Water flow measurement stations shall be of the insertion electromagnetic type with no moving parts; accuracy of +/- 1.0% of reading between 2 to 20

feet per second, flow range between 0.25 to 20 feet per second, fluid temperature between 15 to 250 degrees F, 4-20mA output, 316 stainless steel wetted metal components, weathertight NEMA 4 aluminum enclosure. All meters shall be wet calibrated in a NIST traceable flow laboratory. Basis of design is Onicon F-3500.

2.3 OUTPUT HARDWARE

2.3.1 Electrical Devices

2.3.1.1 Control Relays

Relays shall be double pole, double throw, UL listed, with contacts of the type and rating for the intended application, indicator light, and dust proof enclosure. The indicator light shall be lit when the coil is energized and off when coil is not energized. Relays shall be the socket type, plug into a fixed base, and replaceable without tools or removing wiring.

Modular type "Relay in a Box" (RIB) type devices may be used for stop/start control of A/C motor start circuits where specifically approved by the Contracting Officer.

2.3.1.2 Current Sensing Relays

Current sensing relays (CSR) shall provide a normally-open contact with a voltage and amperage rating greater that it s connected load. Current sensing relays shall be of split-core design. The CSR shall be rated for operation of 200% of the connected load. Voltage isolation shall be a minimum of 600 volts. The CSR shall auto- calibrate to the connected load.

2.3.1.3 Wire Splices

Wire to wire splices shall be of the heat shrinkable, nylon insulated, crimp type with adhesive lining. Operating temperature of -67 to 257 degrees F, 2:1 shrink ratio, cut through resistance of 70 pounds, pullout minimum of 25 pounds, UL listed. All splices shall be made with a calibrated crimping tool. Basis of design is Raychem D-406 Series.

2.3.1.4 Terminal Blocks

Screw type, board mount, dual row, tin plated brass, number of circuits as required.

2.3.1.5 Signal Isolation

DIN rail mount, single channel signal splitter, 4-20 mA input, 4-20 mA output, accuracy of +/- 0.05 percent of span, zero and span calibration pots, UL listed. Basis of design Moore Industries ECT-DIN. Signal splitter shall be utilized to split the building chilled water supply temperature signal between the BAS and the manual panel located at the Industrial Area Chiller Plant.

2.3.1.6 Transformers

120/24 VAC UL listed Class 2 transformer, foot mounting, built-in circuit breaker, minimum volt-amp capacity of 150-percent of the connected load.

2.4 ELECTRICAL POWER AND DISTRIBUTION

2.4.1 Power Supplies

2.4.1.1 PLC

Provide intelligent, supervised power supply / charger to energize PLC and associated components, fiber switch, end-devices, and other related equipment. Unit shall be installed in enclosure which is sized to accommodate two 12VDC batteries and field installed DIN rail with 8 terminals in addition to the control panel. Batteries shall be sized to operate power supply at full load for a minimum of 30 minutes. The following features are required:

1. Input 115VAC @2.7 amp / 24VDC output.
2. 10 amp supply current.
3. Filtered and electronically regulated outputs.
4. Short circuit and thermal overload protection.
5. Built-in charger for sealed lead acid or gel type batteries.
6. Automatic transfer to standby battery when AC fails (zero voltage drop.
7. AC fail supervision (form 'C' contacts).
8. Low battery supervision (form 'C' contacts).
9. Power on-off switch.
10. AC input and DC output LED indicators.
11. Power supply, enclosure, cam lock & battery leads.
12. Power supply / charger unit basis of design is Altronix SMP10PMC24X or equivalent.
13. Batteries shall be rechargeable, sealed lead acid type, 12-volts, connected in series, not less than 10 amp-hour capacity, quick disconnect tab type terminals, UL recognized, basis of design is Power Sonic PS-12120.

2.4.2 Surge and Transient Protection

Provide each PLC and remote I/O controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.

2.4.2.1 Power Line Surge Protection

Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with UL 1449, third edition. Devices shall be provided with the lowest clamping voltage for a 120V application (or other if used). Unit may be wired in parallel and shall have LED status indicator(s).

2.4.2.2 Controller Input/Output Protection

Provide controller inputs and outputs with surge protection via optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection. Protection shall be listed for PLC control circuit applications.

2.4.3 Wiring

Provide complete electrical wiring for the PLC System, including wiring to transformer primaries. Unless indicated otherwise, provide all normally visible or otherwise exposed power, signal and device wiring and cabling in conduit. Where conduit is required, control circuit wiring shall not

run in the same conduit as power wiring over 100 volts. Circuits operating at more than 100 volts shall be in accordance with Section 26 00 00.00 20, BASIC ELECTRICAL MATERIALS AND METHODS. Run all circuits in conduit, metallic tubing, covered metal raceways, or armored cable.

2.4.3.1 Power Wiring

The following requirements are for field-installed wiring:

a. Wiring for 24 V circuits shall be insulated copper 18 AWG minimum and rated for 300 VAC service.

b. Wiring for 120 V circuits shall be insulated copper 14 AWG minimum and rated for 600 VAC service.

2.4.3.2 Analog Signal Wiring

Field-installed analog signal wiring shall be 18 AWG single or multiple twisted pair. Each cable shall be 100 percent shielded and have a 20 AWG drain wire. Each wire shall have insulation rated for 300 VAC service. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape.

2.5 CONTROL VALVES

2.5.1 V-Port Ball Valves

Carbon steel flanged body ASTM A216/A216M, Grade WCB, ASME B16.10, Class 150, 317 stainless steel V-port style ball with heat treated nickel overlay, 317 stainless steel trim, flexible metal seat, shafts and bearings. Drop-in-place, self-aligning, bi-directional interchangeable seats with FCI 70-2/ANSI Class IV shutoff. All fasteners shall be stainless steel and shafts shall have a spline type connection to the ball. Actuators shall be of the modulating one-quarter turn type, cast aluminum polymer coated NEMA 4X enclosure, sealed terminal connection chamber, stainless steel fasteners, brushless type DC motor selected for 50-percent duty cycle at 50-percent rated torque, with a solid-state protective thermistor, manual clutch handwheel, voltage and phase as scheduled. Power transmission shall be of the oil immersed worm-gear type. Controls shall be solid-state and include a 32-character LED display for configuration set-up and valve status. Local controls shall include a remote-stop-local selector switch and open/close position selection. Actuator shall include an integral thermostatically controlled heater. Actuator shall accept a 4-20 mA or 0-10 VDC input and provide a 4-20 mA output of the valve position. Basis of design shall be DeZurik Model VPB valve with Limitorque QX actuator or approved equal.

Provide a manual override winder and locking mechanism for override operation of the actuator on a loss of power to the actuator for valves shown on chilled water entrance control drawing.

Actuator shall be powered by 120 Vac.

Provide with position feedback option where shown on control drawings.

2.6 SEQUENCES OF OPERATION (SOO)

Sequences of operation are contained in the drawing package. Provide programming necessary to implement the sequences. Include and coordinate

ranges, setpoints, deadband, alarms and similar items not specifically called for in the sequences but required for stable operation.

PART 3 EXECUTION

3.1 INSTALLATION

Perform the installation under the direct supervision of system integrators regularly employed in the installation of PLC systems, with specific experience with the hardware (Modicon) and software (Citect) specified.

Equipment shall be installed as indicated and in accordance with the manufacturer's recommendations, including conduit, wiring, controllers, wiring devices, sensors, and miscellaneous devices as required and necessary to provide a completely functional and operational system, to include all points defined on the drawings, specified herein and as required to execute the sequence of operation.

Devices shall be securely attached to the equipment, panel and/or structure as appropriate, conduit shall be properly supported. Attachment of din rails, wiring troughs, and similar items shall only be by mechanical means (self-tapping screws).

All networked devices PLC's, servers and workstations shall be time synchronized through a signal provided by KCCS, the Government shall provide details at the 50 percent software development review.

3.1.1 Naming and Addressing

Provide unique naming and addressing for networks and devices, where possible, follow existing naming convention. PLC IP addresses will be as assigned by the Government.

a. MAC Address

Every network device shall have an assigned and documented Media Access Control (MAC) Address unique to its network. For Ethernet networks, document the MAC Address assigned at its creation.

b. Network Numbering

Assign unique numbers to each new network installed on the internetwork. Provide ability for changing the network number; either by device switches, network computer, or field operator interface.

c. Device Object Identifier Property Number

Assign unique Device tags for each device on the internetwork. Provide for future modification of the device tag; either by device switches, network computer, or field interface.

d. Assign Field Interface Control (FIC) numbers to all PLC's, following standard convention used for the Kennedy Complex Control System (KCCS).

3.1.2 Local Area Networks

Obtain Government approval before connecting new networks with existing networks. Network numbers and device instance numbers shall remain unique

when joining networks. Do not change existing network addressing without Government approval.

3.1.3 Routers, Bridges, and Switches

Provide the quantity of routers, bridges, and switches necessary for communications shown on the Network architecture. Configure each device and bridge, router, or switch to communicate on its network segment.

3.1.4 Wiring Criteria

a. Run circuits in conduit parallel or at right angles to the building structure.

b. Do not run binary control circuit wiring in the same conduit as power wiring over 50 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 50 volts.

c. Provide circuit and wiring protection required by NFPA 70.

d. In facility mechanical rooms, within building and above ceilings, EMT may be used and cable tray may be used for communication circuits where available.

e. Do not use aluminum-sheathed cable or aluminum conduit.

f. Input/output identification: Permanently label each field-installed wire and cable at each end with descriptive text using a commercial heat shrink type wire marking system that fully encircles the wire, cable, or tube. Locate the markers within 2 inches of each termination. Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" in the label. Label all terminal blocks with alpha/numeric labels. All wiring and the wiring methods shall be in accordance with UL 508A.

g. For controller power, provide 120 VAC circuits, with ground. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable.

h. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.

i. Grounding: Ground controllers and cabinets to a good earth ground as specified in Section 26 00 00.00 20, "BASIC ELECTRICAL MATERIALS AND METHODS". Conduit grounding is not acceptable; all grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.

j. The Contractor shall be responsible for correcting all associated ground loop problems.

k. Run wiring in panel enclosures in a cable management system sized for no more than 50-percent fill.

l. Fill conduit to maximum of 40-percent of area and include 1 pull string in each conduit.

m. Make all final terminations to equipment. Tighten per manufacturer's recommendations.

n. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment, without stress to wiring or terminations.

o. All wiring connections to the PLC shall be made at terminal strips or fast-blocks. No more than 2 wires shall be landed onto 1 terminal.

p. Wire connections to sensors shall be at its termination point, soldered, or using crimp splice connectors or wire nuts. Wire nuts may only be used at connection to sensors.

q. All wiring within enclosures shall be run in wire trough, neatly bundled and anchored with screws to prevent restriction to devices and terminals. Devices shall be anchored to panels using self-tapping screw connectors. Panels shall be labeled on the exterior with engraved phenolic nameplates.

r. Install wiring in sleeves where wiring passes through walls and patch holes made.

s. Wire splices shall only be used on existing wiring which is to be reused and only as specifically approved by the Contracting Officer to coordinate with existing conditions. Where approved, splices shall be of the heat shrink sleeve type and be crimped with a calibrated crimping tool. Where wire-to-wire splices are used, the wire on both sides of the splice shall have the same color insulation.

3.1.5 Accessibility

Install all equipment so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install PLC controllers, data ports, and like equipment in locations freely accessible through access doors.

3.1.6 Programmable Logic Controllers

a. Shop fabricate panels and install internal devices, wiring and components. Arrange and select panel components to meet the project specifications, paying particular attention to coordinating with reuse of sensor wiring where possible without the use of wire splices. Test panel operability in the presence of the Contracting Officer representatives prior to delivery to KSC.

b. Locate control cabinets at the locations shown on the drawings. Secure to floor, walls and /or steel framework, provide miscellaneous strut-type framework as necessary for secure mounting.

c. Provide cabinets for remote I/O and install in locations shown on the drawings.

d. Provide cablefast terminal blocks for landing of I/O with interconnecting cables between cablefast terminal blocks and PLC I/O

cards.

e. Provide interconnecting cabling between processor and HMI screens, and other components, devices and remote panels as required.

f. Provide for 24V cabinet power supplies; coordinate 120 VAC panel power and communication cabling with Division 26 and 27.

g. All connections to the cabinets (conduits and control piping) shall be firmly affixed and made in a neat and good workmanship manner. Where coordinating with existing conduits, gutters and pneumatic tubing, take precautions to ensure such openings are properly located. Provide bulkhead type copper fittings for pneumatic piping, and insulated throat type conduit fittings.

3.1.7 Temperature Sensors

Install new temperature sensors in locations as indicated and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.

3.1.7.1 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping where new locations are shown. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Provide thermal conductivity material within the well to fully coat the inserted sensor.

3.1.8 Pressure Sensors

Locate pressure sensors as indicated.

3.1.9 Component Identification Labeling

Provide a unique heat shrink-sleeve type identification label on each cable/conductor. Provide black plastic labels with engraved bold white block lettering permanently attached to each control panel and manual panel displays. Have the labels and wording approved by the Contracting Officer prior to installation.

3.1.10 Network and Telephone Communication Lines

When network connections by the Government are required, provide the Contracting Officer at least 60 days advance notice of need.

3.1.11 Software/Programming

Install all software and provide for all programming for the PLC system. For custom programs controlling similar equipment such as building loop valve control, keep program structure consistent for each building to the extent possible.

For custom programming provide commentary as to the program purpose, SOO reference from the original contract documents, and definition of all variables/points used.

For programs that include PID control of a valve or pump, provide for an initial start-up timer routine which opens the valve/starts the pump at a

minimum position/speed then ramps up based on the timer function, or similar strategy to control ramp-up/ramp-down. Tune all PID loops to provide for stable operation.

Capture and document all programming changes during initial testing, performance verification and commissioning.

3.1.12 Flow Meters

Install flow meters in the general locations indicated on the drawings. Identify proposed locations for new flow meters in the field on piping systems for approval by the Contracting Officer. Pay particular attention to the manufacturers requirements for upstream/downstream straight pipe lengths for both new and existing meter locations and alert Contracting Officer where these requirements cannot be met, prior to submission of flow meter shop drawings. In those instances where the manufacturers requirements cannot be met, the Government may direct the Contractor to use dual turbine type meters.

3.2 CONTROLS SYSTEM OPERATORS MANUALS

Provide electronic and printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly explain all operation requirements for the control system.

Provide with each manual: CDs of the project's control system drawings, control programs, data bases, graphics, and all items listed below. Include gateway back-up data and configuration tools where applicable. Provide CDs in jewel case with printed and dated project-specific labels on both the CD and the case. For text and drawings, use Adobe Acrobat or MS Office file types. When approved by the Government, AutoCAD and Visio files are allowed. Give files descriptive English names and organize in folders.

Provide printed manuals in sturdy 3-ring binders with a title sheet on the outside of each binder indicating the project title, project location, contract number, and the controls contractor name, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. Manuals shall include the following:

a. A copy of the as-built control system (shop) drawings set, with all items specified under the paragraph "Submittals." Indicate all field changes and modifications. Point-to-point wiring diagrams shall be an exact representation of the installed conditions.

b. A copy of the project's design drawings, including any official modifications and revisions.

c. A copy of the project's approved Product Data submittals provided under the paragraph "Submittals."

d. A copy of the project's approved Performance Verification Testing Plan and Report.

e. Printouts of all control system programs, including controller setup

pages if used. Include plain-English narratives of application programs, flowcharts, and source code.

f. Printouts of all physical input and output object properties, including tuning values, alarm limits, calibration factors, and set points.

g. A table entitled "AC Power Table" listing the electrical power source for each programmable logic controller. Include the building electrical panel number, panel location, and circuit breaker number.

h. A list of qualified control system service organizations for the work provided under this contract. Include their addresses and telephone numbers.

i. A written statement entitled "Technical Support" stating the control system manufacturer or authorized representative will provide toll-free telephone technical support at no additional cost to the Government for a minimum of two years from project acceptance, will be furnished by experienced service technicians, and will be available during normal weekday working hours. Include the toll-free technical support telephone number.

j. For all software not currently under Government license, a written statement entitled "Software Upgrades" stating software and firmware patches and updates will be provided upon request at no additional cost to the Government for a minimum of two years from contract acceptance. Include a table of all PLC and SCADA system software and firmware provided under this contract, listing the original release dates, version numbers, part numbers, and serial numbers.

In each PLC and remote I/O cabinet, provide laminated copies of the point-to-point wiring diagram for that panel, inside of a plastic pouch mounted inside the door.

3.3 FUNCTIONAL TESTING (FT)

3.3.1 General

The FT shall demonstrate compliance of the control system work with the contract requirements. The FT shall be performed by the Contractor and witnessed and approved by the Government and CxA. Prior to FT, the Contractor shall perform his own Pre-Functional Testing. A meeting to review the Functional Testing is required to coordinate all aspects of the FT and shall include the Contractor's QA representative, the Contractor's FT administrator, the Contracting Officer's representative prior to the start of FT. FT shall be performed in conjunction with commissioning work specified in Section 01 91 13, "COMMISSIONING". In general these requirements are intended to be the initial function tests (FT's) performed as a precursor to the Commissioning Performance Tests (PT's).

3.3.2 Functional Testing Plan

Submit a detailed FT Plan of the proposed testing for Government approval. Develop the FT Plan specifically for the control system in this contract. The FT Plan shall be an clear list of test items arranged in a logical sequence. Include the intended test procedure, the expected response, and the pass/fail criteria for every component tested. The list which is to be used shall be submitted for approval prior to performing

any testing.

The plan shall clearly describe how each item is tested, indicate where assisting personnel are required, and include what procedures are used to simulate conditions. There shall be a separate sheet for each item to be tested. Include a separate column for each checked item and extra space for comments. Where sequenced control functions are tested, insert the routine from the projects sequence of operation. For each test area, include signature and date lines for the Contractor's FT administrator, the Contractor's QA representative, the CxA, the Contracting Officer's representative to acknowledge successful completion. Refer to the paragraph entitled, "FUNCTIONAL TESTING" in Section 01 91 13, "COMMISSIONING" for additional requirements. Submit copies of the proposed Functional Tests in electronic format (Microsoft Work or Excel files) for review, commenting and editing by the Governments CxA as part of the shop drawing review process.

3.3.3 Calibration

Prior to starting FT's, calibrate all I/O points, new and existing.

All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 degrees F. Pressure sensors shall have an accuracy of + or - 2.0 percent of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

Submit a calibration report for each device, one page per device. Group and identify data by type of device, and device point name.

As part of the FT's, include a check of each points calibration.

3.3.4 FT Sample Size

Test all sensors, flow meters, valves, transducers, equipment, and building pumps/bridge valves, unless otherwise directed (100% testing).

The Government and CxA will witness all testing, the CxA will approve all tests.

3.3.5 Pre-Functional Testing Checklist

Prior to the start of Functional Testing to be witnessed by the CxA, the Contractor shall have verified complete system functionality by completion of Pre-Functional Testing checklist. Submit the following for Government approval documenting satisfactory completion of the Pre-FT's as a list with items checked off once verified. Provide a detailed explanation for any items that are not completed or verified.

a. Verify all required installation work is successfully completed, and all HVAC control equipment is working correctly.

b. Verify all required control system components, wiring, and

accessories are installed.

c. Verify the installed control system architecture matches approved drawings.

d. Verify all control circuits operate at the proper voltage and are free from grounds or faults.

e. Verify all required surge protection is installed.

f. Verify the A/C Power Table specified in "CONTROLS SYSTEM OPERATORS MANUALS" is accurate.

g. Verify all network communications function properly, including uploading and downloading programming changes.

h. Verify communications are error free.

i. Verify each programmable logic controller's programming is backed up.

j. Verify all wiring, components, and panels are properly labeled.

k. Verify all required points are programmed.

l. Verify all sensor readings are accurate and calibrated.

m. Verify each control valve and actuator goes to normal position upon loss of power.

n. Verify all control loops are tuned for smooth and stable operation. View trend data where applicable.

o. Verify each controller works properly in stand-alone mode.

p. Verify all workstations, human machine interfaces, all system and database software is installed, and graphic pages are created for each workstation and HMI.

q. Verify the as-built (shop) control drawings are completed.

The completed Pre-Functional Test Checklist shall be submitted for approval, documenting satisfactory completion of the tests, and that the Contractor is ready to begin Functional Testing.

3.3.6 Conducting Functional Testing

a. Conduct Government-witnessed FT after approval of the FT Plan and the completed Pre-FT Checklist. Notify the Contracting Officer of the planned FT at least 15 days prior to testing. Provide an estimated time table required to perform the testing. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of the FT. Ensure that testing personnel are regularly employed in the testing and calibration of PLC systems. Using the project's as-built control system (shop) drawings, the project's mechanical design drawings, the approved Pre-FT Checklist, and the approved FT Plan, conduct the FT.

b. During testing, identify any items that do not meet the contract requirements and if time permits, conduct immediate repairs and

re-test. Otherwise, deficiencies shall be investigated, corrected, and re-tested. Document each deficiency and corrective action taken.

c. If re-testing is required, follow the procedures for the initial FT. The Government may require re-testing of any control system components affected by the original failed test. If in the sole opinion of the Contracting Officer, with input from the CxA determines the failure rate of the FT's is unacceptably high, the FT will be suspended and the Contractor will be directed to re-perform the Pre-Functional testing and resubmit the checklist. Repetitious type failures/unmet requirements will be evidence that the Contractor has not demonstrated due diligence in performing Pre-Functional testing.

d. All FT's shall be witnessed and approved by the CxA; provide a column for the CxA to sign off on each FT.

3.3.6.1 Programmable Logic Controller Capability and Labeling

Test the following for each controller:

a. Memory: Demonstrate that programmed data, parameters, and trend/ alarm history collected during normal operation is not lost during power failure.

b. Direct Connect Interface: Demonstrate the ability to connect directly to each type of controller with a portable electronic device like a notebook computer. Show that maintenance personnel interface tools perform as specified in the manufacturer's technical literature.

c. Stand Alone Ability: Demonstrate controllers provide stable and reliable stand-alone operation using default values or other method for values normally read over the network.

d. Wiring and AC Power: Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table. Demonstrate the ability to match wiring labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the Communication Architecture Schematic and floor plans.

e. Nameplates and Tags: Show the nameplates and tags are accurate and permanently attached to control panel doors.

3.3.6.2 Communications and Interoperability Areas

Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. If available or required in this specification, use a protocol analyzer to assist with identifying devices, viewing network traffic, and verifying interoperability. These requirements must be met even if there is only one manufacturer of equipment installed. Testing includes the following:

a. Data Presentation: On each Operator Workstation, demonstrate graphic display capabilities.

b. Reading of Any Property: Demonstrate the ability to read and display any used readable object property of any device on the network.

c. Setpoint and Parameter Modifications: Show the ability to modify all setpoints and tuning parameters in the sequence of control or listed

on project schedules. Modifications are initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.

d. Peer-to-Peer Data Exchange: Show all devices are installed and configured to execute sequences (without the need for operator or workstation intervention), to implement the project sequence of operation, and to share global data.

e. Alarm and Event Management: Show that alarms/events are installed and prioritized. Demonstrate time delays and other logic is set up to avoid nuisance tripping. Show that operators with sufficient privilege can read and write alarm/event parameters. Show that operators with sufficient privilege can change routing for each alarm/event including the destination, priority, day of week, time of day, and the type of transition involved.

Archival Storage of Data: Show that data archiving is handled by the operator workstation/server.

g. Modification of Trend Log Object Parameters: Show that an operator with sufficient privilege can change the logged data points, sampling rate, and trend duration.

. Device and Network Management: Show the following capabilities:

(1) Display of Device Status Information

(2) Display of Object Information

(3) Silencing Devices that are Transmitting Erroneous Data

(4) Time Synchronization

(5) Remote Device Reinitialization

(6) Backup and Restore Device Programming and Master Database(s)

3.3.6.3 Control Loop Stability and Accuracy

For all control loops tested, give the Government trend graphs of the control variable over time, demonstrating that the control loop responds to a 20 percent sudden change of the control variable set point without excessive overshoot and undershoot. If the process does not allow a 20 percent set point change, use the largest change possible. Show that once the new set point is reached, it is stable and maintained. Control loop trend data shall be in real-time with the time between data points 30 seconds or less.

3.3.6.4 Functional Testing Report

Upon successful completion of the FT, submit a FT Report to the Government and prior to the Government taking use and possession of the facility. Do not submit the report until all problems are corrected and successfully re-tested. The report shall include the annotated FT Plan used during the FT. Where problems were identified, explain each problem and the corrective action taken. Include a written certification that the installation and testing of the control system is complete and meets all of the contract's requirements. Once the FT is submitted and approved,

participate in Commissioning Functional Testing to verify sequences of operation.

3.3.7 Execution of Sequence of Operation

As part of the work and Performance Tests (PT's) specified in Section 01 91 13, "COMMISSIONING", demonstrate that the HVAC system operates properly through the complete sequence of operation, interactions between sequences and systems are accounted for, "bumpless" operation between modes, and ability to globally read and modify parameters over the internetwork.

3.4 TRAINING REQUIREMENTS

Provide a qualified instructor (or instructors) with two years minimum field experience with the installation and programming of similar PLC systems. Orient training to the specific systems installed. Coordinate training times with the Contracting Officer after receiving approval of the training course documentation. Training shall take place at the job site and/or a nearby Government-furnished location. A training day shall occur during first and second shift hours, last no longer than 8 hours (4 hours per shift) and include 2 15-minute breaks. The project's approved Controls System Operators Manual shall be used as the training text. The Contractor shall ensure the manuals are submitted, approved, and available to hand out to the trainees before the start of training.

3.4.1 Training Documentation

Submit training documentation for review 30 days minimum before training. Documentation shall include an agenda for each training day, objectives, a synopses of each lesson, and the instructor's background and qualifications. The training documentation can be submitted at the same time as the project's Controls System Operators Manual.

3.4.2 Training - Operation

Provide Training shortly after completing FT. The training session shall last 2 days and be conducted at the PLC system workstation, at a panel HMI, and at other site locations as necessary. Upon completion of the Training, each trainee should fully understand the project's PLC system operation. The training session shall include the following:

First day - technician training to be delivered in two shifts: four hours for morning shift and four hours for afternoon shift.

a. A walk-through tour of the mechanical system and the installed PLC components (controllers, surge protection, switches, sensors, etc.)

b. A discussion of the components and functions at each PLC panel

c. Logging-in and navigating at each operator interface type

d. Modifying setpoints

e. Selecting, and viewing trends

f. Viewing and acknowledging alarms

g. Demonstrate switching between manual and automatic at the OWS

h. Second day - Engineering training - eight hours.

i. Using each operator interface to find, read, and write to specific controllers

j. Modifying and downloading control program changes

k. Backing-up and restoring programming and data bases

l. Modifying graphic text, backgrounds, dynamic data displays, and links to other graphics

m. Creating new graphics and adding new dynamic data displays and links

n. Alarm and Event management

o. Adding and removing network devices

The second day training session shall also include an open question and answer discussion between the contract programmers and the Government maintenance and system engineer.

-- End of Section --

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ELECTRIC AND ELECTRONIC CONTROL SYSTEMS FOR HVAC
02/12

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 511	(2010) Certified Ratings Program for Air Control Devices

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-C	(2010) Control Network Protocol Specification
CEA-709.3	(1999; R 2004) Free-Topology Twisted-Pair Channel Specification
CEA-852-B	(2010) Tunneling Component Network Protocols Over Internet Protocol Channels

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 262	(2011) Standard method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
NFPA 70	(2014) National Electrical Code
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568-2	(2009c; Errata 2010) Commercial Building

	Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cable Components
TIA-568-C.1	(2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard

UNDERWRITERS LABORATORIES (UL)

UL 916	(2007; Reprint Mar 2012) Standard for Energy Management Equipment

1.2 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in the Section but are included here for completeness.

1.2.1 Alarm

Notification of an abnormal condition.

1.2.2 Analog

Handling or display of continuously variable parameters signals value such as temperature, current, velocity, etc.

1.2.3 Application Generic Controller (AGC)

A networked device or node that contains a complete, configurable application that is generic in nature and suited for various control tasks. The devices manufacturer produces this application. The manufacturer exposes a high number of network variables and configuration properties on the device to allow the specific use of the device to be configured with network tools. An AGC has limited programming capabilities that can be accessed via an LNS plug-in. Example AGCs include loop controllers and actuators.

1.2.4 Application Specific Controller (ASC)

A networked device or node that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e. Program ID) with configurable settings. All settings shall be configured via LNS plug-ins or by physical settings (such as jumpers or dip-switches) on the device. Example ASCs include VAV controllers and fan coil unit controllers.

1.2.5 Binding

The act of establishing communication between CEA-709.1-C devices by associating the output of one device to the input of another.

1.2.6 Building Automation System (BAS)

The complete BAS is comprised of mechanical system controls etc., as defined in Division 23 of the contract documents. The BAS is a distributed control system built upon a single network infrastructure based upon LonWorks Network Services. This infrastructure shall include field wiring, Cat 5e LAN wiring, workstations, servers, routers, repeaters and raceways as required.

1.2.7 Channel

A channel is the physical media upon which devices communicate and is characterized by its transceiver type. In most applications the channel will be described as TP/FT-10. A channel can consist of multiple subnets but typically include only one. Two channels can be joined together via a router.

1.2.8 Control Logic Diagrams

A graphical logic for multiple processes that make up a process.

1.2.9 Custom Application Controller (CAC)

A programmable control device that is programmed to execute control sequences, control loops or operator functions. The application in the controller is custom software produced specifically for the project. These applications shall conform to the LonMark functional profiles and inter-operability standards. CACs will typically not be provided with LNS plug-ins and are more flexible and much more powerful than an AGC. Example CACs include AHU controllers.

1.2.10 Diagnostic Program

Machine-executable instructions used to detect and isolate system and component malfunctions.

1.2.11 Digital

Two positions I/O data such as open or closed contacts or operating status of on or off where on is a high signal and off is a low signal. Binary is sometime used interchangeably with digital.

1.2.12 Direct Digital Control (DDC)

Automated control of an HVAC process consisting of microprocessor based controllers with the control logic performed by software. AGC, ASC and CAC are examples of DDC type controllers that use Plug-ins or custom software programs to execute the HVAC process logic.

1.2.13 Domain

A domain is a logical collection of nodes on one or more channels. Communications can only take place among nodes configured in a common domain; therefore, a domain forms a virtual network. Multiple domains can occupy the same channels.

1.2.14 Explicit Messaging

A method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received. These messages are non-standard and often vendor (application) dependent.

1.2.15 External Interface File (XIF)

A file which documents a device s external interface, specifically the number and types of LonMark objects; the numbers, types, directions, and

connection attributes of network variables; and the number of message tags; as defined in the LonMark XIF Guide.

1.2.16 Functional Profile

The description of one or more LonMark Objects used to clarify and certify devices.

1.2.17 Gateway

A device that translates from one protocol to another. Gateways are also called Communication bridges or Protocol Translators.

1.2.18 Graphical User Interface (GUI)

See HMI definition.

1.2.19 Human Machine Interface (HMI)

A graphical, object-oriented method by which an operator is capable of communicating with the LonWorks Network. The Human-Machine Interface allows the operator to manage, command, monitor and program the system. Also know as a GUI.

1.2.20 Implicit Messaging

A method of communication between devices or nodes where the communication data transfer (bindings) parameters are assigned by a Network Management Tool such as LonMaker.

1.2.21 Intelligent Devices (ID)

Control products that incorporate solid-state components based around the Neuron chip to perform a dedicated function (i.e., actuators, sensors, switches).

1.2.22 Java Application Control Engine (JACE)

A device that provides connectivity to the BAS network or in some cases multiple networks. The JACE can also function as a gateway.

1.2.23 Kennedy Complex Control System (KCCS)

The centralized processing system for remote control and monitoring of power and utility subsystems at KSC.

1.2.24 LonMark

A certification issued by LonMark International to CEA-709.1-C devices.

1.2.25 LonMark International

Maintains guidelines for the interoperability of CEA-709.1-C devices and issues the LonMark certification for CEA-709.1-C devices.

1.2.26 LonMark Object

A collection of network variables, configuration parameters, and associated behavior defined by LonMark International and described by a

Functional Profile. Defines how information is exchanged between devices on a network.

1.2.27 LonWorks Network Services (LNS)

A network management and database standard for CEA-709.1-C devices.

1.2.28 LNS Plug-in

Software which runs in an LNS compatible software tool. Device configuration plug-ins provide a user friendly interface to configuration parameters.

1.2.29 LonWorks

The overall communication technology, developed by Echelon Corporation, for control systems. The term is often used to refer to the technology in general, and may include references to any/all of the protocol, network management, and interoperability guidelines where the technology is based on the CEA-709.1-C protocol and employs interoperable devices along with the capability to openly manage these devices (via multiple vendors) using a network configuration tool.

1.2.30 LonWorks Technology

The generic technology that supports products that communicate using LonTalk Communication protocol. The technology employs routers, gateways, bridges and multimedia transceivers permitting topology and media independent control solutions.

1.2.31 LonWorks Network Repeater

A LonWorks network device that amplified the LonTalk protocol signal and interconnects two LonWorks segments to extend maximum wire length and overcome the limitation of nodes per segment. Repeaters are generally not recommended and may only be used to increase the segment cable length by 10 percent or to increase the segment device maximum up to 70 devices.

1.2.32 LonWorks Network Router

A LonWorks network device that utilizes LonTalk protocol to transparently route the LonWorks control information and messages between nodes, sub-nets and domains over IP based LAN/WAN. Routers are similar to repeaters but provide the additional functionality of packet filtering and network traffic isolation. Routers are recommended over repeaters for segment cable length extension and segment maximum device extension.

1.2.33 Network

A system of distributed control units that are linked together on a communication bus. A network allows sharing of point information between all control units. Additionally, a network provides control monitoring and control of the entire system from any distributed control unit location.

1.2.34 Network Wiring

Includes conduit, wiring and wiring devices to install complete LonWorks network wiring and high speed Ethernet backbone.

1.2.35 Network Configuration Tool

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.2.36 Node

A device that communicates using the CEA-709.1-C protocol and is connected to a CEA-709.1-C network.

1.2.37 Node ID

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-C device. Sometimes called the Neuron ID.

1.2.38 Open System Alliance (OSA)

Trade organization for LonWorks Network Integrators. Membership is open to any Network Integrator that has demonstrated proficiency with LonWorks networks and meets the training requirements.

1.2.39 Operator Workstation (OWS)

A combination of hardware and software, which incorporates LonWorks Network Services for Windows for remote network client series (LNS Server) and a graphic based Human Machine Interface (HMI). The OWS provides a graphical, object-oriented method by which an operator is capable of communicating with the various BAS components over the LonWorks Network. It also allows the operator to manage, command, monitor, and program the system. The OWS communicates with controllers through an Ethernet connection utilizing LonWorks CEA-852-B.

1.2.40 Operating System (OS)

Software, which controls the execution of computer programs and which provides scheduling, debugging, input/output controls, accounting, compilation, storage assignment, data management, and related services.

1.2.41 Point

Group of data, which corresponds to a hardware input, output, or calculated value.

1.2.42 Segment

A single section of a control network that contains no repeaters or routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

1.2.43 Sensor

A Device capable of measuring the condition or value of a variable.

1.2.44 Standard Configuration Parameter Type (SCPT)

Pronounced skip it, a standard format type (maintained by LonMark

International) for Configuration Parameters.

1.2.45 Standard Network Variable Type (SNVT)

Pronounced snivet, a standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean a network variable of a standard network variable type). In general, the intended meaning should be clear from the context.

1.2.46 Subnet

Consists of a logical (not physical) grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Part of the Node Addressing scheme.

1.2.47 TP/FT-10

A Free Topology Twisted Pair network defined by CEA-709.3.

1.2.48 User-Defined Configuration Parameter Type (UCPT)

Pronounced u-keep-it, a configuration parameter format type that is defined by the device manufacturer.

1.2.49 User-Defined Network Variable Type (UNVT)

A network variable format defined by the device manufacturer. Note UNVTs create non-standard communications (other vendor s devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.3 SYSTEM DESCRIPTION

1.3.1 General Requirements

The following sections apply to work specified in this Section 01 33 00 SUBMITTAL PROCEDURES, 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC, and 01 91 13 COMMISSIONING.

Submit Material, Equipment, and Fixture Lists for control and instrumentation systems including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty and information, and fabrication site information. Submittals shall be clearly marked to identify the exact product or component being provided.

Submit DDC Contractor Design Drawings in hard copy and on CD-ROM in AutoCAD Microstation, or Visio format.

Submit Equipment and Microprocessor Performance Data for each major HVAC equipment type consisting of hardware, point types, physical data, catalog data, software, scan rate and response times to direct commands.

1.3.2 System Requirements

The Building Automation System (BAS) shall provide for fully automatic microprocessor based control, data acquisition, monitoring and display of system components and operating parameters.

The "Workstation Points List"", BAS control diagrams, sequences of operation and controller software requirements shall be considered complementary, in that the work or features called for in any requirement shall apply to the other related items.

Furnish and install a LonWorks based Building Automation System (BAS) to provide a complete, safe and operational system for the monitoring and control of Heating, Ventilation, and Air Conditioning (HVAC) equipment. The BAS shall be comprised of a fully integrated system of various independent controllers, routers, repeaters, temperature sensors, humidity sensors, pressure sensors, air flow measuring stations, switches, and auxiliary control components used to execute the sequence of operation and comply with the "Workstation Points List" shown on the instrumentation drawings. The BAS shall include an Operator Workstation (OWS) which acts as an LNS Server and a Human Machine Interface (HMI) for the entire BAS installed.

An external, gateway-based interface is used to connect the BAS to the existing KCCS Modbus TCP/IP CITECT SCADA system. A selected number of monitor and control points shall be transferred between the BAS and KCCS as indicated on the BAS Point Schedule on the design drawings.

All control points for a system shown on workstation points list shall be wired to one control cabinet. If expansion modules are required they will be connected to the main controller via a sub-network.

1.3.3 Design Requirements

The LonWorks network is intended to seamlessly connect devices throughout the building regardless of subsystem type, e.g., HVAC, VFD's, Power Management, and network sensors and devices shall easily coexist on the same network channel(s). Gateways shall not be used unless specifically authorized by the Contracting Officer. Use of a gateway requires submittal of the gateway documentation and approval of the documentation by the Contracting Officer. Exceptions: The Field Server Gateway or the Niagara AX JACE can be used to translate between LonWorks and MODBUS TCP/IP to integrate the BAS into the KCCS.

The network shall integrate open architecture subsystems that utilize CEA-709.1-C, the LonTalk protocol, as the common communication protocol between all controlled and controlling devices. Where necessary or desired, LonTalk packets shall be encapsulated into TCP/IP messages, in accordance with CEA-852-B, to take advantage of existing infrastructure or to increase network bandwidth. LonWorks routers shall use the standard IP protocol stack (Cisco Certified) and shall utilize LonTalk protocol to transform the routing messages from/to the devices on the network (layer 3 routing). Any such encapsulation of the LonTalk protocol into IP datagram s shall conform to existing LonTalk guidelines using LNS for Windows for such encapsulation.

Furnish and install a Windows-based, LonWorks Network Services, LonWorks-protocol network including routers, repeaters and network cabling. Integrate and verify subsystems per the "Workstation Points List

", sequence of operations and the approved submittal drawings. An OSA member network integrator, using LonWorks Network Services for Windows (LNS), shall provide IP Network services. A network integrator shall perform integration of the LonWorks network and must directly be an OSA member. Parent Corporation, ancillary or affiliated membership is not acceptable.

The products used in constructing the network shall be LonWorks Network Services (LNS) compatible; LonMark certified and shall bear the LonMark seal. The software tools required to configure the network shall be provided without additional fees or software licenses. Two (2) complete, fully documented, fully executed licenses for all software utilized on the project shall be required as part of the close out documents. All devices (nodes) on the network shall be able to be installed and configured using a standard network management tool such as LonMaker for Windows. No proprietary or non-open tool set for installation or configuration will be accepted. No non-open integration tools, devices, or host software shall be used as part of this open system. All network tools must be generally available for purchase to any integrator without the requirement for exclusive contracts. All configuration tools, installation tools, Plug-ins, databases and software shall remain with the job and be owned by the Government. All software tools shall be properly licensed in duplicate and conveyed at contract sign-off.

Local monitor and control shall be through the OWS and it shall provide complete access to any point in the system at any time. The host PC interface shall use openly available software packages that are non-exclusive.

Loss of power at either the OWS or the controller (AGC,ASC,CAC) level shall not result in a loss of the set-point data or programs. Where the information resides in volatile memory, an uninterruptible power supply with 30 minute duration shall be furnished for each controller and workstation.

Provide a graphic plan layout for each HVAC system (AHU, VAV, FCU, Pump etc.). If a web-based browser is used, it shall not support internet access through the worldwide web. The graphics shall display all points per the "Workstation Points List" or as directed by the Contracting Officer. The system operator, when logged in under the appropriate pass word level, shall change set points through the graphics (HMI).

Provide a graphic plan layout of each floor of the building. Each zone temperature/humidity sensor and its associated VAV box shall be placed on the graphical plan. The respective temperature/humidity shall be displayed adjacent to the graphic representation. Graphics shall provide an indication for all the points listed on the drawings as well as occupancy schedules, alarms, trends and modes of operation, including the KCCS modes.

KCCS monitor and control shall be through the gateway. The gateway configuration tools shall be supported by the LNS database in a client-server fashion. The gateway shall convert the BAS LonTalk protocol to Modbus TCP/IP protocol and utilize the standard Modbus RTU I/O register addressing scheme. The conversion point list, with complete Modbus addresses for all monitor and control points, shall be provided to the contracting officer and be incorporated into the BAS shop drawings. All monitor and control points on the list shall be demonstrated and verified to the contracting officer via a Modbus test and diagnostic tool such as

ModScan 32 or Modbus Poll. The contractor is responsible for providing the Modbus tool and the laptop that shall be used to perform the verification.

Work includes update of the CITECT KCCS Head-end software and graphical screens. Existing graphics shall be revised, and new graphical screens created to coordinate with the work to be performed. Refer to the " Workstation Points List" for the minimum points to be displayed and functions to be provided through the KCCS workstation. The controls contractor shall submit a request to the Contracting Officer for data on a sample CITECT project with similar existing operator interface screens for use as a reference in the development of the new screens. The KCCS shall be capable of starting and stopping the AHUs and other specified HVAC equipment installed under this contract regardless of the commands or time schedule of the BAS.

Provide a wiring diagram depicting the electrical connections for all the components that make up the BAS. The diagram shall show start and end points of each device, part number and source, terminal blocks, termination details, addresses, wire type, color code and numbering scheme. Each individual wire and cable in power, control, indication, and instrumentation circuits shall be provided with identification markers at the point of termination. Locate the label within 2 of the wire, cable or tube termination. Conductor identification shall consist of plastic sleeves with pre-printed individual alpha/numeric element inserts. Plastic sleeves shall fully encircle the conductor. Conductors shall also be color coded.

Provide three (3) design review meetings held at KSC throughout the duration of the contract. The first meeting will be a kickoff meeting and the two remaining meetings will be software review meetings. The kickoff meeting will be an informal review of the overall project requirements and include a discussion of the following topics;

BAS hardware that will be used for the project

BAS software that will be used for the project

KCCS interface that will be used for the project

Project submittal requirements

Project sequencing requirements

Qualifications and Certifications

Lessons learned from previous BAS construction projects

The two (2) software review meetings are described in detail in accordance with paragraph entitled, "Installation," of this section. Additional informal review meetings are encouraged whenever necessary.

1.3.4 Performance Requirements

Each channel on the network shall on average occupy no more than 50 percent of the available bandwidth. Transient peaks are permitted but shall occupy no more than 80 percent of the available bandwidth. The overall error rate history shall be less than 3 percent.

KCCS commands shall be executed in less than four (4) seconds. The execution time is the total time elapsed between the time the command is issued at the workstation and the time a notification of a status change is displayed at the same workstation.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists; G

SD-02 Shop Drawings

DDC Contractor Design Drawings; G

Control Diagrams; G

Device Tag Schedules; G

Sequence of Operation; G

Damper Schedule; G

Valve Schedule; G

Software Schedule; G

Network Connection Diagrams; G

Composite Wiring Diagrams; G

Terminal Wiring Diagrams; G

Panel Layout Drawings; G

Software Package; G

SD-03 Product Data

Equipment and Microprocessor Performance Data; G

Equipment and Performance Data; G

SD-05 Design Data

Training Course Outline; G

SD-06 Test Reports

Field Test Plan (FTP); G

FTP Results; G

Controls Checkout Plan (CCP); G

CCP Results; G

KCCS Validation Plan; G

KCCS Validation Plan Results; G

SD-07 Certificates

Office Location; G

Similar BAS Installation Projects; G

Design Engineers; G

Installers; G

Integrators; G

Start-up Personnel; G

SD-08 Manufacturer's Instructions

Operation Instructions; G

Parts List; G

Equipment and Performance Data; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

As-Built Drawings; G

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

Submit Qualification Documentation for the items listed below:

The Contractor shall validate that they have an office location within 100 miles of the Kennedy Space Center (KSC) that is staffed with qualified technicians and services personnel, and is capable of providing system operation instructions and routine maintenance services on all system components utilized.

Submit a list of no less than three (3) installations of similar BAS installation projects by the manufacturer being utilized and installed by the Contractor. These projects must be completely installed and fully functional such that the systems can be observed in full operation.

Submit a list of specific personnel who will be involved in the design, installation, programming, and start-up and commissioning of the BAS. If personnel changes occur during implementation of the project, update and re-submit a new list identifying the new participants.

Submit resumes listing application and design engineers qualifications and a list of recently completed projects demonstrating three (3) years of system installation experience with the LonWorks products being installed. Resumes will include Certificates documenting the following: Echelon Course 201- LonWorks Network Design training; Certified Cat 5E Network installation Engineer; Open System Alliance (OSA) Membership for the Network integrator. Provide name(s), address and telephone numbers for supervisory personnel.

Submit resumes listing installers qualifications and a list of recently completed projects demonstrating three (3) years of system installation experience with the LonWorks products being installed. Resumes will include Certificate documenting the following: Echelon Course 320- iLon100/iLon600 Installation and Configuration training. Provide name(s), address and telephone numbers for supervisory personnel.

Submit resumes listing integrators qualification and a list of recently completed projects demonstrating three (3) years of system installation experience with the LonWorks products being installed. Resumes will include Certificates documenting the following: LNS Server/Database training; and Human Machine Interface (HMI) training specific to the HMI that is installed on the OWS. Provide name(s), address and telephone numbers for supervisory personnel.

Submit resumes listing integrators qualifications and a list of recently completed projects demonstrating three (3) years system integration/configuration experience with the CITECT product being installed. Resumes will include Certificates documenting the following: CITECT Course Citect HMI/SCADA Configuration training and CITECT Course - Cicode Programming training. Provide names(s) address and telephone numbers for supervisor personnel.

Submit resumes listing start-up personnel qualifications and a list of recently completed projects demonstrating three (3) years of system start-up experience with the LonWorks products being installed. Resumes will include Certificate documenting the following: Echelon Course 301- Using the LonMaker Integration Tool training. Provide names(s) address and telephone numbers for supervisory personnel.

1.6 DELIVERY, STORAGE AND HANDLING

Seal openings after manufacturing and inspection, until ready for installation.

Carefully handle instruments and equipment, do not subject to shock, and protect from weather, dust construction materials and damage.

1.7 PROJECT SEQUENCING

The sequence that follows shall be used by both the Contractor and the Contracting Officer to track the progress of meeting the overall BAS installation requirements. The requirements are listed in chronological order but maybe overlapped or worked simultaneously at the discretion of the Contracting Officer.

Contract Award

Kickoff meeting - 120 days after contract award

Shop drawings and product data submittals - Prior to begin installation

Certification submittals - 14 days after kickoff meeting

First software submittal package - within 60 days after kick off meeting

Design review meeting held at KSC -1 4 days after first software submittal

Second software submittal package - 90 days prior to performing the CCP

Live demonstrations of BAS and KCCS at KSC - 30 days after second software submittal

FTP submittal - 60 days prior to execution

CCP submittal - 60 days prior to execution

KCCS validation plan submittal - 45 days prior to execution

Perform FTP and submit results for approval - 45 days prior to construction end date

Perform CCP and submit results for approval - after FTP has been approved

Perform KCCS validation and submit results for approval - after CCP has been approved

O&M and as-built submittal-within 30 days of successful completion of CCP

Training submittal - 45 days prior to execution

Conduct training - within 30 days after successful completion of the CCP

1.8 OPERATIONS AND MAINTENANCE MANUAL

Include Data Package 5 and the following:

a. Narrative description on how to perform and apply all functions, features, modes, and other operations, including unoccupied operation, seasonal changeover, manual operation, and alarms. Include detailed technical manual for programming and customizing control loops and algorithms.

b. Full as-built sequence of operations.

c. Copies of all checkout tests and calibrations performed by the Contractor (not Cx tests).

d. Full points list. A listing of rooms shall be provided with the following information for each room:

(1) Floor

(2) Room number

(3) Room name

(4) Air handler unit ID

(5) Reference drawing number

(6) Air terminal unit tag ID

(7) Heating and/or cooling valve tag ID

(8) Minimum cfm

(9) Maximum cfm

e. Full print out of all schedules and set points after testing and acceptance of the system.

f. Full as-built print out of software program.

g. Electronic File:

(1) Assemble each manual into a composite electronically indexed file in PDF format. Provide DVD's or CD's as appropriate, so that each one contains all maintenance and record files, and also the Project Record Documents and Training Videos, of the entire program for this facility.

(2) Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.

(3) Link the index to separate files within the composite of files. Bookmark maintenance and record files, that have a Table of Contents, according to the Table of Contents.

h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

PART 2 PRODUCTS

2.1 GENERAL

The Building Automation System (BAS) shall utilize microprocessor-based controllers: for monitoring alarms, contact closures, static pressures, temperatures and humidity; to provide for the control of pumps, dampers, control valves, air handling units, fans, etc.; and the BAS shall have the capability for data acquisition, alarm monitoring, set point and alarm point adjustment through the HMI installed and the OWS. The BAS shall be UL 916 listed.

Hardware devices and software applications shall be the most current version as available from the manufacturer.

All equipment on the control network shall conform to the LonMark Interoperability Guide version 3.3 or higher and be LonMark tested and certified for compliance on the open system network. The control systems shall be installed using products from the currently available suppliers that meet the system specification. In some cases, this may require mixing several suppliers products on the same control network.

A 120 volt power source shall be provided under Division 26, for power to controllers and routers. Extension of power (including necessary transformers, fusing, disconnect switches, wiring and conduit) to control devices, transmitters, actuators, and similar control elements shall be provided under this section of the specifications.

The BAS shall include but not be limited to the following components:

The operator workstation shall consist of hardware and software that allows full user monitoring and adjustment of system parameters.

Equipment Controllers (custom application, application specific, application generic) shall provide distributed control where required to implement control sequence.

The Data Communications capability shall allow data to be shared between the various controllers in the architecture using LonMark CEA-709.3, TP/FT-10 and LonMark CEA-852-B communication protocols.

The system software shall include software for global application functions, application software for DDC controllers, configuration software and HMI and LNS Server software loaded on the operator workstation. System expansion shall not affect the operation of the existing hardware and software unless directed by this specification.

End devices such as sensors, actuators, dampers, valves, and relays.

The failure of any single component shall not interrupt the control strategies of the other operational devices. System expansion shall be through the addition of end devices, controllers and other devices described in this specification.

Electrical work to include wiring, conduit, switches, terminals, fusing, pilot lights, contactors, transformers, and similar elements as required for a completely functional system. Electrical work and materials shall meet the requirements specified in Division 26 of the specifications and those of the manufacturer.

2.2 COMMUNICATIONS

The IP Network shall communicate using Ethernet technologies to implement LonMark CEA-852-B. The IP network shall fully implement the OSI 7 layer TCP/IP protocol. All equipment used on the network will be Cisco compliant, level three transparent. The IP network shall be media independent. Cabling shall be UL listed for the application and shall comply with TIA-568-C.1, TIA-568-2 and NFPA 70.

A gateway shall provide for bi-directional data transfer between LonWorks and Ethernet Modbus TCP protocols. The gateway shall include both hardware and software necessary for translation. The device shall include a port for connection to LonWorks, an Ethernet port isolated from the local HMI, LED indicators power, run, system error, configuration error, and communication activity, configuration and diagnostic capabilities. Software drivers shall be provided to perform the required translation, and configuration.

2.3 DIAGNOSTICS

Microprocessor control shall include a diagnostic routine that can be

performed by the user to check the operation of the microprocessor.

Diagnostic routines shall be fully tested by the manufacturer prior to delivery. Diagnostics shall provide two levels of testing.

A protocol analyzer shall be furnished along with database monitoring capabilities to perform routine and advanced diagnostics.

2.3.1 Automatic Diagnostics

Automatic diagnostics shall be executed upon system start-up and then shall run concurrently and shall include a read/write check to memory for memory testing, minimal instruction execution check, bus and port checks. The diagnostics shall report status, automatically cull defective devices (nodes) and provide self-healing and automatic download to repaired/replaced devices (nodes).

2.3.2 Comprehensive Diagnostics

Comprehensive diagnostics shall include the following:

Microprocessor instructions: All defined functions and their variations.

Microprocessor memory testing: Memory testing shall include comprehensive memory test with memory execution characteristic printout. Limits on memory access time, all patterns run, run time, and number of successful executions in worst-case pattern shall be included in this printout.

Power supply status.

Bus and port checks.

Capability to be initiated remotely (through the IP Network).

Performance of the diagnostics shall meet the above requirements for final acceptance.

2.4 ACQUISITION POINT REQUIREMENTS

Devices (nodes) shall monitor and transmit the values of the points required in the "Workstation Points List" on the drawings to/from the LonWorks/MODBUS TCP/IP Bridge to communicate with the KCCS. The response time to initiate a command from KCCS and receive status back that it was received, shall be less than or equal to four seconds.

Devices (nodes) shall monitor and transmit the values of the points required in the "Workstation Points List" on the drawings and provide the Sequence of Operation as detailed on the drawings.

Devices (nodes) shall monitor and transmit the values of the points required in the "Workstation Points List" on the drawings to/from the OWS for dynamic display on the HMI graphic screens. Include dynamic display of operating parameters of all data acquisition points and alarm states.

All controllers (AGC, ASC, CAC) and microprocessor based equipment connected to the BAS shall respond to a scan request in no more than five (5) seconds, total, for up to 16 scanned points.

2.5 CONTROL POINT REQUIREMENTS

Devices (nodes) shall monitor and transmit the values of the points required in the "Workstation Points List" on the drawings and provide the Sequence of Operation as detailed on the drawings.

Devices (nodes) shall monitor and transmit the values of the points required in the "BWorkstation Points List" on the drawings to/from the LonWorks/MODBUS TCP/IP Bridge to communicate with the KCCS.

Devices (nodes) shall monitor and transmit the values of the points required in the "Workstation Points List" on the drawings to/from the OWS for dynamic display on the HMI graphic screens. Include dynamic display of operating parameters of all data control points and alarm states.

All analog control points shall utilize PID control.

2.6 CONTROL COMPONENTS

2.6.1 Routers

The LonWorks Network Routers shall be equipped with a Type 2-TP network transceiver in each inbound and outbound network port. The router shall be designed to route messages from a segment, sub-net or domain in full duplex communication mode, and utilize LonTalk protocol transport, network, and session layers to route messages between nodes, sub-nets and domains.

The router shall provide the highest performance Layer - 3 routing of LonWorks control packet and support LonWorks/IP channels up to 256 devices. The routers shall be fully configurable and permit a design engineer to define message traffic, destination and other network management functions for the LonWorks devices within the BAS network.

2.6.2 Repeaters

Repeaters shall amplify the LonTalk protocol signal and interconnect two LonWorks segments to extend maximum wire length and overcome the limitation of 64 nodes per segment. Repeater shall be fully configurable and permit a design engineer to define message traffic, destination and other network management functions for the LonWorks devices within the BAS network. The repeaters shall be equipped with status LED lights for network traffic and power. Repeaters are not encouraged and shall only be used to increase the segment cable length by 10 percent or to increase the device maximum up to 70 devices.

2.6.3 Custom Application Controller (CAC)

Provide LNS-based custom application controllers to perform the functionality required. Sufficient (see below) I/O and spares shall be provided to meet the system requirements. Multiple CAC's may be used to provide the required I/O, and shall be located within the same control cabinet. Where control functions are based upon sensor values (such as chilled water valve control based upon the leaving air temperature) they shall be grouped on the same CAC. Point expansion devices which utilize multiplexing technology to increase point capacity by allowing connection of multiple points to a single CAC input or output are not allowed. Each CAC shall have an integral communication port for connection of a laptop

computer.

All CACs shall be of one manufacturer. Provide two (2) spare of each type of I/O (DI, DO, AI, AO). Each HVAC equipment set (AHU, chiller, boiler, etc.) shall have its own CAC or set of CACs. Do not share CACs between HVAC equipment sets except for summary programs necessary to calculate overall system status such as total VAV damper position.

2.6.4 LCD User Interface

Provide one (1) LCD User Interface for each CAC, mounted on the face of the CAC enclosure. Operator shall be able to access select control points from any CAC from any touch screen. Interface shall be configured per the Contracting Officer's direction. Coordinate interface requirements with the contracting Officer to provide required programming, monitoring and start/stop capability. Interface shall provide on board navigation instructions and user prompts. Provide data retention capability upon power loss. At a minimum the LCD user interface shall be provided with the following:

64 Kbytes Non-Volatile Flash Memory; 64 Kbytes Non-Volatile Flash Storage

TP/FT-10A 78 kbps LonWorks port supporting communication by LonTalk protocol.

Six (6) button interface for navigation and data entry.

Read/Write support for up to 250 points (SNVT, UNVT).

Support for up to 50 point groups, each group capable of containing at least 5 points each.

Configurable through LNS plug-in.

User passwords.

Auto log-off.

Backlit 2.1" LCD screen with a resolution of 128 x 128.

Panel Mounting.

Service pin.

The LCD shall be Distech Controls EC-Display EasyControls LCD Display, or approved equal.

2.6.5 Application Generic Controller (AGC)

Provide a LNS-based Application Generic Controller (AGC) where called for to provide functionality as required meeting the project requirements. Unless otherwise approved, the AGC shall utilize LNS based plug-ins for programming, configuration and monitoring of the device. It shall be possible to launch the plug-ins from any LNS based network management tool or HMI. The programmed AGC shall conform to the LonMark Interoperability Guide.

2.6.6 Application Specific Controller (ASC)

Provide a LNS-based Application Specific Controller (ASC) where called for to provide functionality as required meeting the project requirements. ASC shall utilize LNS based plug-ins for programming, configuration and monitoring of the device. It shall be possible to launch the plug-ins from any LNS based network management tool or HMI. For VAV terminal box application, provide the following additional hardware:

Damper actuator: The damper actuator shall mount on the VAV box damper axle and shall provide complete 3-point floating control of the damper. The motor shall have a closure torque of 35 in-lb. minimum. Full torque shall be applied at close-off to assure minimum leakage ratings.

Air flow pick-up: Provide a multi-point averaging air flow probe and a differential pressure transmitter which are compatible with the ASC. The air flow probe shall not amplify the velocity pressure.

Space temperature sensor: Provide a space temperature sensor for each controller with an accuracy of plus or minus 0.5 F.

Transformer: Provide a transformer to supply required low voltage power for the VAV Box Controller. The primary side of the transformer shall be connected to the unit fan power source or a 120 Volt AC circuit provided under Division 26.

2.6.7 Exhaust Fan Controller/Contactor

Each controlled device shall be wired to the closest AHU CAC or have its own Application Generic Controller (AGC). Provide LNS based AGC with correct input/output configuration to meet the requirements of the application. Provide the controller for each fan system.

Contactors for exhaust fans shall be of the magnetic industrial type designed for AC motor starting. Device shall be horsepower rated and provided with NEMA 1 enclosures where located indoors and NEMA 4 enclosures, NEMA 250 when located outdoors. Devices shall be UL listed and include integral 24 volt control transformer. As an option, an enclosed power rated relay with integral hand-off-auto switch may be used similar and equal to Relay in a Box (RIB), as manufactured by Functional Devices, INC.

All exhaust fans shall report on/off status back to the BAS via a current sensing switch.

2.6.8 Control Dampers

Dampers shall be low leakage, airfoil blade, extruded aluminum, high performance type with concealed stainless steel linkage. Extruded aluminum 0.125 inch thick frame with 6 inch wide heavy gauge aluminum airfoil shape blades. Bronze bearings, minimum 1/2 inch hex or square shaft, with mechanically fastened extruded vinyl, ethylene-propylene (EPDM) or silicon blade edge seals, and flexible metal jamb seal. Axles shall be stainless steel. Leakage not to exceed 6.2 CFM per square foot for a 16 square foot damper at 4 inches water gauge, with manufacturer s published submittal data to be provided for all available damper sizes through 10 inches water gauge. Leakage and pressure drop shall be tested and certified in accordance with AMCA 511. Dampers shall be UL approved.

Interior use dampers and dampers used for air modulation shall be opposed blade design. Exterior use dampers and dampers used for two position operation shall be parallel blade design.

Dampers shall have manual hand quadrants and external electric actuators.

All dampers shall have the following failure positions:

Service	Failure Position
Supply air	Open
Return air	Open
Outside air	Closed
Exhaust air (general)	Closed
Exhaust air (lab, toxic or noxious)	Open
Communication Rooms	

All electric dampers connected to the BAS shall be supplied with damper position feedback, unless otherwise specified. Coordinate final damper configuration requirements with Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.

Basis of design for all dampers shall be Greenheck or approved equal.

2.6.9 Damper Actuators

Damper actuators shall be UL listed electronic, 120 volt or 24 volt, spring return and shall be properly sized so as to stroke the damper smoothly and efficiently throughout its range. Actuator response shall be linear in response to the control signal.

Actuators shall utilize a brushless DC motor with a microprocessor based sensing function to detect a stall condition and protect the motor. Rotation shall be from-5 degrees to 90 degrees and arranged to provide tight shut-off against damper seals.

Actuators shall include two (2) built-in auxiliary switches to signal damper closed and open positions. The closed position switch shall activate at 5 degrees, the open position switch shall activate between 25 to 85 degrees (adjustable).

Actuators shall be direct coupled type which requires no crank arm and linkage. Actuators shall be sized for a torque not less than 125 percent of the torque required to operate the damper. Run time shall be constant, independent of torque, full stroke not to exceed 180 seconds.

2.6.10 Control Valves

Valve bodies shall be 2-way, modulating, equal percentage, globe style, single seated, shut-off type. Valve bodies 2 inches and smaller shall be bronze, screwed type and shall be rated at 175 psi. Valve bodies 2-1/2

inches and larger shall be iron, brass or bronze flanged and rated at 125 psi except where otherwise noted.

Valves shall have extended neck stainless steel stems and allow for servicing including packing, stem, and disk replacement. Valve CV shall between 80 to 120 percent of the calculated value based on a pressure drop of 5 psi at design flow rate. Packing shall be TFE(tetrafluorethylene).

Bodies for valves larger than 2 inches shall be provided with flanged ends. Bodies for 2 inch valves shall have threaded ends.

2.6.11 Valve Actuators

Valve actuators shall be electronic, spring return, and properly selected for the valve body and service, and provide a linear force capable of overcoming the system differential and capable of tightly seating the valve, easily unseating the valve from the closed position and have ample power to overcome the flowing fluid and friction of associated packing, linkage, and provide not less than scheduled shut-off pressure.

Actuators shall be of the modulating type (tri-state type are not acceptable) and include positive positioning and accept both 2-10 VDC and 4-20 mA inputs. Current limiting circuitry or microprocessor based overload protection shall be provided. Devices shall include appropriate mounting hardware and provide visual indication of the valve position.

Actuators shall be fully proportioning and be spring return for normally open or normally closed operation as called out in the sequence of operations.

Actuators used for chilled or hot water valves that control the main water flow into a building shall include a valve position feedback indication, connected to the building BAS.

Provide a manual override winder and locking mechanism for override operation of the actuator on a loss of power to the actuator for critical valves as identified on drawings.

2.6.12 Temperature Sensors

Water (cold and hot)temperature sensors shall be platinum Resistance Temperature Detector (RTD) type, 100 ohms plus or minus 0.1 percent at 0 C. RTD sensors shall be provided with transmitters to provide a 4-20 milliamp signal with a linearity of plus or minus 0.1 percent of the span.

Duct temperature sensors at coils shall be RTD or thermistor averaging type. Averaging sensors shall be a minimum of 18 feet in length, in a copper case bendable to a radius of 4 inches with a minimum of 8 point sensors, or continuous type.

Immersion temperature sensors shall be RTD type and be provided with a separable stainless steel or brass well filled with thermal conducting paste.

Averaging sensors shall be continuous element at least 1 foot long per square foot of cut cross sectional area at the installed location. The sensing element shall have a bendable copper sheath.

Space temperature sensors shall be RTD or thermistor type and equipped

with set point adjustment, communication port, override pushbutton and LCD readout. Space temperature sensors shall have user adjustable set points of plus 5/minus 2 degrees F, from the BAS set point. Enclosures shall be ventilated plastic with detachable base plate secured with tamper resistant screws for flush wall mounting to a handy-box. Accuracy shall be plus/minus 0.36 degrees F. Addressable LonWorks sensors connected to the TP/FT-10 network are not acceptable for this application. The sensors shall have a communication port that allows the user to connect to the LonWorks network or the local VAV controller. Basis of design shall be Distech Controls model EC-SENSOR-SLO-CW or Building Automation Products L-Combo with set point and override or approved equal.

Outside air temperature sensors shall be RTD type and shall include a ventilated plastic outside air probe and sun guard.

2.6.13 Relative Humidity Sensors

Relative humidity sensors shall be capacitance or bulk polymer resistance type. Output shall be transmitted in an analog 4-20 mA format and include means for field calibration in-place.

Duct humidity sensors shall have a sensing range of 0 to 100 percent RH with an operating range of 23 to 131 degrees F. Accuracy shall be plus or minus 2 percent. RH in the 0 to 95 percent range.

Indoor humidity sensors shall have a sensing range of 0 to 100 percent RH and an operating range of 24 to 132 degrees F. Accuracy shall be plus or minus 3 percent RH in the 0 to 95 percent range. Enclosure shall be ventilated plastic with detachable base plate secured with tamper resistant screws.

Basis of design shall be Vaisala HMW for wall mount and HMD for duct mount or approved equal.

Outdoor humidity sensors shall have a sensing range of 0 to 100 percent RH and an operating range of -20 to 140 degrees F. Accuracy shall be plus or minus 2 percent RH in the 0 to 95 percent range. Humidity sensors mounted outdoors shall be fully contained in mechanically ventilated aspirating type housing. Housing shall be constructed of painted galvanized steel with a lockable latch and include a 24 VDC fan motor. Enclosure may contain the outdoor air temperature sensor where available from the manufacturer. Basis of design shall be Minco Model HT829-0-S2 or approved equal.

2.6.14 Combination temperature and humidity sensor

The combination temperature and humidity sensor shall be capable of measuring Relative Humidity (RH) over the entire range of 0 to 100 percent. The sensor shall have the accuracy of either ±2 percent or ±3 percent RH. Sensor's humidity elements shall produce voltage output signals proportional to measured humidity for humidity indication. Temperature sensors shall be thinfilm nickel with accuracy of ±0.34 degrees F at 70 degrees F, The sensor shall be National Institute of Standards and Technology (NIST) Traceable, Tested, verified, and audited per NIST standards.

2.6.15 Freezestat

Freeze protection thermostat shall be manual reset with an adjustable set

point between 32 and 55 F. Thermostat shall include sensor that responds to lowest temperature sensed in any one foot segment of the element. At least one foot of sensing element shall be provided per square foot of coil.

Install sensor as per the manufacturer's recommendations. Basis of design shall be Johnson Controls Model A70HA-1 or approved equal.

2.6.16 Carbon Dioxide Sensors

Carbon dioxide sensor shall have a range of 0 to 2000 PPM with an accuracy of plus or minus 100 PPM and an LCD readout. The sensor shall include automatic zero compensation and span calibration, maximum 30 second response time, membrane filter, 4-20 mA output and a 1 year calibration interval. Unit shall be FCC 47 Part 15, subpart B listed. Carbon dioxide sensors shall be used for all HVAC units dedicated to conference rooms, lobbies and other high occupancy areas as shown on the drawings. Carbon dioxide sensors shall be integrated into the control sequence of modulating outside air dampers as indicated on the design drawings. Basis of design shall be GE Telaire Ventostat 8002 for wall mount and 8002B for duct mount or approved equal.

2.6.17 Dew Point Sensors

Sensor shall measure relative humidity and temperature and calculate dew point from this information. Accuracy shall be plus or minus 1 percent RH between 0 and 90 percent RH and plus or minus 0.36 degrees F. Dew point range shall be -20 to 120 degrees F. Sensor shall be immune to particulate contamination. Transmitter shall utilize a current or voltage output compatible with the controller being used. Provided sensors with duct mounting kits.

2.6.18 Differential Pressure Switches

Differential Pressure Switches shall be furnished as indicated for status purposes in air and water applications. Provide single pole double throw switch with fully adjustable set point, matched to the system operating characteristics.

Air differential pressure switches shall be of the diaphragm operated type with adjustable set point with a visual scale. Device shall be tested to a 25 psig maximum surge pressure, and be rated for a 10 psig operating pressure. Range shall be suitable for the application.

Water differential pressure switches shall be of the diaphragm operated type with adjustable set point with a visual scale, die cast aluminum weatherproof housing with polycarbonate scale window. Device shall be tested to a 600 psig maximum surge pressure. Range shall be suitable for the application.

2.6.19 Differential Pressure Sensors

Shall be of the industrial grade microprocessor based capacitance cell type, minimum of 30 to 1 range ability, with plus or minus 0.075 percent accuracy and user selectable linear or square root output. The capacitance cell shall be isolated mechanically, electrically, and thermally from the process medium. An electronic transmitter module shall convert the digital output to a 4-20 mA output and have an integral LCD output in conventional engineering units (psi or feet of water). Housing

shall be aluminum. Transmitter shall be factory calibrated to provide a 4-20 mA output over the required range. Basis of design shall be Rosemount Model 3051CD or approved equal.

2.6.19.1 Outdoor Static Pressure Sensor (Pickup Port)

Pickup port assembly shall be a recessed, outdoor-rated, UV resistant pickup port designed to minimize effects of wind and air movement. BAPI ZPS-ACC10-V or approved equal. Finish the exposed portion of the assembly to match the color of the surrounding surface. Submit color samples to Architect for final color selection.

2.6.19.2 Room Static Pressure Sensor (Pickup Port)

Pickup port assembly shall be a recessed pickup port designed for ceiling mounting in a standard wall box with a standard size face plate. Finish the exposed portion of the assembly to match the color of the surrounding surface. Submit color samples to Architect for final color selection.

2.6.20 Water Flow Measurement Stations

2.6.20.1 Magnetic

Water flow measurement stations shall be of the insertion electromagnetic type with no moving parts; accuracy of +/- 1.0 percent of reading between 2 to 20 feet per second, flow range between 0.25 to 20 feet per second, fluid temperature between 15 to 250 degrees F, 4-20mA output, 316 stainless steel wetted metal components, weathertight NEMA 4 aluminum enclosure. All meters shall be wet calibrated in a NIST traceable flow laboratory. Basis of design is Onicon F-3500.

2.6.21 Natural Gas Flow Measurement Stations

2.6.21.1 Thermal Mass

Natural gas flow measurement stations shall be of the insertion thermal mass type complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand-insertable up to 250 psi. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall provide SFPM flow readings from a pair of encapsulated platinum sensors and shall not require additional temperature or pressure compensation. In addition, the meter shall continuously display of information that can be used to validate the calibration of the meter. Each flow meter shall be individually wet-calibrated against a standard that is directly traceable to NIST. Provide a certificate of calibration with each flow meter. Accuracy shall be within ± 1% of rate from 500-7000 SFPM and ± 2 percent of rate from 100-7000 SFPM. Overall turndown shall exceed 1000:1. Output signals shall consist of the following: (1) analog 4-20mA output and (1) scalable pulse output for totalization. The meter shall be equipped with an integrally mounted graphical display that may be optionally remote mounted up to 1000 feet from the sensor. Each flow meter shall be covered by the manufacturer's one-year warranty. Basis of design is Onicon F-5100.

2.6.22 Air Flow Measurement Stations (AFMS)

Airflow Straightner: AFMSs shall contain an airflow straightner if required by the AFMS manufacturer's published installation instructions. The straightner shall be contained inside a flanged sheet metal casing,

with the AFMS located as specified according to the published recommendation of the AFMS manufacturer. In the absence of published documentation airflow straightners shall be provided if there is any duct obstruction within 5 duct diameters upstream of the AFMS. Air-flow straightners, where required, shall be constructed of 0.125 inch aluminum honeycomb and the depth of the straightner shall not be less than 1.5 inches.

Air flow measurement stations shall be of the thermal dispersion type, using instrument grade self-heating, class encased thermistor type sensors and microprocessor based solid-state electronics. Accuracy shall be plus/minus 3 percent of reading and the station shall not require periodic calibration.

Flow measurement drift shall not exceed plus/minus 0.2 percent of scale for the life of the equipment, auto zeroing sensors are not acceptable.

The sensor array shall be as selected/designed by the manufacturer to provide the specified performance. A factory trained authorized representative shall oversee and approve device placement, model selection station start up.

Performance shall meet the following:

Temperature Range: 30 to 60 degrees F (electronics and flow station)

Velocity Range: Less than 0.01 inch wg at 2,000 fpm

Humidity Range: 0 to 99 percent RH (non-condensing)

Output: 4-20 mA

Velocity Accuracy: plus/minus 2 percent reading

Repeatability: plus/minus 0.2 percent of scale

Resolution: 0.4 percent of scale

Basis of design shall be Ebtron model GTL116-PC or approved equal.

2.6.23 Transformers

Transformers shall be UL listed and provided with secondary fusing and terminal type connectors. Transformer's volt/amp rating shall not be less than 120 percent of the connected load.

2.6.24 DC Power Supplies

DC power supplies shall provide a regulated direct current power and over current protection. Regulation shall not be greater than 1.5 percent at full rated current. Device shall be rated for not less than 120 percent of the applied load.

2.6.25 Uninterruptible Power Supply (UPS)

Chilled water entrance pump controllers are provided with UPS back up from central electrical UPS system.

2.6.26 Terminal Blocks

Terminal blocks shall be UL listed and shall be of the direct-mount multiple types, with fully encased polyamide construction that prohibits contact with the conductor. Conductors shall insert from the side and be held in-place by a screw accessible from the front, but recessed into the block. Barrier type strips are not acceptable. Mounting shall be either direct or rail type. Terminal block jumpers shall be centered mounted screw type bus bar where applicable.

2.6.27 Relays

Relays shall be UL listed, encapsulated plug-in type, rated for not less than 120 percent of the amperage drawn. Number of poles and latching/non-latching functions shall be as required. Relays shall be equipped with an indicating light to indicate energized state.

2.6.28 Current Sensing Relays

Current sensing relays (CSR) shall provide a normally-open contact with a voltage and amperage rating greater that it s connected load. Current sensing relays shall be of split-core design. The CSR shall be rated for operation of 200% of the connected load. Voltage isolation shall be a minimum of 600 volts. The CSR shall auto- calibrate to the connected load.

2.6.29 Switches

Switches shall be UL listed lever type, 3-position hand-off-auto with indicating lamp for hand position, suitable for mounting on control enclosure.

2.6.30 Enclosures

Indoor enclosures shall be UL listed, NEMA 250 Type 1 cabinet, fabricated of not less than 16 gauge steel with 16 gauge perforated sub-panels for component mounting and have removable, hinged doors. Enclosures shall be sized to house the controllers, power supplies, transformers, relays, wire duct, din rails and miscellaneous equipment required to support the application. Enclosure power supply shall provide at least one 40VA and one 100VA transformer with individual on/off switches and circuit breakers and two 120VAC outlets. Enclosures and power supplies shall be UL listed Class 2. Provide one (1) enclosure per CAC, and at other locations as required. Door shall include a keyed locking mechanism, and be furnished with not less than two (2) keys per panel, and all panels shall be keyed alike. Enclosures shall include suitable knockouts for conduit penetrations and have an enamel finish. Equipment and components, including wire management fasteners, shall be securely fastened to the backplane using self-tapping screw. Adhesives or tape are not allowed. Outdoor enclosures shall be UL listed NEMA 250 type 4.

2.6.31 Emergency Override Button

Emergency override buttons shall be UL listed installed with a protective switch housing to prevent accidental actuation and a turn to reset mechanism. The button shall be located in the building lobby or as defined in the design drawings. The button shall be used to initiate the actions described in the design sequence of operation. Basis of design shall be Safety Technology International model SS-2009 with appropriate labeling or approved equal.

2.6.32 Tags

All space temperature sensors shall be permanently labeled with laminated plastic nameplates, white with black lettering, with minimum inch lettering. Tag shall include Room Number and VAV Box ID as shown on as-built documentation. Tag shall also state the function of the respective VAV Box as "Cooling Only" or "Heating/Cooling". Tags shall be fastened to wall below the space temperature sensor with a minimum of two metal screws. Where metal screws cannot be used, due to type of wall construction, fasten tags with suitable adhesive.

2.6.33 Explosion Proof Gas Detection Monitor

Explosion proof gas detection monitor shall be dual source technology for improved infrared sensor life, 316 stainless steel, with multiple-end mounting enclosure. Operation shall be beased on dual-wave length, heated-optics technology; provide with display.

2.6.34 Work Station

Display

20.1 inch Widescreen LCD

300 cd/m2 brightness

800:1 contrast

Digital and Analog input

8ms response time

Video Card

ATI fire V3400

128MB of ram

Processor

Dual Core

2.4 GHz

Storage

500GB SATA drive

Memory

Minimum requirements

4GB of DDR2 RAM

Ports

Provide case with four USB

One serial

One fire wire port

Power Supply

500 Watt

W/SATA connectors

Optical Drives

DVD/CD Burner

Motherboard

Four SATA 300 ports

One IDE

One PCI

One PCI x16

One PCI x1

Keyboard and mouse

Standard generic keyboard with number pad

Provide mouse with 2 buttons and scroll wheel

2.7 SYSTEM APPLICATION SOFTWARE

2.7.1 System Security

The system security shall be available through the HMI application software and is supplemental to the security built in at the Windows Operating System Level.

User access shall be secured using individual security passwords for a minimum of eight users.

Passwords shall have at least three levels of user access with data entry restrictions being assignable by password. Examples of the three levels include manager level with view only access, technician level with alarm acknowledge and set point change access, and system engineer level with full access to all application configuration programs.

The system shall protect itself from unauthorized use by automatically logging off after 15 minutes of non-use.

2.7.2 Alarms

The BAS shall provide alarms for the following:

Remote equipment failure

Equipment run time

Number of start/stop

Program failure

Card failure

Sensor failure

Command failure

Each analog sensor and binary point shall be individually alarmed for values in excess of individual high/low limits or status.

Alarm the following points, when their value deviates from associated set point:

Air Temperature - +/- 3 degrees F

Water Temperature - +/- 3 degrees F

Outside Air Flow - +/- 10 percent

Static Pressure - +/- 0.5 inches or 25 percent (whichever is lower)

When an alarm state is detected, the alarm shall automatically be stored and the user notified by sounding and audible tone, and flashing an alarm message on the operator workstation. Alarms reporting to text devices such as email, pagers and smart phones shall be coordinated with facilities.

Program alarm levels as indicated in sequences, based on the following levels.

Level 1 HVAC Critical

Level 2 HVAC Non-Critical

All input/output points and BAS data objects shall have alarm parameters available for defining alarms monitoring and programming functions shall be restricted by individual password protections.

Level 1 alarms shall be annunciated by initiating a page and/or phone call.

All level 1 alarms shall be annunciated locally at the BAS.

When a system is shut down by BAS command, all alarms for that system shall be suppressed and not re-activated until the system is restarted by BAS command and the system operates for 10 minutes.

All alarm set point values shall be easily adjustable by BAS operator.

2.8 ENERGY MANAGEMENT SOFTWARE

The following Energy Management capabilities shall be furnished standard as part of the BAS, in addition to those functions required by the sequence of operation and called for on the drawings.

2.8.1 Scheduling

The master schedule shall be individually editable for each day of the week and holiday. It shall include leap year and daylight savings time adjustments.

On any day, a time of day events may be edited including:

Equipment start/stop

Optimum start/stop

Occupied/unoccupied

An "outage" mode shall be provided by which the scheduled start/stop - occupied/unoccupied program is overridden. The outage mode shall be selectable at the operator s workstation or KCCS console.

A temporary start/stop - occupied/unoccupied schedule shall be able to be created at the operator s workstation. The temporary schedule shall include a start/stop date to define when the program will go into effect and when it will end. After the end of the temporary schedule programming shall revert back to the original schedule.

The equipment shall also be capable of being manually commanded on or off from either the operators workstation or from KCCS.

2.8.2 Optimum Start/Stop

An optimum start program shall determine the required equipment start timing by applying inside/outside temperature information to the user's time of day schedule.

The optimum start program shall run independently for each controlled load or zone.

The program shall automatically make adjustments to itself based on historical data.

2.9 BUILDING MANAGEMENT SOFTWARE (BMS)

The following building management capabilities shall be furnished as part of the BAS.

2.9.1 Timed Override

A timed override program shall be provided to enable the building operator to set up devices or groups to be temporarily turned on for a defined period of time from the existing operator workstation.

The override time shall be adjustable from 1 to 120 minutes.

2.9.2 Direct Digital Control (DDC)

The Direct Digital Control program shall allow modulating on/off ladder logic and stepped control of remote devices based on sensed data in accordance with the sequence of operation.

Standard control strategies shall include proportional, proportional plus

integral, and proportional plus integral plus derivative control. Tri-state control is not acceptable in lieu of modulating control.

Control routines shall allow operator to set parameters and make adjustments.

Direct Digital Control loop setup and modification shall be done through pre-formatted edit screens, with parameters listed in English language.

Program shall include a dynamic graphic display routine to indicate the status and real-time performance of the control loop.

Auto tuning loops or another method of testing and providing control loop response shall also be provided.

2.9.3 Custom Programming Language

A custom control language capability shall be provided to allow the operator to create real time, equation based, custom control routines.

All binary and analog points in the BAS shall be available as inputs to the custom routines.

Equation operations shall include math functions such as addition, subtraction, multiplication, division, square root, minimum, maximum and average. Logical functions such as greater than, less than, equal to, not equal to, less than or equal to, greater than or equal to, variable timing and delays shall also be allowed.

2.9.4 Totalizing

A totalizing program shall be provided to enable the building operator to monitor and totalize any user-defined variables such as water flow.

A minimum of 6 totalizing equations shall be provided.

2.9.5 Run Time Maintenance

The system shall monitor equipment status and generate maintenance messages based upon user designated run time, starts and/or calendar date limits.

A minimum of 32 separate devices shall be monitored under this function.

Run times shall be stored by device and include both cumulative hours and daily hours.

2.9.6 Reports, Trends and Logs

The system shall include the following reports, trend graphs and logs.

Weekly Temperature Report: A previous 7 day summary of the minimum and maximum temperatures for temperature sensors.

Trend graphs: A custom report generator allowing the user to trend and store sample points based on a user-defined schedule. Files shall have sufficient space to allow for 15 minute samples for not less than 180 days (17,280 points). Sample interval shall be user adjustable from 1 second to 24 hours. A minimum of 24 points shall be capable of being graphed

simultaneously. The graphs shall provide the capability to scroll forward and backward over the entire length of the trended data. All input and control points shall be capable of being trended by themselves, over a user-defined schedule or trended against other devices. All trend points shall be stored in a resident hard drive. Partition hard drives such that data storage is not greater than 80% of partition memory. When maximum file size is reached, new points shall overwrite the oldest points.

Building Automation System workstation should have the capacity to store all analog and command/status points for a period of three years at 15 minutes intervals.

Trend all input points, output points and set points at a 15 minutes interval. Event Logs: The system shall track system events including alarms, log-ons, and diagnostics.

Input/Output Status Reports: This reporting tool shall allow the operator to review the status of all system points.

HVAC Equipment Reports: Reports shall be provided which indicate the HVAC equipment status, as well as the status of all input/output points of connected HVAC equipment.

Custom Report Capability: The building operator shall be provided with a simple method of creating custom reports.

2.9.7 Custom Programming Requirements

A custom DDC programming utility shall be provided to allow the building operator to tailor the system to meet individual needs and respond to changing building requirements.

The building operator shall be able to create custom DDC routines using analog and binary point values, alarm states, constants, and shared variables to perform calculations. The results of these calculations shall be used to perform analog control, binary control, DDC loop enable/disable, and other control functions.

The building operator shall be able to download these routines to the controllers through the OWS or a laptop computer.

Custom routines in distributed controllers shall be maintained in nonvolatile memory to prevent loss in a power outage.

2.9.8 Diagnostics

Microprocessor controllers shall include a diagnostic routine that can be performed by the user to check the operation of the microprocessor. Diagnostics routines shall be fully tested by the manufacturer prior to delivery.

2.9.9 Automatic Diagnostics

Automatic diagnostics shall be executed upon system start-up and shall include a read/write check to memory for memory testing, minimal instruction execution check, buss and port checks as standard with the manufacturer.

2.9.10 Acquisition Point Requirements

Refer to the drawings for required points.

Provide a customized main display with menu items that allow the operator to select lower level displays from any screen. Each display may be protected from viewing unless the operator has been granted the appropriate security level to access the page. Provide at least 3 security levels, and each level may be assigned to each display and data object. The graphics shall include the following lower level displays:

Entire floor plan and enlarged floor plan for each zone with the location of associated equipment, each space temperature/humidity sensors and each space temperature/humidity read-out. When the mouse pointer is placed on the zone its respective temperature/humidity shall be displayed. In addition, the zone color shall change as a function of the space temperature/humidity.

HVAC equipment summary page with current status, temperature/humidity and set point information.

Dynamic graphic displays for AHUs, VAV Boxes, Relief Fans and Toilet Exhaust Fans. If two or more screens are required to show a system, i.e. AHU, show the entire system with major information and data points, and include screen selection buttons to select larger scale partial displays. The graphic shall display all points per the " Workstation Points list" listed in the design drawings or as directed by the Contracting Officer. The system operator shall change set points through the graphic.

Global supervisory displays for alarm, scheduling, trend-graph, etc.

Input/output summary page for each equipment item and each controller. Provide graphics for the Panel Mounted LCD Displays with a simple menu structure to give the operator intuitive access to system operation by Keypad. Coordinate the associated control points and equipment start/stop capability to be provided with Contracting Officer.

2.9.11 Sequence of operation

Refer to the design drawings for the sequence of operation.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated and accordance with the manufacturer's recommendations, including conduit, wiring, controllers, wiring devices, sensors and miscellaneous devices as required and necessary to provide a completely functional and operational system, to include all points defined on the drawings, specified herein and as required to execute the sequence of operation.

Devices shall be securely attached to the equipment, panel and/or structure as appropriate. Control devices, including sensors shall be labeled to match the design documents or the approved shop drawings.

A control wiring schematic and sequence of operation shall be provided for

each CAC, not less than 11 inches by 17 inches, located within or adjacent to the CAC enclosure in a clear plastic pouch.

A framed network configuration diagram shall be provided for the BAS, not less than 11 inches by 17 inches, located next to the OWS.

The control system equipment shall be protected against the occurrence of electrical noise, both spurious and harmonic, in the building power distribution system, where it may occur in the operating building environment. The equipment shall meet all specified requirements when subjected to electromagnetic interference to include, but not limited to, VHF and UHF FM signals, AM and FM signals and continuous or intermittent background RFI and electronic discharge noise. In addition, the control system shall not cause as a result from its operation, direct or indirect electrical interference to be inducted into the buildings electrical power and systems in accordance with FCC Part 15.

Equipment connected to ac circuits shall be protected against or withstand power-line surges. Equipment protection shall meet the requirements of IEEE C62.41.1, IEEE C62.41.2. Fuses shall not be used for surge protection.

DDC hardware shall be protected against or withstand surges induced on control and transmitter wiring installed outdoors and as shown on the design documents. The equipment shall be protected against the following two waveforms:

A waveform with a 10-microsecond rise time, a 1,000-microsecond decay time and a peak current of 60 amps.

A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

If two or more CACs are installed in the same enclosure and they are controlling two independent AHUs, the AC power to each CAC will be separately fused to allow one controller to be taken electrically off line without interrupting the other controller.

Submit Control Diagrams for each major HVAC equipment type (eg. chillers, boilers, pumps, AHUs, fans, VAVs etc.). Each diagram shall be provided on an individual and separate sheet complete with a system flow diagram, a bill of material, a sequence of operation in a text format and tagging information. System flow diagrams shall show the location of each control device associated with that system. Typical diagrams are only allowed for equipment types that are exactly alike.

Submit Device Tag Schedules that at a minimum indicate device type, tag identifier, terminal connection points for wiring on the controller, BAS software point name, complete BAS point address, BAS expanded point descriptor and KCCS point integration information, including KCCS MODBUS addresses for each point. A separate listing shall be provided for each controller.

Submit Sequence of Operation on the control drawings for each system with a complete written sequence of operation pertaining to the control diagram.

Write sequence in similar steps to the sequences of operation presented on the Mechanical Drawings. At a minimum, all control processes shall be clearly shown in a text narrative form. Sequences

shall be written in the contractor's own words in order to demonstrate a clear understanding of how the system is to operate and be specific to the control system equipment used. Copying or duplication of the sequences presented is not acceptable.

Incorporate device tags from the control diagrams and "Workstation Points list" into the sequences.

Submit Damper Schedule indicating duct size, damper size, damper type, damper model number, damper torque requirements, loaded damper operator full rotation time, damper actuator type, quantity of actuators per damper, damper actuator model number and damper failure position.

Submit Valve Schedule indicating valve model number, body type, calculated required Cv, valve Cv factor, actual pressure drop, actuator model number, and valve pressure shutoff rating.

Submit Software Schedule indicating all the software required to design, install, test and modify the entire BAS. Provide complete name of software application, version number and a brief description of what it is used for.

Submit Network Connection diagrams for the Building Automation System. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect actual installed conditions.

Provide floor plans locating all control units, workstations, servers, LAN interface devices, etc. Include all Wide Area Network (WAN) and Local Area Network (LAN) communication wiring routing. Indicate network number, device ID, address, device instance, IP address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All isolators, repeaters, end-of-line terminators, junctions, ground locations etc, shall be located on the floor plans.

In addition, a network riser diagram shall also be provided, clearly identifying all of the components and routing shown on the floor plans.

Include all Microprocessor Based Controllers and indicate the relation and connection of devices and apparatus on the network by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, internal tubing and the routing of the associated network wiring.

Clearly identify the point and method of connection with the existing BAS network.

Submit Composite Wiring Diagrams detailing the control and interlock wiring connections. Show mechanical and electrical equipment furnished and all electrical interlocks, indicating terminal designation for all equipment. Respective equipment manufacturers shall furnish, through the supplier, approved drawings of equipment to be incorporated in this diagram. Clearly differentiate between factory-installed and field-installed wiring. Wiring diagrams shall also show start/stop motor control wiring for all motors (fans, VFDs, etc.) and heaters controlled by the BAS. Include voltage, currents, and terminal strip termination information.

Submit Terminal Wiring Diagrams for each controller and the electrical devices connected with the system controls. Wiring diagrams will show start and end points of each device, part number and source, terminal blocks, termination details, addresses, wire type, color code and numbering scheme. Include voltage, currents, and terminal strip termination information. Each controller wiring diagram shall be depicted on separate, individual sheets. Typical diagrams depicting multiple controllers are not allowed.

Submit Panel Layout Drawings of the panel layouts of both inside and face plate. Include mounting locations, indicators and terminal strip termination information. Submit layout drawings for each panel installed. Typical layout drawings are not allowed.

Submit Software Package for each DDC control panel, panel mounted LCD display, BAS and KCCS/CITECT interface, including the gateway address files. Software package shall include representative samples of all graphical displays, alarm and trend-graph displays, software product data and programming logic diagrams.

Three Software Package submittals will be required. Provide the first Software Package submittal within one hundred and sixty (160) days of Contract Award. Provide the second Software Package submittal thirty (30) days prior to performing the CCP and provide the final Software Package submittal at contract closeout. Two weeks after the first and second submittals, a design review meeting will be held at KSC to discuss options, modifications and concerns related to the overall controls integration process. The review of the second Software Package shall include a live demonstration to be held at the project site to illustrate the screens and system functionality. The second Software Package submittal shall also include one sample of each type of CAC control code fully documented with program comments. Informal reviews of the graphical displays and programs are encouraged throughout the development cycle.

Provide color copies of all graphical interface displays for the BAS and the KCCS/Citect software. The controls contractor shall obtain examples of existing displays for use as a reference and coordinate with the Contracting Officer to determine any additional requirements for the new displays. Submit request to Contracting Officer to obtain this information.

Provide logical programming diagrams for the BAS and the KCCS. Provide information on the software programming for the BAS, the gateway, LonWorks interface and the KCCS/CITECT integration method including any modifications, configuration settings, and supplemental drivers required. Provide additional information for use as a reference in reviewing the logical diagrams, i.e. list of the logical devices, functions and abbreviations. Provide descriptive program comments on all DDC control programs and logic diagrams.

Provide product information on Proportional, Integral, Derivative (PID) algorithms that will be used to maximize control loop performance. Include manufacturer s procedures for tuning control loops and recommended verification techniques to ensure control loops have been tuned correctly.

Provide complete product data for all necessary software, tools and plug-ins used.

Provide Software product data and sample graphics for the Panel Mounted LCD displays. Include a list of available control points, Keypad functions, software limitations and capabilities.

Provide complete operator's manuals and programmer's manuals.

Provide complete application program source listing, LonMark external interface files (XIF files), point lists, and programming logic diagrams. Programming shall be submitted on CD-ROM media compatible with the operating system.

The first Software Package shall contain the following items;

One color graphic sample of each major HVAC equipment type

One sample each of a trend, alarm and schedule screen

One sample CAC program that clearly illustrates the programming language being use

The list of all Plug-ins being used for the project

A sample of the PID algorithm and a narrative explanation of how the control loops will be tuned or set

One sample of the LCD display screen for at least one major HVAC equipment type

Description of how the KCCS/Citect interface will be accomplished

One sample KCCS screen including genies and super genies for at least one major HVAC equipment type

Complete list of all software application programs being used for the project including operator and programming manuals

Block diagram of the LonWorks and Router networks

The second Software Package shall contain all the items submitted in the first Software Package revised to incorporate all review comments and updated to include the following;

All the graphics developed for the BAS and KCCS

All the CAC programs fully documented with program comments

The XIFs

The final Software Package shall contain all the items listed above updated to the as-built or final configuration and include all software program disks (including operating system) and licenses used on the project.

3.2 WIRING

Install conduit, wiring and electrical work in accordance with NFPA 70, NFPA 90A and Division 26 requirements, except that a 1/2 inch diameter conduit is acceptable.

All exposed wiring, wiring installed below the ceiling, in mechanical rooms and routed on the surface of finished walls shall be in conduit. Exceptions are wiring connections between the VAV boxes and wall mounted thermostats. This wiring does not need to be installed in conduit but must be rated for the location the wire is routed through.

Concealed wiring, wiring located above the ceiling or behind finished walls not installed in conduit shall be plenum rated cable.

All wiring, exposed or concealed, associated with the communications network shall be installed in conduit.

Ethernet network/communication wiring shall be run separately from other wiring.

Communication or shielded control wiring shall be installed as continuous lengths with no splices permitted.

Use metal conduit only.

All wiring shall be stranded type. Cable and wire shall be non-halogenated low smoke producing cable tested in accordance with NFPA 262.

All signal wire shall be twisted, shielded, jacketed cable, minimum gauge #18 AWG, and minimum 300V insulation.

Do not install low voltage wiring in conduit containing high voltage wiring. Boxes and panels containing high voltage shall not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

All signal wiring shall be segregated from 120 VAC circuits and all switched circuits.

Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, provide step-down transformers.

Fill conduit to maximum of 40% of area and include one pull string in each conduit.

Make all final terminations to equipment. Tighten per manufacturer's recommendations.

Provide sufficient slack and flexible connections to allow for vibration of piping and equipment, without stress to wiring or termination.

All connections shall be made at termination points and terminal strips.

Install wiring in sleeves where wiring passes through walls and patch holes made.

Provide clean high and/or low power supply where required.

Verify integrity of all wiring to ensure freedom from shorts and grounds and to ensure continuity.

The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other

relevant wiring criteria.

All wiring within enclosures shall be run in wire trough, neatly bundled and anchored to prevent restriction to devices and terminals. Wire nuts shall not be allowed in controller enclosures, except on the wire connections on the 120 VAC transformers. Devices shall be anchored to perforated panels using self-tapping screw connectors. Panels shall be labeled on the exterior with engraved phenolic nameplates meeting the requirements of Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.

Control panels shall be pre-assembled at the contractor's shop and installed on site as a unit. Terminal blocks shall be installed within the panel and pre-wired to the terminals strips of each controller. All wires entering the panel enclosure shall be terminated onto these terminal blocks. Each terminal block shall be labeled with a unique tag that can be cross referenced with the wiring diagrams for that panel.

Use color-coded conductors and cables throughout with different colored cables for each function. For direct current systems and circuits, use red for positive and black for negative. 120 VAC power wiring shall be black color. 120 VAC neutral shall be white color.

Each individual wire and cable in power, control, network/communication, and instrumentation circuits shall be provided with identification markers at the point of termination. Locate and label within 2" of the wire, cable or tube termination. Conductor identification system shall consist of plastic sleeves with pre-painted individual alpha/numeric element inserts. Plastic sleeves shall fully encircle the conductor. Conductors shall also be color coded. Field tags are not acceptable. Numbering shall be identical to numbering on corresponding control diagram.

3.3 PROGRAMMING

Provide programming of BAS controllers, gateway and KCCS CITECT software modifications as required to implement system operation, sequences, interlocks, communications, alarms, trend logs, graphic screens and similar aspects of the work, and to integrate with the existing KCCS system. Provide programming to implement sequences and to print summary tables as specified on the drawings, as well as alarms and trend logs identified during the creation of graphical screens, implementation, commissioning and start-up where not otherwise specifically identified.

Develop CITECT Human Machine Interface (HMI) screens for all data points and demonstrate the ability of all data points to be communicated with the CITECT system. Insure that the programming code is sufficiently commented/documented so that the in-house KCCS development teams can interpret it. Code shall be structured in such a manner as to reduce the number of network reads required to pass data to CITECT. To maintain KSC security, the contractor shall utilize a test IP address, not provided by NASA, for development and testing.

Coordinate with the Contracting Officer as to the correct version of CITECT software to use and contact CITECT directly to obtain the software or download the software from CITECT's Web site. The Contracting Officer shall provide the standardized code for trending and alarming, as required. Final HMI screens shall be turned over to the Contracting Officer for integration into the existing CITECT system, by the in-house KCCS Development Team.

Program all devices to meet the sequence of operations. All the code and software associated with the CITECT interface shall be turned over to the in-house KCCS Development Team. In addition, BAS control logic software, local OWS graphics and configuration software, and CITECT HMI screens shall be turned over to the Contracting Officer.

Calibrate all sensors and devices, and participate in HVAC system testing and balancing in accordance with requirements of Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Devices shall be calibrated to be within their specified accuracy.

Adjust sequences, set points, dead bands, gains, and reset ratios such that the equipment and systems operate in a stable manner without hysteresis or excessive cycling.

Load LNS Server database software and HMI BAS graphic screens on to the OWS.

3.4 OPERATION AND MAINTENANCE

Submit Operation and Maintenance Manuals 30 calendar days prior to performing the CCP. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

Submit As-Built Drawings of the BAS to include wiring and system risers (configuration drawings). Drawings shall be submitted in both hard copy and DWG,DXF, or Visio format.

3.4.1 Manufacturers Instructions

Submit Operation Instructions indicating the correct procedures to operate the system. Operating instructions shall consists or standard operating procedures including startup, shutdown and emergency operations. The instructions shall consist of the manufacturer s recommended procedures and be delivered via hard copy or on a CD. The instructions shall be developed specifically for this project. General data and non-project specific information shall be edited from the documentation.

Submit Parts List for BAS equipment listing by manufacturer s name, part number, nomenclature, and stock level required for maintenance and repair necessary to ensure continued operation with minimal delay.

Submit Equipment and Performance Data for all routers and CACs on the BAS network consisting of scan rates and response times to direct commands.

3.5 ON-SITE TESTING

3.5.1 General

Provide Contracting Officer approved operation and acceptance testing of the complete system. Obtain approval for each phase of testing before beginning any test. The Contracting Officer shall witness all tests. Provide Contracting Officer written notification of planned testing at least 45 days prior to each test.

3.5.2 Field Test Plan (FTP)

When installation of the system is complete, calibrate equipment and

verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the installer. Provide a detailed cross-check of each sensor or control device within the system by making a comparison between the reading at the device and a standard, traceable to the National Bureau of Standards. Factory certification of calibration is not acceptable.

Provide a cross-check of each control point within the system by making a comparison between the control command and the field-controlled device. Apply a control signal to each valve and actuator and verify that they operate properly from closed to full range of stroke. Mark all actuators to indicate the closed and full open positions.

Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power. Turn off power to the control panel for 2 minutes and verify that the controllers automatically resume proper control once power is restored.

Verify surge protection, meeting the requirements of this specification, has been installed on incoming power to the DDC controls system and the communication network.

Provide test compliance of the application software by demonstrating the following:

The ability to communicate with DDC controllers, uploading and downloading of control programs.

Text editing program: Demonstrate ability to edit the control programs off line.

Reporting or alarm conditions: Force alarms conditions for each alarm and ensure workstation receives notification of alarm point.

Trends and Schedules: Demonstrate ability of software to receive, display and save trend graphs and equipment schedules.

Graphic editing: Demonstrate the ability to modify the graphics and link the graphics to any point connected via the BAS network.

Submit a Field Test Plan (FTP) for the BAS control system with a proposed time schedule. Approval of the plan and schedule shall be obtained from the Contracting Officer at least sixty (60) days prior to the execution of the Plan.

Submit the FTP results of calibrations, point-to-point cross checks, and functional and diagnostic tests to the Contracting Officer for final system acceptance.

3.5.3 Controls Checkout Plan (CCP)

When the FTP is complete, conduct the controls checkout plan to demonstrate the control system executes the correct sequence of operation, the control loops are properly tuned, control system maintains set points and the BAS network operates efficiently. Conduct the controls checkout plan during seven days of continuous HVAC and BAS systems operation and before final acceptance of work.

Demonstrate the HVAC system operates properly thorough the complete

sequence of operation, including occupied/unoccupied, optimum start, night setback and warm-up. Demonstrate proper control system response for abnormal conditions by simulating system disturbances and observing the control system responds with the proper corrective action. Demonstrate hardware, software and safety interlocks to include dampers, exhaust fans, relief fans, and fire alarms. Verify control system performs correctly after loss of power to the DDC controller.

Verify control loop stability and system accuracy by providing screen shots or print outs of trend graphs that monitor the control loops and set points. Control loop variables shall respond to set point changes and stabilize within 5 minutes or less. Demonstrate control loops respond in small increments and do not swing from full off to full on. Control loop trend graphs shall be real time data and the time between data points shall not be greater than one minute. The contractor is responsible for producing the graphs in hard copies and including them in the accepted Controls Checkout Plan submittal.

Verify all of the graphic functions, including monitor, command, alarm, trend, schedule and override functions perform correctly at the HMI.

Provide network performance data via the protocol analyzer that shows the general statistics, packet types, bandwidth utilization and error rate history for all channels on the network.

Perform a post CCP verification check 60 and 180 days after the final system acceptance. The CCP verification check shall consist of a comparison of the real time and trended performance data to the data submitted on the original CCP including a re-verification of the sequence of operation. Correct all anomalies, including re-programming the BAS, tuning control loops and replacing malfunctioning sensors as required to meet the original design requirements.

Submit a CCP for the BAS control system with a proposed time schedule. Approval of the plan and schedule shall be obtained from the Contracting Officer at least sixty (60) days prior to the execution of the Plan.

Submit the CCP results of sequence of operation, control loop stability, system accuracy and network performance to the Contracting Officer for final system acceptance.

3.5.4 KCCS Validation Plan

The LonWorks BAS shall directly interface with the existing KCCS as indicated in the design documentation, the BAS point function schedule and the contractor shop drawings. All monitor and control points shall be demonstrated and verified using a Modbus diagnostic tool installed on a laptop provided by the contractor and the local HMI workstation. Monitor points shall be compared real time to the HMI and commands will be issued and verified at the HMI and the end equipment item. Demonstrate the Modbus addresses indicated on the shop drawings match the addresses displayed on the Modbus diagnostic tool. In addition, the KCCS interface can be verified via a functional Citect Project at the option of the Contracting Officer. The Contractor will be notified 60 days in advance if this option will be executed.

Submit a KCCS Validation Plan for the KCCS interface with a proposed time schedule. Approval of the plan and schedule shall be obtained from the Contracting Officer at least sixty (60) days prior to the execution of the

Plan.

Submit the KCCS Validation Plan results of HMI verification and Modbus address validation to the Contracting Officer for final system acceptance.

3.5.5 Training

Provide Training shortly after completing FT. The training session shall last 2 days and will be conducted at workstation and at other site locations as necessary. Upon completion of the Training, each trainee should fully understand the project's BAS system operation. The training session shall include the following:

First day - technician training to be delivered in two shifts: four hours for morning shift and four hours for afternoon shift.

a. A walk-through tour of the mechanical system and the installed BAS components (controllers, surge protection, switches, sensors, etc.)

b. A discussion of the components and functions at each BAS panel

c. Logging-in and navigating at each operator interface type

d. Modifying setpoints

e. Selecting and viewing trends

f. Viewing and acknowledging alarms

g. Demonstrate switching between manual and automatic at the OWS

Second day - Engineering training - eight hours.

i. Using each operator interface to find, read, and write to specific controllers

j. Modifying and downloading control program changes

k. Backing-up and restoring programming and data bases

l. Modifying graphic text, backgrounds, dynamic data displays, and links to other graphics

m. Creating new graphics and adding new dynamic data displays and links

n. Alarm and Event management

o. Adding and removing network devices

The second day training session shall also include an open question and answer discussion between the contract programmers and the Government maintenance and system engineer.

The system shall not be turned over to the Owner until training is complete and final project completion is attained, unless otherwise agreed to by the Owner.

The training course shall be conducted at the project site. Audiovisual

equipment and ten (10) sets of all other training materials and supplies shall be provided..

For guidance in planning the required instruction, assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each HVAC control panel, the location of each control device external to the panels, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, tuning and repair procedures. Typical systems and similar systems shall be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, and adjustment report shall be presented as benchmarks of the HVAC control system performance by which to measure operation and maintenance effectiveness.

Topics shall include, but not be limited to, purpose/function, start-up, shutdown, interlocks, safeties, overrides, normal operating range, regular and preventive maintenance, potential hazards, automatic control, PID loop tuning, emergency procedures, and similar topics as necessary for safe and efficient operation of the equipment.

A certified representative of the controller equipment manufacturer shall be present during training and conduct that portion of the training specific to the functionality of the manufacturer's equipment.

All training topics shall be documented in writing and be included in the operation and maintenance manuals.

The training shall include hands-on start-up and shutdown of the system by the Contracting Officer, supervised by the Trainer. Failures, power outages, and safety type shutdown of equipment shall be simulated for troubleshooting by the Contracting Officer. The Contracting Officer shall also be instructed in manual operation of the system in the "hand" mode.

3.5.5.1 Training Course Material

Submit a Training Course Outline for the BAS control system with a proposed time schedule. Approval of the outline and schedule shall be obtained from the Contracting Officer at least sixty (60) days prior to the start of the training. The training course material shall include the operation manual, maintenance and repair manual(s) and CD s containing all material covered and used in the Training Course.

3.5.6 Commissioning

Provide manpower and support required to coordinate with and perform testing with the commissioning Agent (CxA). Testing associated with the Commissioning effort is separate, above and beyond any testing described within this Section. See Section 01 91 13, COMMISSIONING.

-- End of Section --

SECTION 23 11 25

FACILITY GAS PIPING
11/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.15/CSA 9.1	(2009) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves
ANSI Z21.18/CSA 6.3	(2007; Addenda A 2010) Gas Appliance Pressure Regulators
ANSI Z21.21/CSA 6.5	(2005; Addenda A 2010) Automatic Valves for Gas Appliances
ANSI Z21.24/CSA 6.10	(2006; Addenda A 2009) Connectors for Gas Appliances
ANSI Z21.41/CSA 6.9	(2011) Quick-Disconnect Devices for Use with Gas Fuel Appliances
ANSI Z21.69/CSA 6.16	(2009) Connectors for Movable Gas Appliances
ANSI Z21.80/CSA 6.22	(2011) Line Pressure Regulators

AMERICAN PETROLEUM INSTITUTE (API)

API RP 1110	(2007) Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids or Carbon Dioxide
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API Spec 6D	(Addendum 3 2012) Specification for Pipeline Valves
API Std 598	(2009) Valve Inspecting and Testing

API Std 607	(2010) Testing of Valves: Fire Test for Soft-Seated Quarter-Turn Valves

ASME INTERNATIONAL (ASME)

ASME A13.1	(2007; R 2013) Scheme for the Identification of Piping Systems
ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2010) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.11	(2011) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.33	(2002; R 2007) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psi, Sizes NPS 1/2 - NPS 2
ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.9	(2011) Building Services Piping
ASME B36.10M	(2004; R 2010) Standard for Welded and Seamless Wrought Steel Pipe
ASME B40.100	(2005; R 2010) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A105/A105M	(2011a) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,

Welded and Seamless

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2008) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2012) National Fuel Gas Code
NFPA 58	(2011; TIA 10-1; Errata 10-1; TIA 11-2; TIA 11-3; Errata 11-2; Errata 12-3) Liquefied Petroleum Gas Code
NFPA 70	(2014) National Electrical Code

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir	(2011) Flammable and Combustible Liquids and Gases Equipment Directory

1.2 SYSTEM DESCRIPTION

The gas piping system includes natural gas piping and appurtenances from point of connection with supply system, as indicated, to gas operated equipment within the facility. Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, in three separate packages. Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section, with additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following to the Contracting Officer for review:

SD-02 Shop Drawings

Gas Piping System; G

SD-03 Product Data

Pipe and Fittings; G

Gas equipment connectors; G
Gas Piping System; G
Pipe Coating Materials; G
Pressure regulators; G
Risers; G
Valves; G
Warning and identification tape; G

SD-06 Test Reports

Testing; G
Pressure Tests; G

SD-07 Certificates

Welders procedures and qualifications; G
assigned number, letter, or symbol; G

SD-08 Manufacturer's Instructions

pipe coating materials; G

1.4 QUALITY ASSURANCE

Submit manufacturer's descriptive data and installation instructions for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Mark all valves, flanges and fittings in accordance with MSS SP-25.

1.4.1 Welding Qualifications

a. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators in accordance with API RP 2009, ASME BPVC SEC IX, and ASME B31.9. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.9. Notify the Contracting Officer at least 24 hours in advance of tests, and perform at the work site if practicable.

b. Submit a certified copy of welders procedures and qualifications metal and PE in conformance with ASME B31.9 for each welder and welding operator. Submit the assigned number, letter, or symbol that will be used in identifying the work of each welder to the Contracting Officer.

1.4.2 Shop Drawings

Submit drawings for complete Gas Piping System, within 30 days of contract award, showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of gas equipment connectors and supports. Include LP storage tank, pad, and mounting details.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, transport, and store plastic pipe and fittings carefully. Plug or cap pipe and fittings ends during transportation or storage to minimize dirt and moisture entry. Do not subject piping to abrasion or concentrated external loads. Discard PE pipe sections and fittings that

have been damaged.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures. Conform to NFPA 54 NFPA 58 and with requirements specified herein. Provide supply piping to appliances or equipment at least as large as the inlets thereof.

2.2 GAS PIPING SYSTEM AND FITTINGS

2.2.1 Steel Pipe, Joints, and Fittings

a. Pipe: Black carbon steel in accordance with ASTM A53/A53M, Schedule 40 , threaded ends for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.

b. Threaded Fittings: ASME B16.3, black malleable iron.

c. Socket-Welding Fittings: ASME B16.11, forged steel.

d. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.

e. Unions: ASME B16.39, black malleable iron.

f. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1, with flange faces having integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

Provide steel pipe conforming to ASME B36.10M; and malleable-iron threaded fittings conforming to ASME B16.1 and ASME B16.3. Provide steel pipe flanges and flanged fittings, including bolts, nuts, and bolt pattern in accordance with ASME B16.5 and ASTM A105/A105M. Provide wrought steel buttwelding fittings conforming to ASME B16.9. Provide socket welding and threaded forged steel fittings conforming to ASME B16.11.

2.2.2 Sealants for Steel Pipe Threaded Joints

Provide joint sealing compound as listed in UL Gas&Oil Dir, Class 20 or less. For taping, use tetrafluoroethylene tape conforming to UL Gas&Oil Dir.

2.2.3 Warning and Identification

Provide pipe flow markings, warning and identification tape, and metal tags as required.

2.2.4 Flange Gaskets

Provide gaskets of nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service, to be used for hydrocarbon service.

2.2.5 Pipe Threads

Provide pipe threads conforming to ASME B1.20.1.

2.2.6 Escutcheons

Provide chromium-plated steel or chromium-plated brass escutcheons, either one piece or split pattern, held in place by internal spring tension or set screw.

2.2.7 Insulating Pipe Joints

2.2.7.1 Insulating Joint Material

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.2.7.2 Threaded Pipe Joints

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

2.2.7.3 Flanged Pipe Joints

Provide joints for flanged pipe consisting of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts.

2.2.8 Flexible Connectors

a. Provide flexible connectors for connecting gas utilization equipment to building gas piping conforming to ANSI Z21.24/CSA 6.10 or ANSI Z21.41/CSA 6.9 for quick disconnect devices, and flexible connectors for movable food service equipment conforming to ANSI Z21.69/CSA 6.16.

b. Do not install the flexible connector through the appliance cabinet face. Provide rigid metallic pipe and fittings to extend the final connection beyond the cabinet, except when appliance is provided with an external connection point.

2.3 VALVES

Provide shutoff or service isolation valves as indicated in the drawings conforming to the following:

2.3.1 Valves 2 Inches and Smaller

Provide valves 2 inches and smaller conforming to ASME B16.33 of materials and manufacture compatible with system materials used.

2.3.2 Valves 2-1/2 Inches and Larger

Provide valves 2-1/2 inches and larger of carbon steel conforming to API Spec 6D, Class 150.

2.4 RISERS

Provide manufacturer's standard riser, transition from plastic to steel pipe with 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide wall-mounted riser supports .

2.5 PIPE HANGERS AND SUPPORTS

Provide pipe hangers and supports conforming to MSS SP-58 and MSS SP-69.

2.6 REGULATORS AND SHUTOFF VALVES

Provide pressure gauges and attachments conforming to ASME B40.100. Provide regulators conforming to ANSI Z21.18/CSA 6.3 for appliances , and ANSI Z21.80/CSA 6.22 for line pressure regulators. Provide shutoff valves conforming to ANSI Z21.15/CSA 9.1 for manually controlled gas shutoff valves and ANSI Z21.21/CSA 6.5 for automatic shutoff valves for gas appliances.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy or areas of conflict before performing the work.

3.2 GAS PIPING SYSTEM

Provide a gas piping system from the point of delivery, defined as the outlet of the meter set assembly to the connections to each gas utilization device.

3.2.1 Protection and Cleaning of Materials and Components

Protect equipment, pipe, and tube openings by closing with caps or plugs during installation. At the completion of all work, thoroughly clean the entire system.

3.2.2 Workmanship and Defects

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Repair of defects in piping, tubing or fittings is not allowed; replace defective items when found.

3.3 PROTECTIVE COVERING

3.3.1 Aboveground Metallic Piping Systems

3.3.1.1 Ferrous Surfaces

Touch up shop primed surfaces with ferrous metal primer. Solvent clean

surfaces that have not been shop primed . Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances by power wire brushing or commercial sand blasted conforming to SSPC SP 6/NACE No.3 and prime with ferrous metal primer or vinyl type wash coat. Finish primed surfaces with two coats of exterior oil paint or vinyl paint.

3.3.1.2 Nonferrous Surfaces

Except for aluminum alloy pipe, do not paint nonferrous surfaces. Paint surfaces of aluminum alloy pipe and fittings to protect against external corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by such liquids as water, detergents or sewage. Solvent-clean the surfaces and treat with vinyl type wash coat. Apply a first coat of aluminum paint and a second coat of alkyd gloss enamel or silicone alkyd copolymer enamel.

3.4 INSTALLATION

Install the gas system in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54NFPA 58, AGA XR0603, and as indicated. Perform all pipe cutting without damage to the pipe, with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable. On steel pipe 6 inches and larger, an approved gas cutting and beveling machine may be used. Cut thermoplastic and fiberglass pipe in accordance with AGA XR0603.

3.4.1 Metallic Piping Installation

Bury underground piping a minimum of 18 inches below grade. Make changes in direction of piping with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either tees or forged branch outlet fittings. Provide branch outlet fittings which are forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Do not use aluminum alloy pipe in exterior locations or underground.

3.4.2 Concealed Piping in Buildings

Do not use combinations of fittings (unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints) to conceal piping within buildings.

3.4.2.1 Piping in Partitions

Locate concealed piping in hollow, rather than solid, partitions. Protect tubing passing through walls or partitions against physical damage both during and after construction, and provide appropriate safety markings and labels..

3.4.3 Aboveground Piping

Run aboveground piping as straight as practicable along the alignment and elevation indicated, with a minimum of joints, and separately supported from other piping system and equipment. Install exposed horizontal piping no farther than 6 inches from nearest parallel wall and at an elevation which prevents standing, sitting, or placement of objects on the piping.

3.4.4 Final Gas Connections

Unless otherwise specified, make final connections with rigid metallic pipe and fittings. Make final connections to kitchen ranges using flexible connectors not less than 40 inch long, to afford access to coupling and to permit movement of equipment for cleaning. In addition to cautions listed in instructions required by ANSI standards for flexible connectors, insure that flexible connectors do not pass through equipment cabinet. Provide accessible gas shutoff valve and coupling for each gas equipment item.

3.5 PIPE JOINTS

Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

3.5.1 Threaded Metallic Joints

Provide threaded joints in metallic pipe with tapered threads evenly cut and made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, ream pipe and remove all burrs. Caulking of threaded joints to stop or prevent leaks is not permitted.

3.5.2 Welded Metallic Joints

Conform beveling, alignment, heat treatment, and inspection of welds to NFPA 54. Remove weld defects and make repairs to the weld, or remove the weld joints entirely and reweld. After filler metal has been removed from its original package, protect and store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating.

3.6 PIPE SLEEVES

Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make all rectangular and square openings as detailed. Extend each sleeve through its respective wall, floor or roof, and cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Extend sleeves in mechanical room floors above grade at least 4 inches above finish floor. Unless otherwise indicated, use sleeves large enough to provide a minimum clearance of 1/4 inch all around the pipe. Provide steel pipe for sleeves in bearing walls, waterproofing membrane floors, and wet areas . Provide sleeves in nonbearing walls, floors, or ceilings of steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, seal the annular space between the pipe and sleeve with fire-stopping material and sealant that meet the requirement of Section 07 84 00 FIRESTOPPING.

3.7 PIPES PENETRATING WATERPROOFING MEMBRANES

Install pipes penetrating waterproofing membranes as specified in Section

22 00 00 PLUMBING, GENERAL PURPOSE.

3.8 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors in accordance with Section 07 84 00 FIRESTOPPING.

3.9 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.10 SPECIAL REQUIREMENTS

Provide drips, grading of the lines and branch outlet locations as shown and conforming to the requirements of NFPA 54NFPA 58.

3.11 BUILDING STRUCTURE

Do not weaken any building structure by the installation of any gas piping. Do not cut or notch beams, joists or columns. Attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

3.12 PIPING SYSTEM SUPPORTS

Support gas piping systems in buildings with hangers suitable for the size of piping. Do not support any gas piping system by other piping. Conform spacing of supports in gas piping installations to the requirements of NFPA 54NFPA 58. Conform the selection and application of supports in gas piping installation to the requirements of MSS SP-69. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.13 ELECTRICAL BONDING AND GROUNDING

Provide a gas piping system within the building which is electrically continuous and bonded to a grounding electrode as required by NFPA 70.

3.14 SHUTOFF VALVE

Install the main gas shutoff valve controlling the gas piping system to be easily accessible for operation, as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled.

3.15 TESTING

Submit test reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Test entire gas

piping system to ensure that it is gastight prior to putting into service. Prior to testing, blow out the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve in conformance with API Std 598 and API Std 607. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test. Install bulkheads, anchorage and bracing suitably designed to resist test pressures if necessary, and as directed and or approved by the Contracting Officer. Do not use oxygen as a testing medium.

3.15.1 Pressure Tests

Submit test reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Do not use Oxygen for test. Measure pressure with a mercury manometer, slope gauge, or an equivalent device calibrated to be read in increments of not greater than 0.1 pound. Isolate the source of pressure before the pressure tests are made.

3.15.2 Purging

After testing is completed, and before connecting any appliances, fully purge all gas piping. Conform testing procedures to API RP 1110. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54 NFPA 58 are followed.

3.15.3 Labor, Materials and Equipment

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

3.16 PIPE COLOR CODE MARKING

Provide color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS, conforming to ASME A13.1.

-- End of Section --

SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS
11/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B40.100	(2005; R 2010) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM D2688	(2011) Corrosivity of Water in the Absence of Heat Transfer (Weight Loss Methods)
ASTM D596	(2001; R 2011) Reporting Results of Analysis of Water

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011; Errata 2012) Motors and Generators

1.2 SYSTEM DESCRIPTION

This section covers the provisions and installation procedures necessary for a complete and totally functional water system(s) chemical treatment. Provide and install the system with all necessary System Components, Accessories, Piping Components, and Supplemental Components/Services.

1.2.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work and products specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Water Analysis; G

Spare Parts
Field Instructions
Tests; G
Training Course; G

SD-06 Test Reports

SD-10 Operation and Maintenance Data

1.4 QUALITY ASSURANCE

1.4.1 Safety

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired.

1.4.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.6 MAINTENANCE

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings, not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with source of supply

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

a. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for two years prior to bid opening.

b. The two-year use shall include applications of equipment and materials under similar circumstances and of similar size. The two years experience shall have been satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

c. All products shall be supported by a service organization. Submit a certified list of qualified permanent service organizations for support of the equipment, including their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and shall be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

d. The selected service organization shall provide the chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall provide all chemicals required for the chilled water and heating hot water systems and fill the systems with chemicals to the levels specified. The chemical shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and cooling tower. Acid treatment chemicals shall not be used.

2.2 NAMEPLATES

Each major component of equipment shall have the manufacturer's name, address, type or style, and catalog or serial number on a plate securely attached to the item of equipment. Nameplates shall be provided for:

a. Pump(s)

b. Pump Motor(s)

2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical motor driven equipment specified complete with motors, motor starters, and controls. Electrical characteristics and enclosure type shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, or totally enclosed fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. All motors shall be continuous duty with the enclosure specified. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Furnish motors with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor starter shall be provided with NEMA 1 NEMA 3R enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.4 GAUGES

Gauges shall conform to ASME B40.100, Class 1, 2, or 3, Style X, Type I or III as required, 4-1/2 inches in diameter with phenolic or metal case.

2.5 WATER ANALYSIS

Conditions of make-up water to be supplied to the boilers, chilled water systems, chilled beam water systems and heating hot water systems reported

in accordance with ASTM D596 are as follows:

Date of Sample	_____	
Temperature	_____	degrees C.
Silica (SiO 2)	_____	ppm (mg/L)
Insoluble	_____	ppm (mg/L)
Iron, total (Fe)	_____	ppm (mg/L)
Aluminum (Al)	_____	ppm (mg/L)
Calcium (Ca)	_____	ppm (mg/L)
Magnesium (Mg)	_____	ppm (mg/L)
Carbonate (HCO 3)	_____	ppm (mg/L)
Sulfate (SO 4)	_____	ppm (mg/L)
Chloride (Cl)	_____	ppm (mg/L)
Nitrate (NO 3)	_____	ppm (mg/L)
Turbidity	_____	ntu
pH	_____	
Residual Chlorine	_____	ppm (mg/L)
Total Alkalinity	_____	ppm (mg/L)
Non-Carbonate Hardness	_____	ppm (mg/L)
Total Hardness	_____	ppm (mg/L)
Dissolved Solids	_____	ppm (mg/L)
Conductivity	_____	micromho/cm

2.6 CHILLED WATER SYSTEM

2.6.1 Chemical Feeder

A 5 gallon shot feeder shall be provided on the chilled water piping system as indicated. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.6.2 Chilled Water Treatment

Treat chilled water with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment can be used with glycol. Borax/nitrite treatment shall be maintained at the limits of 600 to 1000 ppm nitrite, 40 - 50 ppm copper corrosion inhibitor (TT or MBT), and pH of 8.5 to 9.5. Molybdate treatment shall be maintained at the limits of 100 to 125 ppm molybdate, 40 - 50 ppm copper corrosion inhibitor (TT or MBT), and pH of 8.0 to 9.0.

2.6.3 Chilled Water Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided (e.g. pH and nitrite or molybdate).

2.7 LOW AND MEDIUM TEMPERATURE HOT WATER BOILERS AND HEAT EXCHANGERS

Low and medium temperature hot water boilers are defined as those operating below 350 degrees F, (250 degrees F for Low Temperature).

2.7.1 Chemical Feeder

A 5 gallon shot feeder shall be provided on the hot water piping as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.7.2 Low and Medium Temperature Hot Water Treatment

Hot water shall be treated with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment can be used with glycol. Borax/nitrite treatment shall be maintained at the limits of 600 to 1000 ppm nitrite, 40 - 50 ppm copper corrosion inhibitor (TT or MBT) and pH of 8.5 to 9.5. Molybdate treatment shall be maintained at the limits of 100 to 125 ppm molybdate, 40 - 50 ppm copper corrosion inhibitor (TT or MBT) and pH of 8.0 to 9.0.

2.7.3 Test Kit Requirements

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided (e.g. pH and nitrite or molybdate).

2.8 CHILLED BEAM WATER

2.8.1 Chemical Feeder

A 5 gallon shot feeder shall be provided on the chilled beam water piping system as indicated. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.8.2 Chilled Beam Water Treatment

Treat chilled beam water with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment can be used with glycol. Borax/nitrite treatment shall be maintained at the limits of 600 to 1000 ppm nitrite, 40 - 50 ppm copper corrosion inhibitor (TT or MBT), and pH of 8.5 to 9.5. Molybdate treatment shall be maintained at the limits of 100 to 125 ppm molybdate, 40 - 50 ppm copper corrosion inhibitor (TT or MBT), and pH of 8.0 to 9.0.

2.8.3 Chilled Beam Water Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided (e.g. pH and nitrite or molybdate).

2.9 SUPPLEMENTAL COMPONENTS/SERVICES

Drain and makeup water piping shall comply with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE. Drains which connect to sanitary sewer systems shall be connected by means of an indirect waste.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy, before performing any work.

3.2 INSTALLATION

Provide all chemicals, equipment and labor necessary to bring all system waters in conformance with the specified requirements. Perform all work in accordance with the manufacturer's published diagrams, recommendations,

and equipment warranty requirements.

3.3 PIPING

Connections between dissimilar metals shall be made with a dielectric union.

3.4 TRAINING COURSE

Submit a schedule, at least 2 weeks prior to the date of the proposed training course, that identifies the date, time, and location for the training. Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 8 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. Submit field instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and posted where indicated by the Contracting Officer. The field instructions shall cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

3.5 TESTS

If the waters of the mechanical systems are not in conformance with the specified requirements or in accordance with manufacturer's recommendations, the water treatment company shall take corrective action to enable compliance. Daily operational tests shall be performed in the directed frequencies to maintain required control to prevent corrosion, scaling and damage to equipment during operation Submit test schedules, at least 2 weeks prior to the start of related testing, for the condenser/chilled/boiler/condensate/feedwater water quality tests. The schedules shall identify the date, time, frequency and collection location for each test.

3.5.1 Chilled Water Testing (monthly)

Once a month, the following tests will be performed on chilled water.

PH	_____	
Nitrite or Molybdate	_____	ppm (mg/L)
Conductivity	_____	micromho/cm

3.5.2 Hot Water Boiler Water Quality Testing

3.5.3 Low and Medium Temperature Systems (monthly)

Monthly testing shall be completed and recorded for the following parameters.

PH	_____	
Nitrite or Molybdate	_____	ppm (mg/L)

3.5.4 Quality Assurance Testing

Conduct QA testing periodically by an independent water treatment lab/consultant to verify to managers that the mechanical and water treatment systems are being maintained properly. Provide the QA evaluation reports to the government COR.

3.5.4.1 Chilled Water Quality Assurance Testing (quarterly)

Quarterly, the following tests shall be performed on chilled water.

PH	_____
Nitrite or Molybdate	_____ ppm (mg/L)
Conductivity	_____ micromho/cm
Iron (total, as Fe(2)O(3))	_____ ppm (mg/L)
Written evaluation summary	

3.5.4.2 Hot Water Boiler Water Quality Assurance Testing

a. Quarterly testing of Low and Medium Temperature Systems shall be completed and recorded for the following parameters.

PH	_____
Nitrite or Molybdate	_____ ppm (mg/L)
Iron (total, as Fe(2)O(3))	_____ ppm (mg/L)
Written evaluation summary	

b. The hot water boiler water shall be analyzed once a month for a period of 1 year by an independent consultant. The analysis shall include the following information recorded in accordance with ASTM D596.

PH	_____
Sulfite (Na2SO3)	_____ ppm (mg/L)
Hardness(as CaCO3)	_____ ppm (mg/L)
Iron (total, as Fe(2)O(3))	_____ ppm (mg/L)
Written evaluation summary	

3.5.5 Corrosion Testers

Install corrosion coupon and rack systems to verify corrosion control in the systems. Testers or coupons are installed in flowing system water through a sidestream or rack system. Both mild steel and copper metal samples are to be tested in the corrosion testers in accordance with ASTM D2688. Samples are to be replaced and analyzed every 3 months. Rates of corrosion less than 3 mpy for steel and 0.2 mpy for copper are acceptable. Corrosion testers shall be installed on the piping systems of the following systems.

Chilled water loop
Hot water loop

3.6 INSPECTIONS

3.6.1 Inspection General Requirements

Thirty days after project completion, inspect the cooling tower and

condenser for problems due to corrosion, scale, and biological growth. If the cooling tower and condenser are found not to conform to the manufacturer's recommended conditions, and the water treatment company recommendations have been followed; the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

3.6.2 Boiler/Piping Test

Thirty day after project completion, inspect the boiler and piping for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

-- End of Section --

SECTION 23 31 13.00 40

METAL DUCTS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2011) Steel Construction Manual
AISC 360	(2010) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE EQUIP IP HDBK	(2008; Errata 1 2010) Handbook, HVAC Systems and Equipment (IP Edition)
ASHRAE FUN IP	(2009; Errata 2010) Fundamentals Handbook, I-P Edition

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2011) Specification for Filler Metals for Brazing and Braze Welding

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	(2013a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A480/A480M	(2013) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A924/A924M	(2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C1071	(2012) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM E90	(2009) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition
SMACNA 1987	(2006) HVAC Duct Systems Inspection Guide, 3rd Edition

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS 2480	(2009; Rev H) Phosphate Treatment, Paint, Base

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Painting Manual	(2002) Good Painting Practice, Steel Structures Painting Manual, Volume 1

UNDERWRITERS LABORATORIES (UL)

UL 181	(2005; Reprint Oct 2008) Factory-Made Air Ducts and Air Connectors
UL 555	(2006; Reprint May 2012) Standard for Fire Dampers

1.2 DESIGN REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS apply to work specified in this section.

Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT applies to work in this section.

Submit equipment and performance data for medium/high pressure ductwork systems consisting of use life, system functional flows, safety features, and mechanical automated details. Submit test response and performance characteristics curves for certified equipment.

Submit design analysis and calculations for medium/high pressure ductwork systems indicating the manufacturer's recommended air velocities, maximum static pressure, and temperature calculations.

1.2.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.3 SCOPE OF WORK

Encompass low-pressure systems ductwork and plenums where maximum air velocity is 2,000 feet per minute(fpm) and maximum static pressure is 2 inches water gage (wg), positive or negative.

Submit connection diagrams for low pressure ductwork systems indicating the relation and connection of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit design analysis and calculations for low pressure ductwork systems indicating the manufacturer's recommended air velocities, maximum static pressures, temperature calculations and acoustic levels.

Encompass high velocity systems ductwork where:

Minimum air velocity exceeds 2,000 feet per minute (fpm) or static pressure exceeds 2 inches water gage (wg).

Medium static pressure ranges from over 2 inches wg through 3 inches wg, positive or negative, or over 3 inches wg through 6 inches wg positive.

High static pressure ranges from over 6 inches wg through 10 inches wg, positive.

Do not use rigid fibrous-glass ductwork.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Material, Equipment, and Fixture Lists and Records of Existing Conditions in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Submit the following in accordance with paragraph entitled, "Drawings," of this section.

Connection Diagrams

Record Drawings; G

SD-03 Product Data

Submit Equipment and Performance Data for medium/high pressure ductwork systems in accordance with paragraph entitled, "Design Requirements," of this section.

Submit manufacturer's catalog data for the following items:

Galvanized Steel Ductwork Materials; G

Brazing Materials; G

Mill-Rolled Reinforcing and Supporting Materials; G

Round Sheet Metal Duct Fittings; G

Turning Vanes; G

Sound Attenuators; G

Flexible Connectors; G

Flexible Duct Materials; G

Power Operated Dampers; G

Flexible Connectors; G

Fire Dampers and Wall Collars; G

Gravity Backdraft and Relief Dampers; G

Manual Volume Dampers; G

Barrier Security Grilles; G

SD-05 Design Data

Submit Design Analysis and Calculations for medium/high pressure ductwork systems in accordance with paragraph entitled, "Design Requirements," of this section.

SD-06 Test Reports

Submit test reports for medium/high pressure ductwork systems in accordance with the paragraphs entitled, "Ductwork Leakage Tests" and "Fire Damper Tests," of this section.

Ductwork Leakage Tests; G

Operational Tests; G

SD-07 Certificates

Listing of Product Installations for medium/high pressure ductwork systems in accordance with paragraph entitled, "Installation," of this section.

Submit certificates, showing conformance with the referenced standards contained in this section for:

Galvanized Steel Ductwork Materials

Brazing Materials

Mill-Rolled Reinforcing and Supporting Materials

Round Sheet Metal Duct Fittings

Turning Vanes

Dampers

Sound Attenuators

Flexible Connectors

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals; G in accordance with paragraph entitled, "Operation and Maintenance," of this section.

Power Operated Dampers; G

Fire Dampers and Wall Collars; G

1.5 GENERAL REQUIREMENTS

Submit records of existing conditions consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes acceptance of existing conditions.

Include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information within material, equipment, and fixture lists.

1.6 DRAWINGS

Submit connection diagrams for medium/high pressure ductwork systems indicating the relation and connection of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Provide record drawings with current factual information including deviations from, and amendments to, the drawings and concealed or visible changes in the work, for medium/high pressure ductwork systems.Label drawings "As-Built".

1.7 DELIVERY, STORAGE AND HANDLING

Protect duct and fittings from damage due to normal handling during shipment and storage. Protection shall be applied to ends of duct to prevent dirt and moisture from entering ducts and fittings.

1.8 DESCRIPTION

All products shall conform to NFPA 90A, and shall possess flame spread rating of not over 25 and smoke developed rating no higher than 50.

Unless otherwise indicated, construct all ductwork of galvanized sheet metal for pressure class not less than +2" WG for positive pressure ductwork and not less than -2" WG for negative pressure ductwork.

Ductwork shall comply with Local, State and Federal requirements.

Unless otherwise indicated, pressure class for VAV system supply ductwork between supply fan discharge and air terminal device inlet shall be equal to static pressure at fan discharge but not less than 4" WG; pressure class for ductwork on suction side of air handling unit and suction side of return fan shall be equal to static pressure at inlet of return fan but not less than 2" WG.

Unless otherwise indicated, pressure class for constant air volume system ductwork shall be equal to external static pressure (fan entrance or discharge pressure minus associated unit internal component pressure drop), but not less than + or - 2" WG.

Duct transverse joints and reinforcement material, including angle ring flanges and stiffeners, shall be of same material as duct.

Except as modified in this Section of specifications, use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA Publications:

HVAC Duct Construction Standards Metal and Flexible, 3rd Edition, 2005, for rectangular and round ductwork up to positive 10" WG and negative 10" WG and flat oval ductwork up to positive 10" WG.

a. Internal tie rods are not allowed for welded ductwork and special exhaust systems, such as fume hood exhaust, shower room exhaust, kitchen hood exhaust, dishwasher exhaust, etc.

b. Midpanel tie rods described in SMACNA Addendum No. 1, November 1997, are not allowed.

Round Industrial Duct Construction Standards, 2nd Printing, 1999

Round Industrial Duct Construction Standards, 2nd Edition, September, 1999

Rectangular Industrial Duct Construction Standards, 2nd Edition, 2004

Accepted Industry Practice for Industrial Duct Construction, 2nd Edition, 2008, for round ductwork -4" to -20" WG (Table 1-A) and for rectangular ductwork 4" to -20" WG (Table 2-A).

1.9 WELDING REQUIREMENTS

The following requirements cover arc and braze welding of nonstructural sheet metal ductwork for HVAC, architectural metal and other FDA process applications where pressures do not exceed 120" WG (positive or negative). These requirements also apply to welding of structural members whose sole purpose is stiffening, supporting, or reinforcing of sheet metal material, as well as attachment of brackets or other accessories/components required to provide complete systems.

Procedure and Qualification:

Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) shall be prepared by Installing Contractor and/or fabricator prior to execution of related work. Qualification of welding procedure shall meet or exceed requirements of the latest revision of American Welding Society, Sheet Metal Welding Code ANSI/AWS D9.1.

Provide certification of satisfactory performance testing for all welders and welding operators, which provide welding services on Project.

Establish and provide written quality assurance/quality control (QA/QC) procedures to ensure compliance with specification requirements. Clearly identify appropriate steps for safe welding procedures (review Appendix J of D9.1) including additional safety material, screens, eye, personnel and clothing protection, fire suppression equipment, and fume extraction equipment needed adjacent to welding work area

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Ductwork Materials

Galvanized steel ductwork sheet metal shall be carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A924/A924M and ASTM A653/A653M, Designation G90. Treat duct surfaces to be painted by phosphatizing. Use G90 Galvaneal or Zincgrip where painting is specified.

Conform to ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966 for sheet metal gages and reinforcement thickness.

Low pressure ductwork minimum standards are as follows:

MINIMUM SHEET METAL GAGE

DUCT WIDTH INCHES	GAGE
0 - 12	26
13 - 30	24
31 - 60	22

2.1.2 Uncoated Black Steel

Aluminum alloy, ASTM B209, Type 3003H-14 capable of double seaming without fracture.

2.1.3 Aluminum Steel Sheet

First quality, cold rolled annealed, pickled, ASTM A240/A240M and ASTM A480/A480M, Finish No. 2B for concealed work and Finish No. 4 for exposed work. Unless otherwise indicated, use Type 304L where welded duct construction is specified and Type 304 where non-welded duct construction is allowed.

2.1.4 Stainless Steel Sheet

First quality, cold rolled annealed, pickled, ASTM A240/A240M and ASTM A480/A480M, Finish No. 2B for concealed work and Finish No. 4 for exposed work. Unless otherwise indicated, use Type 304L where welded duct construction is specified and Type 304 where non-welded duct construction is allowed.

2.1.5 Brazing Materials

Brazing materials shall be silicon bronze conforming to AWS A5.8/A5.8M.

2.1.6 Mill-Rolled Reinforcing And Supporting Materials

Conform to ASTM A36/A36Mfor mill-rolled structural steel and, wherever in contact with sheet metal ducting galvanize to commercial weight of zinc or coated with materials conforming to ASTM A123/A123M SSPC Painting Manual.

Equivalent strength, proprietary design, rolled-steel structural support systems may be submitted for approval in lieu of mill-rolled structural steel.

2.2 COMPONENTS

2.2.1 Round Sheet Metal Duct Fittings

Shop fabricate fittings.

Manufacture as separate fittings, not as tap collars welded or brazed into duct sections.

Submit for approval offset configurations.

Miter elbows shall be two-piece type for angles less than 31 degrees, three-piece type for angles 31 through 60 degrees, and five-piece type for angles 61 through 90 degrees. Centerline radius of elbows shall be 1-1/2 times fitting cross section diameter.

Crosses, increasers, reducers, reducing tees, and 90-degree tees shall be conical type.

Cutouts in fitting body shall be equal to branch tap dimension or, where smaller, excess material shall be flared and rolled into smooth radius nozzle configuration.

Manufacturers: Lindab, Semco or McGill AirFlow, equal to McGill AirFlow

Uni-Seal duct and fittings suitable to positive 10" WG.

Ducts shall be machine formed round and/or flat oval as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Longitudinal seam construction may be used for ductwork over 80" diameter with minimum 16 ga. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

Unless otherwise indicated, connection shall be slip type with minimum 2" insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone Angle Rings welded to duct.

2.2.2 Manufactured Round Ductwork (Postive or Negative Pressure)

Manufacturers: McGill AirFlow Industrial duct and fittings, Semco and Lindab, or approved equal, suitable to +/-10 inches WG.

Ducts shall be machine formed round duct constructed of G90 galvanized steel. Use spiral lockseam construction unless otherwise indicated. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

Connection shall use slip coupling with minimum 2 inches insertion length, angle ring or Van Stone Connectors in accordance with manufacturer's recommendations.

Fitting gauge shall be one even gauge heavier than the lightest allowable gauge of connecting downstream section of duct.

2.2.3 Duct Sealant and Gasket

Sealant:

UL Classified sealant as compounded specifically for sealing joints and seams in ductwork. Hardcast, McGill AirSeal, Ductmate, Mon-Eco Industries or H.B. Fuller/Foster. Duct tapes are not allowed.

Select sealants as recommended by manufacturer for specific application.

Submit sealant manufacturer's data sheets including performance data, pressure ratings, surface burning characteristics data, detailed installation instructions.

2.2.4 Reinforcement

Support inner liners of both duct and fittings by metal spacers welded in position to maintain spacing and concentricity.

2.2.5 Fittings

Make divided flow fittings as separate fittings, not tap collars into duct sections, with the following construction requirements:

Sound, airtight, continuous welds at intersection of fitting body and tap

Tap liner securely welded to inner liner, with weld spacing not to

exceed 3 inches

Pack insulation around the branch tap area for complete cavity filling.

Carefully fit branch connection to cutout openings in inner liner without spaces for air erosion of insulation and without sharp projections that cause noise and airflow disturbance.

Continuously braze seams in the pressure shell of fittings. Protect galvanized areas that have been damaged by welding with manufacturer's standard corrosion-resistant coating.

Submit for approval offset configurations.

Elbows shall be two-piece type for angles through 35 degrees, three-piece type for angles 36 through 71 degrees, and five-piece type for angles 72 through 90 degrees.

Crosses, increasers, reducers, reducing tees, and 90-degree tees shall be conical type.

2.2.6 Turning Vanes

Turning vanes shall be double-wall type, commercially manufactured for high-velocity system service.

Construct turning vanes in accordance with SMACNA HVAC Duct Construction Standards.

Square Throat Elbow Turning Vanes (Vane Runner Length up to 18 inches and Vane Length up to 36 inches):

Use single thickness vanes having 2 inches radius and 1-1/2 inches spacing, 24 ga minimum. Construct vanes in accordance with SMACNA HVAC Duct Construction Standards.

Square Throat Elbow Turning Vanes (Vane Runner Length over 18 inches or Vane Length over 36 inches):

Use double thickness vanes having 4.5 inches radius and 3.25 inches spacing, 24 ga minimum.

Radius Elbow Splitter Vanes:

Splitter vanes for radius elbows shall be extended entire length of fitting and constructed in accordance with SMACNA HVAC Duct Construction Standards.

2.2.7 Dampers

Low pressure drop, high-velocity manual volume dampers, and high-velocity fire dampers shall be constructed in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

2.2.8 Sound Attenuators

Provide sound attenuators as scheduled where shown in the mechanical plans.

Manufacturers: Industrial Acoustics Company, Price, Semco, Aerosonics,

United McGill, Aeroacoustic, Commercial Acoustics, Vibro-Acoustics, VAW Systems, Ruskin Sound, or Dynasonics, or appoved equal.

Factory fabricate sound attenuators, and acoustic confirmation of cataloged attenuation made by an independent laboratory in accordance with ASTM E90. Confirm pressure drop measurements in accordance with ASHRAE EQUIP IP HDBK, Chapter 18. Noise-reduction data shall include effects of flanking paths and vibration transmission. Testing shall be with standard metal inlet and outlet connections under indicated capacity flow. Units shall be tested in accordance with ASTM E-477-99 silencer test standard in aero-acoustic test facility which is NVLAP accredited for ASTM E-477-99 standard. Each test shall have been conducted within last 12 month period. Submit copy of laboratory's NVLAP accreditation certificate on dynamic insertion loss, self-noise power levels, and aerodynamic performance.

Attenuation shall be in accordance with ASHRAE FUN IP. Certification shall include a graphic system noise spectrum indicating proposed fan sound power level. Attenuation of ducting system proposed for installation based on ASHRAE FUN IP for bends, branches, and other duct system construction details; sound pressure level without sound attenuator; attenuation required; and excess attenuation compared to specific noise criteria curve.

Sound trap shall reduce fan-rated sound-power level to not less than 65 decibels in the 250-hertz third octave band when measured at trap discharge end.

Pressure drop at rated flow shall not exceed ratings in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966 or design criteria.

Attenuators shall be airtight when operating under an internal pressure of 0.37 pound per square inch. Air-side surface shall be capable of withstanding air velocities of 10,000 feet per minute without any particulate matter leaving the trap and being carried downstream.

Sound attenuators shall be double-metal walled, round or rectangular as scheduled. Sheet metal shall be mill-galvanized steel with commercial weight of zinc, conforming to ASTM A653/A653M. Exterior metal shall act as a vapor barrier, and metal thickness shall be not less than that required for the pressure service, in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966, but not less than 22-gage G90 galvanized steel. Absorbing material, on the sound-impinging side, shall be covered with formed perforated mill-galvanized steel of not less than 26-gage. Exterior sheet joints shall be continuously welded or made with lockseams filled, prior to forming, with a chloroprene mastic. Media shall be long fiber fiberglass protected with covering material and lined with not less than 26 ga galvanized perforated steel. Filler and facing material shall meet requirements of NFPA 90A with flame spread rating of 25 or less, and smoke development rating of 50 or less.

Interior surfaces shall be spot welded not more than 3 inches on center. Connections to duct transitions shall be flanged with through-bolted 1/8 inch by 1 inch continuous rubber gasketing. Supports shall be trapeze type, vibration isolated.

Absorption material shall be long fiber, fibrous glass. Surface exposed to airstream shall protected with woven fibrous-glass cloth conforming to

ASTM C1071. Covering material shall be glass fiber cloth, high tensile strength, long strand glass fiber woven to thread count of 44 by 32 and have minimum weight of 6 ounce/square yard, minimum breaking strength 250 by 200 lbs/inch, similar to Burlington Style 1675, BGF Industries Style 1528, or JP Stevens Style 7628. Total compressed thickness shall provide required attenuation and thermal insulation to preclude condensation on exterior surface under operating conditions normal to installed location. Compressed material density shall be approximately 4.5 pounds per cubic foot. Material shall conform to fire hazard requirements of NFPA 90A.

Ends of attenuators shall be covered at factory with plastic, heavy-duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuators. Caps shall not be removed until attenuator is installed in duct system.

Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

2.2.9 Flexible Connectors For Sheet Metal

Connectors shall be UL listed, 30-ounce per square foot, waterproof, fire-retardant, airtight, woven fibrous-glass cloth, double coated with chloroprene. Clear width, not including clamping section, shall be 6 to 8 inches.

2.2.10 Duct Hangers

Duct hangers in contact with galvanized duct surfaces shall be galvanized steel painted with inorganic zinc.

2.2.11 Mill-Rolled Reinforcing And Supporting Materials

Mill-rolled structural steel shall conform to ASTM A36/A36M and, whenever in contact with sheet metal ducting, shall be galvanized in accordance with ASTM A123/A123M.

Equivalent strength, proprietary-design, rolled-steel structural support systems may be submitted for approval in lieu of mill-rolled structural steel.

2.2.12 Flexible Duct Materials

Flexible duct connectors shall be in accordance with UL 181, Class 1 material and shall comply with NFPA 90A.

2.2.12.1 Metallic Flexible Duct

Metal duct shall be bendable through 180 degrees without damage, with an inside bend radius not greater than one-half the diameter of duct. Metal shall be aluminum.

2.2.12.2 Non-Metallic Flexible Duct

Unless otherwise indicated, duct shall be nonmetallic insulated type composed of polyester film, polyethylene film, nylon film, CPE film, or coated woven fiberglass liner bonded permanently to corrosion resistant coated steel wire helix without adhesive. Working pressure rating of ducting shall be not less than three times maximum system pressure, and

temperature range shall be minus 20 to plus 250 degrees F. Insulation shall be flexible fiberglass insulation with minimum R-value of 6 at mean temperature of 75 degrees F. Vapor barrier jacket shall be aluminum foil reinforced, polyethylene, or metalized polyester film with minimum perm rating of 0.05 perm per ASTM. Insulation material shall not be exposed to air stream.

Factory fabricated, UL listed under UL-181 as Class 1 duct, meeting requirements of NFPA 90A with flame spread of 25 or less and smoke developed rating of 50 or under.

Flexible duct shall have minimum ratings as follows:

1. Operating Temperature: 20 degrees F to 250 degrees F
2. Internal Working Pressure: Positive: 6 inches WG
   Negative: 1 inch WG
3. Burst Pressure: 3 times working pressure
4. Velocity: 5000 fpm

Lined flexible duct shall have the following minimum acoustical performance in accordance with ARI Standard 885. Dynamic Insertion Loss in each octave band of 5 feet or 10 feet straight duct shall not be less than the following:

DUCT DIAMETER (in)	Dynamic Insertion Loss (dB) Octave Band Center Frequency (Hz) (Based on 5 ft length)					
	125	250	500	1000	2000	4000
6 inches	6	9	18	22	24	15
8 inches	6	10	18	20	21	12
10 inches	5	11	18	18	18	9

DUCT DIAMETER (in)	(Based on 10 ft length)					
	125	250	500	1000	2000	4000
6 inches	10	15	28	33	35	22
8"	10	18	29	32	32	20
10"	9	19	28	31	29	18

2.2.13 Manual Volume Dampers

Conform to SMACNA 1966 for volume damper construction.

Equip dampers with an indicating quadrant regulator with a locking feature externally located and easily accessible for adjustment and standoff brackets to allow mounting outside external insulation. Where damper rod lengths exceed 30 inches , provide a regulator at each end of damper shaft.

All damper shafts shall have two-end bearings.

Splitter damper shall be 22-gage sheet metal 2 gages heavier than duct in which installed. Hinges shall be full length piano-type 1/8 inch thick

door type.

Damper shaft shall be full length and shall extend beyond damper blade. A 3/8 inch square shaft shall be used for damper lengths up to 20 inches and a 1/2 inch square shaft shall be used for damper lengths 20 inches and larger. Where necessary to prevent damper vibration or slippage, adjustable support rods with locking provisions external to duct shall be provided at damper blade end.

Dampers in ducts having a width perpendicular to the axis of the damper that is greater than 12 inches shall be multiblade type having a substantial frame with blades fabricated of 16-gage metal. Blades shall not exceed 10 inches in width and 48 inches in length and shall be welded to 1/2 inch diameter shafts. Dampers greater than 48 inches in width shall be made in two or more sections with intermediate mullions, each section being mechanically interlocked with the adjoining section or sections. Blades shall have oil-impregnated sintered bronze bearings and shall be connected so that adjoining blades rotate in opposite directions.

Manufacturers: Ruskin, Vent Products or Air Balance, constructed in accordance with SMACNA HVAC Duct Construction Standards, except as modified below.

2.2.13.1 Rectangular Dampers

For low pressure ductwork, for damper blade height up to 12 inches, use single blade type with minimum 22 ga galvanized steel blade with minimum 3/8 inch rod for blade width up to 18 inches, and with minimum 18 ga galvanized steel blade with minimum 1/2 inch continuous rod for blade width from 19 inches to 48 inches. For damper blade height more than 12 inches, use multiple blade type with minimum 16 ga galvanized steel channel frames, opposed blade linkage operation, with blades minimum 16 ga and 6 inches to 8 inches maximum blade width, minimum 1/2 inch continuous rod and 1/2 inch x 1/2 inch galvanized steel angle blade stops. Bearings shall be nylon or molded synthetic. Construct dampers over 48 inches in width or height in multiple sections with mullions.

For high pressure ductwork, dampers shall be constructed to withstand maximum pressure of 5 inches WG at closed position and maximum velocity of 2000 fpm at open position. Frame and blades shall be constructed of minimum 16 ga with minimum 1/2 inch diameter or square rod.

2.2.13.2 Single Blade Round Dampers:

For low pressure ductwork, damper shall have blade 24 ga, but no less than two gauges more than duct gauge. Rod shall be minimum 3/8 inch diameter or square continuous. Bearings shall be nylon or molded synthetic.

For high pressure ductwork, damper blade shall be minimum 16 ga. Rod shall be minimum 1/2 inch square continuous and tack welded to blade. Provide sealed end bearing similar to Ventlok #609 and acorn nut type dial regulator similar to Ventlok #635 or 641.

Provide damper operators with locking devices and damper position indicators. Sheet metal screws are not allowed in construction or installation of dampers. Use rivets or tack welds.

Dampers shall be properly stiffened and fabricated to prevent vibration, flutter or other noise.

Extend damper shafts through duct insulation or use elevated regulators for externally insulated ducts to accommodate specified insulation thickness.

2.2.14 Gravity Backdraft And Relief Dampers

Frame shall be constructed of not less than 1-1/2- by 4 inch reinforced 16 -gage galvanized carbon steel. Frames and mullions shall be solidly secured in place and sealed with elastomer caulking against air bypass.

Maximum blade width shall be 9 inches , and maximum blade length shall be 36 inches . Blade material shall be 16-gage galvanized steel or 4-gage 6063 alloy aluminum . Blades shall be provided with mechanically retained seals and 90-degree limit stops.

Dampers used for relief service shall have blades linked together to open not less than 30 degrees on 0.05 inch wg differential pressure.

Shaft bearings shall be oil-impregnated bronze.

Counterbalanced dampers shall be equipped with fixed or adjustable counterbalancing weights.

Counterbalanced barometric relief dampers that are mounted on the top of G-3 return grilles shall be Ruskin Type CBD2 counterbalanced dampers or equal. The dampers are to be mounted on the top of the grilles with necessary sheetmetal transitions to allow proper damper duct sealing, damper operation and operational adjustment. Damper counterweight adjustment shall be through the hinged G-3 grille face.

Gravity backdraft dampers in sizes 18 by 18 inches or smaller, when furnished integral with air moving equipment, may be equipment manufacturer's standard construction.

Dampers shall be multi-blade, weighted type with counter-balanced blades and with 12 ga flanged, galvanized steel frame and extruded aluminum airfoil-shaped blades. Manufacturers are Ruskin, Greenheck, Tamco (equal to Ruskin Type CBS 92).. Counterweight adjustment bar is to be installed external to the duct for adjustment and position indication. Blade edges shall have silicon rubber seals with ball bearings. Dampers shall be suitable for flange and gasket connection to ductwork or fan outlet.

The (Ruskin CBS 92 style) dampers are to be used in the fan discharge duct for isolating Fans SF-1, SF-2, SF-3, SF-4, EF-1, EF-2, EF-3, and EF-4. A hinged and gasketed duct inspection door is to be provided adjacent to each fan isolation damper.

Dampers shall be rated to maximum velocity of 4000 fpm, maximum temperature of 250 degrees F and maximum system pressure of 5 inches WG for damper width of 60 inches and 14 inches WG for damper width of 12 inches.

Maximum damper leakage shall be 13.5 cfm/sf based on pressure differential of 1 inch WG.

2.2.15 Power-Operated Dampers

Dampers shall conform to applicable requirements specified under Section 23 09 33.13 98 ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC.

All outside air intake dampers are to be manufactured with only aluminum or 304 stainless steel components. No galvanized steel components are to be used in the fabrication of the outside air dampers.

2.2.16 Fire Dampers And Wall Collars

Fire damper locations shall be in accordance with NFPA 90A.

Fire dampers in ductwork shall be provided at firewall barriers.

Fire dampers shall be constructed and labeled in accordance with UL 555 to provide damper and mounting fire-resistance that equals or exceeds fire-resistance of the construction in which installed. For link loads in excess of 20 pounds , UL-approved quartzoid links shall be provided.

Wall collars shall be constructed in accordance with UL 555.

Manufacturers: Air Balance, Prefco, Greenheck, Nailor, Cesco, Pottorff, Louvers and Dampers, or Ruskin.

Fire damper assemblies shall be listed by UL with 165 degreesF fusible link and shall meet construction standards as set forth in NFPA 90A. 212F fusible link is available if required.

Fire resistance rating of fire dampers shall be as shown on drawings.

Dampers shall be dynamic type dampers rated to minimum 2000 fpm and 4 inches WG. Where shown, dampers shall be dynamic type rated to a minimum 4000 fpm and 6 inches WG

Dampers shall be curtain type with blades out of air stream when in open position. Where curtain type dampers are not available because of size, use multiple blade type dampers.

For round ducts, dampers equal to Ruskin Model FDR25 may be used.

Damper fire rating shall be compatible with rating of building surface in which damper is used.

Submit UL installation details to showing mounting method and duct connection method.

Where ceiling fire dampers are used, they are to be equal to Ruskin CFD(R) 2 or 3, UL Classified for installation in fire rated floor or roof/ceiling assemblies.

2.2.17 Combination Fire and Smoke Dampers

Manufacturers: Ruskin, Air Balance, Prefco, Greenheck, Nailor, Cesco, Pottorff, Louvers and Dampers, similar to Ruskin FSD-60.

Dampers shall meet requirements of NFPA 90A. Dampers shall be 1-1/2 or 3 hr rated as shown on drawings, leakage rated at no higher than leakage Class I (4 cfm/ft2 at 1 inch WG and 8 cfm/ft2 at 4 inch WG) under UL

555/555S at temperature category 350 degrees F, and compatible with system static pressures. Furnish dampers with factory-mounted, caulked sleeves and damper operators.

Dampers shall use airfoil shaped damper blades. Dampers shall be rated pressures to 4" WG and velocities to 2000 fpm.

For round ducts, dampers equal to Ruskin Model FSDR 25 may be used.

Operators shall be 120 V electric powered with auxiliary switch built in for position indication, similar to Ruskin Model MS 4120S, factory installed outside airstream, linked to dampers for fail closed operation, and be UL Listed and labeled for the application. Operators to be capable of closing damper at pressures encountered in system. Electric operators shall be rated for energized hold open position period of 6 months or more. Dampers shall be furnished with heat sensor set at 165 degrees F.

Smoke detector required at each damper will be provided by Electrical Contractor.

2.2.17.1 Firestat

Dampers shall be furnished with UL Classified firestat equal to Ruskin TS150-EZ, functioning to close dampers when duct temperatures exceed 165 degrees F while allowing reset capability from control system specified in Section 15901 - Direct Digital Controllers and Networks. Include damper position switch linked directly to damper blade to provide capability of remotely indicating damper blade position. Firestat and position indicator switches to be capable of interfacing electrically with building fire alarm system or automation system.

Firestats shall be equipped with high limit temperature sensors meeting requirements of NFPA 92A by returning damper to fire protection mode when temperature reaches 350 degrees F.

Firestats and position switches shall be 120 V.

Furnish EP switches where pneumatic operators are used.

Submit UL installation details showing mounting method and duct connection method.

2.2.18 Smoke Dampers

Manufacturers: Air Balance, Johnson Controls, Ruskin, Greenheck, Nailor, NCA Manufacturing, Cesco, Pottorff Louvers and Dampers, or Prefco, similar to Ruskin SD-60.

Dampers shall be leakage rated at no higher than Leakage Class I (4 cfm/ft2 at 1 inch WG and 8 cfm/ft2 at 4 inches WG) under UL 555S at temperature category 250 degrees F. Furnish dampers with factory-mounted, caulked sleeve and actuator assemblies. Damper shall have 16 ga or heavier frame with air foil-shaped blades, rated to minimum 4 inches WG in closed position and to 2000 fpm in open position.

For round ducts, dampers equal to Ruskin Model SDRS25 may be used.

Actuator assemblies shall be installed outside airstream, linked to damper for fail (normally) closed operation. Actuator shall be capable of

closing damper at pressures encountered in system.

Size smoke dampers as close as possible to duct size, but in no case is damper size to be less than duct size.

Electric actuators shall be 120 V non-stall type unless otherwise stated with auxiliary switch built in for position indication, similar to Ruskin Model MS 4120S. Actuators shall be rated for energized hold open position period of 6 months or more.

Smoke detector required at each damper will be provided by Electrical Contractor.

2.2.19 Remote Operated Volume Control Dampers

Young Regulator Co., or Metroporitan Air Technology similar to Young Regulator Model 830 dampers, furnished with Bowden 270-275 remote cable controls.

2.2.20 INSTRUMENT TEST HOLES

Manufacturers: Ventlok 699 (up to 1 inch insulation thickness) or Ventlok 699-2 (over 1 inch insulation thickness).

Use concave gaskets for round ductwork.

2.2.21 Barrier Security Grilles

The security barrier grilles sleeve frame shall be constructed of minimum 3/16 inch thick welded steel. One fixed (welded) and one loose (for field installation) 1-1/2 inches by 1-1/2 inches by 3/16 inch steel angle iron frames shall also be provided with each assembly.

The internal steel bars shall be minimum 3/4 inch diameter and be welded in place within the sleeve on a maximum 6 inches by 6 inches spacing on center with a maximum 1/2 inch deviation in vertical or horizontal spacing permissible.

Size of the grille assemble shall be as shown on the duct plans or schedules.

The grille assembly shall be finished with a white powder coat finish.

Manufacturer: Titus Model SG-BG-SLV (or approved equal).

PART 3 EXECUTION

3.1 PREPARATION

Provide sheet metal construction in accordance with the recommendations for best practices in ASHRAE EQUIP IP HDBK, Chapter 16, SMACNA 1966, NFPA 90A, and ASHRAE FUN IP, Chapter 32. Also refer to the Duct Pressure Class, Material and Leakage schedule in the mechanical drawings for additional duct design information.

Where construction methods for certain items are not described in the referenced standards or herein, perform the work in accordance with recommendations for best practice defined in ASHRAE EQUIP IP HDBK.

Clean free of oil, grease, and deleterious substances sheet metal surfaces to be painted and surfaces to which adhesives are to be applied.

Duct strength shall be adequate to prevent failure under service pressure or vacuum created by fast closure of duct devices. Provide leaktight, automatic relief devices.

Supplementary steel shall be designed and fabricated in accordance with AISC 360 and AISC 325.

3.2 INSTALLATION

Within listing of product installations for medium/high pressure ductwork systems include identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Include purchaser, address of installation, service organization, and date of installation.

Fabricate airtight and include reinforcements, bracing, supports, framing, gasketing, sealing, and fastening to provide rigid construction and freedom from vibration, airflow-induced motion and noise, and excessive deflection at specified maximum system air pressure and velocity.

Enclose dampers located behind architectural intake or exhaust louvers by a rigid sheet metal collar and sealed to building construction with elastomers for complete air tightness.

Provide outside air-intake ducts and plenums made from sheet metal with soldered watertight joints.

Provide offsets and transformations as required to avoid interference with the building construction, piping, or equipment. Make allowances for beams, pipes or other obstructions in building construction and for work of other Contractors. Check plans showing work of other trades and consult with Engineer in event of interference. Transform, divide, or offset ducts as required, in such a manner as to maintain same cross sectional area of duct as indicated on drawings. Where it is necessary to install pipes or similar obstructions through ducts, consult. with Engineer and obtain written approval from Engineer and Owner. If approved, provide streamlined encasement or collar designed in accordance with SMACNA Standards and seal to prevent air leakage..

Install ductwork parallel to building walls and ceilings and at such heights not to obstruct any portion of ceiling, window, doorway, stairway, or passageway. Install ductwork to allow adequate access and service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical ductwork plumb. Where interferences develop in field, offset or reroute ductwork as required to clear such interferences. In all cases, consult drawings for exact location of duct spaces, ceiling heights, door and window openings or other Architectural details before installing ductwork.

Ductwork shall be free of kinks and dents.

Wherever ducts pass through firewalls or through walls or floors dividing conditioned spaces from unconditioned spaces, provide a flanged segment in that surface during surface construction.

Clean free of oil, grease, and deleterious substances sheet metal surfaces

to be painted or surfaces to which adhesives will be applied.

Where duct systems are exposed and are required to be painted, the duct, duct hanging systems, duct insulation, duct sealant and duct accessories must be installed neatly for an exposed presentation. Coordinate the paint selections for the duct systems to be painted with the Architect.

Where interiors of ducting may be viewed through air diffusion devices, construct the viewed interior with sheet metal and paint flat black.

Make plenum anchorage provisions, sheet metal joints, and other areas airtight and watertight by caulking mating galvanized steel and concrete surfaces with a two-component elastomer.

Fabricate and install duct, fittings, joints, seams, reinforcement, supports, sealing, liner, etc., in sizes indicated on drawings and in accordance with manufacturer's published data and SMACNA Standards except as modified in this Section of Specifications.

Provide transitions where different size or different shape ductwork segments are connected. Use concentric transitions unless otherwise shown. Unless otherwise indicated, make diverging transitions with maximum angle of 15 per side (30 total diverging) and converging transitions with maximum angle of 25 per side (50 total converging.

Provide transitions at ductwork system components and connections to equipment.

Refer to ductwork symbols list on drawings for additional and dimensional requirements for fittings.

Seal duct seams and joints to meet SMACNA Class A as minimum for all ductwork including low-pressure ductwork

Construct ductwork so that interior surfaces are smooth. Internal duct hangers and internal bracing are not allowed. Refer to Part 1, Design Criteria for internal tie rods.

Support coils, filters, air terminals, dampers, sound attenuator devices or other devices installed in duct systems with angles or channels, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets, nuts, bolts and washers.

Air terminal devices may be supported by strap hangers if air terminal manufacturer approves. Strap hangers are not allowed for fan powered devices, double wall type and Titus Steri-Loc type devices.

Install outside air intake duct to pitch down at minimum 1 inch per 20 foot toward intake louver or plenum and to drain to outside of building. Solder or seal seams to form watertight joints.

Install exhaust air duct to pitch down at minimum 1 inch per 20 foot toward exhaust louver.

Blank off unused portion of outside air intake or exhaust louvers.

Where 2 different metal ducts meet, install joint in such a manner that metal ducts do not contact each other by using proper gasket seal or

compound.

Install motor operated dampers and connect to or install equipment furnished by others. Provide necessary blank-off plates or transitions to mount control dampers as specified.

Do not install ductwork over electrical panelboards, switchgear, switchboards or motor control centers.

When original galvanized finish is altered or damaged, apply field galvanizing paint as follows:

a. Prepare surface with use of power sanders or wire brushes to remove rust, paint, etc. Apply cold galvanizing material equal to ZRC Products, Inc. or approved equal.

3.3 APPLICATION

3.3.1 Low Pressure Sheet Metal Ducts

Weld angle iron frames at corners and ends, whenever possible. Angle iron reinforcements shall be riveted or welded to ducts not more than 6 inches on center, with not less than two points of attachment. Spot welding, where used, shall be 3 inches on center.

Standard seam joints shall be sealed with an elastomer compound to comply with SMACNA 1966 Seal Class A, B or C as applicable.

Crossbreaking shall be limited to 4 feet and shall be provided on all ducts 8 inches wide and wider. Bead reinforcement shall be provided in lieu of crossbreaking where panel popping may occur. Where rigid insulation will be applied, crossbreaking is not required.

3.3.1.1 Longitudinal Duct Seams

Corner seams shall be Pittsburg lock.

3.3.1.2 Joints and Gaskets

Companion angle flanges shall be bolted together with 1/4 inch diameter bolts and nuts spaced 6 inches on center. Flanged joints shall be gasketed with chloroprene full-face gaskets 1/8 inch thick, with Shore A 40 durometer hardness. Gaskets shall be one piece and vulcanized at joints.

3.3.1.3 Flexible Duct Joints

Joints between flexible duct without sheet metal collars and round metal ductwork connections shall be made by trimming the ends, coating the inside of the flexible duct for a distance equal to depth of insertion with elastomer caulk, and by securing with sheet metal screws or binding with a strap clamp.

3.3.1.4 Elbows

Rectangular Duct:

Unless specific type is indicated, use radius elbows with minimum centerline radius to width or diameter ratio of 1.5. Where 1.5 radius

elbows do not fit, use the following elbows:

a. Supply Air Ductwork:

(1) 1.0 radius elbows

(2) Square throat elbows with turning vanes where 1.0 radius elbows do not fit

b. Return or Exhaust Air Ductwork:

(1) 1.0 radius elbows with full splitter vanes(SMACNA Type RE3) as follows:

(a) One vane for duct width 24 inches to 48 inches
Two vanes for duct width 49 inches to 72 inches
Three vanes for duct width 73 inches and larger
Fabricate vanes in accordance with SMACNA HVAC Duct Construction Standard, Chart 4-1 (p 4.11) and Figure 4-9 (p 4.13).

(2) 45 throat with radius heel elbows with full splitter vanes as follows where 1.0 radius elbows do not fit:

(a) One vane for duct width 12 inches to 24 inches
Two vanes for duct width 25 inches to 36 inches
Three vanes for duct width 36 inches and larger
Fabricate vanes in accordance with SMACNA HVAC Duct Construction Standards, chart 4-1 and Figure 4-9.

(a) Square throat - radius heel elbows or square throat elbows or Tees with or without turning vanes are not allowed on return or exhaust systems unless specifically approved by the engineer because of space limitations. Whenever square throat fittings are used on the approved systems, duct access doors shall be provided directly adjacent to the fitting to allow the cleaning of the turning vanes.

Round and Oval Duct:

Unless specific type is indicated, use radius elbows with centerline radius to diameter ratio of 1.5. Where 1.5 radius elbows do not fit, use 1.0 radius elbows.

3.3.1.5 Outlets, Inlets, And Duct Branches

Install branches, inlets, and outlets so that air turbulence will be reduced to a minimum and air volume properly apportioned. Install adjustable splitter dampers at all supply junctions to permit adjustment of the amount of air entering the branch. Wherever an air-diffusion device is shown as being installed on the side, top, or bottom of a duct, and whenever a branch takeoff is not of the splitter type, a commercially manufactured 45 degree side-take-off (STO) fitting with manual; provide volume damper to allow adjustment of the air quantity and to provide an even flow of air across the device or duct it services.

Where a duct branch is to handle more than 25 percent of the air handled by the duct main, use a complete 90-degree increasing elbow with an inside radius of 0.75 times branch duct width. Size of the leading end of the increasing elbow within the main duct shall have the same ratio to the

main duct size as the ratio of the related air quantities handled.

Where a duct branch is to handle 25 percent or less of the air handled by the duct main, the branch connection shall have a 45 degree side take-off entry in accordance with SMACNA 1966.

3.3.1.6 Duct Transitions

Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, the angle of the side of the transition piece from the straight run of duct connected thereto shall not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.3.1.7 Branch Connections

Construct radius tap-ins in accordance with SMACNA 1966.

3.3.1.8 Access Openings

Install access doors and panels in ductwork upstream and downstream from coils, adjacent to fire dampers, at controls or at any item requiring periodic inspection, adjustment, maintenance, or cleaning, and where indicated, and every 20 feet 6.1M for indoor air quality housekeeping purposes.

Minimum size of access opening shall be 12 by 18 inches, unless precluded by duct dimensions or otherwise indicated.

Construct access door in accordance with SMACNA 1966, except that sliding doors may be used only for special conditions upon prior approval. Insulated doors shall be double-panel type.

Access doors that leak shall be made airtight by adding or replacing hinges and latches or by construction of new doors adequately reinforced, hinged, and latched.

Duct access shall be particularly suitable for commercial duct cleaning methods utilizing vacuum devices. Space access openings with a frequency and at points which will permit ready access to duct internals with essentially no duct or insulation cutting. Where access through an air-diffusion device or through access doors specified herein is not available at a specific point, 8 inch diameter, 16-gage provide access plates not more than 10 feet on center. Where duct is insulated and vapor-sealed, provide mastic seals around circumference of access. When access plate is in place and insulated, externally identify the location.

3.3.1.9 Plenum Construction

Intake and discharge plenum shall have companion angle joints with the following minimum thickness of materials:

LONGEST ANGLES SIDE INCHES	SHEET METAL USS GAGE ALL SIDES	COMPANION ANGLES INCHES	REINFORCEMENT INCHES, 24 INCHES ON CENTER MAXIMUM
To 48	20	1-1/2 by 1-1/2 by 1/8	1-1/2 by 1-1/2 by 1/8
49 to 84	18	2 by 2 by 1/8	2 by 2 by 3/16
85 to 120	16	2 by 2 by 1/8	2 by 2 by 1/8
121 and larger	14	2 by 2 by 3/16	2 by 2 by 3/16

At the floor line and other points where plenums join masonry construction, panels shall be bolted 12 inches on center to minimum 2- by 2- by 3/16 inch thick hot-dip galvanized steel angle that has been secured to the masonry with masonry anchors and bolts 24 inches on center and caulked tight to the masonry.

Panels shall be anchored to curbing by not less than 2- by 2- by 3/16 inch thick hot-dip galvanized steel angle iron. Concrete curbing shall include angle iron nosing with welded studs for the anchoring of panels. Nosing shall be level at curb height within plus or minus 1/16 inch .

Plenum access doors shall be constructed in accordance with SMACNA 1966 except that access doors smaller than man-access doors shall have door openings framed with angle iron that is one commercial size smaller than specified panel reinforcement.

Man-access door size shall be per SMACNA 1966 and paragraph entitled, "Access Openings," of this section. Insulated and uninsulated construction shall be per SMACNA 1966. Door openings shall be framed with channel iron. Doors shall be framed with angle iron. Channel iron and angle iron shall be approximately the same size as specified panel reinforcement. Exterior door skin shall be 16 gage . Latches shall be fabricated steel, hinges shall be at least 4 inches long, and bolting shall be at least 3/8 inch diameter.

Angle iron and channel iron shall have welded and ground miter corners.

3.3.1.10 Manual Volume Dampers

Balancing dampers of the splitter, butterfly, or multilouver type, shall be provided to balance each respective main and branch duct.

Dampers regulated through ceilings shall have regulator concealed in box mounted in the ceiling, with a cover finish aesthetically compatible with ceiling surface. Where ceiling is of removable construction, regulators shall be above ceiling, and location shall be marked on ceiling in a manner acceptable to the Contracting Officer.

Install manual balancing dampers in all branch ducts of supply, return and exhaust ductwork, as indicated on drawings and as required to regulate airflow to meet air balance requirements.

Install manual balancing damper in branch duct to each diffuser and

grille. Install dampers as close as possible to take-offs.

Install balancing dampers so as not to flutter or vibrate and as far as possible upstream from the air outlet.

Balancing dampers are not required for supply ductwork upstream of air terminal devices.

Balancing dampers are not required for return and exhaust ductwork at outlet side of air terminal devices.

Non-standard. Edit properly when return air or exhaust air terminal devices are used.

Balancing damper is not required where terminal air device serves a single diffuser or grille.

Do not install manual balancing dampers in the following exhaust ductwork:

Kitchen hood exhaust ductwork

3.3.1.11 Remote Operated Volume Control Dampers

a. Provide remote operated volume control dampers for all balancing dampers located above hard ceilings or otherwise inaccessible locations.

b. Install connecting wire in the wall.

3.3.1.12 Flexible Connectors For Sheet Metal

Air handling equipment, ducts crossing building expansion joints, and fan inlets and outlets shall be connected to upstream and downstream components by treated woven-cloth connectors.

Connectors shall be installed only after system fans are operative, and vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkle caused by misalignment or fan reaction. Width of surface shall be curvilinear.

3.3.2 Rectangular Sheet Metal Ducts

3.3.2.1 Medium-Pressure Gages, Joints, And Reinforcement

Minimum sheet metal gages, joints, and reinforcements between joints shall be in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

Longitudinal Seams - Unless otherwise indicated, use Pittsburgh Lock Seam for rectangular ductwork. Button punch snap lock construction (SMACNA L-2) may be used for ductwork for 2 inches WG (+ or -) and lower, and sizes 48 inches and smaller in width. Button punch snap lock construction is not allowed for ductwork in chases and areas above inaccessible ceiling. Button punch snap lock construction is not allowed on aluminum ductwork.

Traverse Joints - Transverse joints shall be in accordance with SMACNA HVAC Duct Construction Standards. Ductmate 25/35 connection systems with corner clips or optional nuts and bolts may be used. Incorporate use of all Ductmate accessories to ensure integrity of transverse

connection. Install joints in strict accordance with the latest edition of Ductmate 25/35 Assembly and Installation Instruction Manual and Duct Construction Standards. Nexus or WDCI will be acceptable. Lockformers TDC or Engles TDF may be used in accordance with T-25 flanges of SMACNA HVAC Duct Construction Standards Metal and Flexible, 2005, provided that corner pieces with bolts are used. If TDF/TDC flanges are damaged, replace the damaged joint(s) by straightening and reinforcing with minimum 1-1/2 inches by 1-1/2 inches by 1/4 inch angle at each side of transverse joint.

Sheet metal minimum thickness, transverse reinforcement between joints, and joints of ducts shall be in accordance with the following:

LONGEST SIDE INCHES	SHEET METAL GAGE ALL SIDES	COMPANION ANGLE INCHES	REINFORCEMENT ANGLES INCHES, 24 INCHES ON CENTER MAXIMUM (BACK TO BACK)
97 to 108	16	2 by 2 by 1/8, two tie rods along angle	Two 2 by 2 by 1/8, two tie rods along angle
109 to 132	16	2 by 2 by 3/16, two tie rods along angle	Two 2 by 2 by 3/16, two tie rods along angle
133 and longer	14	2 by 2 by 3/16, with tie rods every 48 inches	Two 2 by 2 by 3/16, with tie rods every 48 inches

3.3.2.2 Medium- And High-Pressure Branches, Inlets, Outlets

Install branches, inlets, and outlets to minimize air turbulence and to ensure proper airflow.

Install dampers so that the amount of air entering duct mains can be adjusted.

Provide commercially manufactured air extractors to allow adjustment of the air quantity and to provide an even flow of air across the device or duct served.

Where a duct branch is to handle over 25 percent of the air handled by the duct main, a complete 90-degree increasing elbow shall be used, with an inside radius of 0.75 times duct branch width. Size of the trailing end of the increasing elbow within the main duct shall be in the same ratio to the main duct size as the ratio of the relative air quantities handled.

Where a duct branch is to handle 25 percent or less of the air handled by the duct main, the branch connection shall have an inside radius of 0.75 times branch duct width, a minimum arc length of 45 degrees, and an outside radius of 1.75 times duct branch width. Arc shall be tangent to duct main.

3.3.2.3 High-Pressure Gages, Joints, And Reinforcement

Sheet metal minimum thickness, joints, and reinforcement between joints shall be in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

Longitudinal Seams - Unless otherwise indicated, use Pittsburgh Lock Seam for rectangular ductwork. Button punch snap lock construction (SMACNA L-2) may be used for ductwork for 2 inches WG (+ or -) and lower, and sizes 48 inches and smaller in width. Button punch snap lock construction is not allowed for ductwork in chases and areas above inaccessible ceiling. Button punch snap lock construction is not allowed on aluminum ductwork.

Traverse Joints - Transverse joints shall be in accordance with SMACNA HVAC Duct Construction Standards. Ductmate 25/35 connection systems with corner clips or optional nuts and bolts may be used. Incorporate use of all Ductmate accessories to ensure integrity of transverse connection. Install joints in strict accordance with the latest edition of Ductmate 25/35 Assembly and Installation Instruction Manual and Duct Construction Standards. Nexus or WDCI will be acceptable. Lockformers TDC or Engles TDF may be used in accordance with T-25 flanges of SMACNA HVAC Duct Construction Standards Metal and Flexible, 2005, provided that corner pieces with bolts are used. If TDF/TDC flanges are damaged, replace the damaged joint(s) by straightening and reinforcing with minimum 1-1/2 inches by 1-1/2 inches by 1/4 inches angle at each side of transverse joint.

The following types of ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966 transverse joints shall be used:

Welded flange joint with angle

Companion angle flanged joint

The following types of longitudinal seams shall be used:

Approved lock seams, back brazed, or continuously brazed seams for ducts with largest dimension up to 72 inches

Continuously welded or brazed seams for ducts with largest dimension greater than 72 inches

Sheet metal minimum thickness, transverse reinforcement between joints, and companion angle joints of ducts with longest side greater than 96 inches shall be in accordance with the following:

LONGEST SIDE INCHES	SHEET METAL GAGE ALL SIDES	COMPANION ANGLE INCHES	REINFORCEMENT ANGLES INCHES, 24 INCHES ON CENTER MAXIMUM (BACK TO BACK)
97 to 108	16	2 by 2 by 1/8, two tie rods along angle	*Two 2 by 2 by 1/8, two tie rods along angle
109 to 132	16	2 by 2 by 3/16,	*Two 2 by 2 by 3/16,

LONGEST SIDE INCHES	SHEET METAL GAGE ALL SIDES	COMPANION ANGLE INCHES	REINFORCEMENT ANGLES INCHES, 24 INCHES ON CENTER MAXIMUM (BACK TO BACK)
		two tie rods along angle	two tie rods along angle
133 and longer	14	2-1/2 by 2-1/2 by 3/16, with tie rods every 24 inches	*Two 2-1/2 by 2-1/2 by 3/16, with tie rods every 24 inches

3.3.3 Round Sheet Metal Ducts

3.3.3.1 Duct Gages, Joints, And Reinforcement

Sheet metal minimum thickness, joints, and reinforcement between joints shall be in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

Longitudinal duct joint shall be manufactured by machine, with spiral lockseams to and including 60 inch diameters, and to dimensional tolerances compatible with fittings provided.

Ducts shall have supplemental girth angle supports, riveted with solid rivets 6 inches on center to duct. Girth angles shall be located as follows:

DIAMETER, INCHES	REINFORCEMENT-MAXIMUM SPACING, INCHES
25 to 36	1-1/4 by 1-1/4, 1/8 thick, 72 inches on center
37 to 50	1-1/4 by 1-1/4, 1/8 thick, 60 inches on center
51 to 60	1-1/2 by 1-1/2, 1/8 thick, 48 inches on center

Draw band girth joints are not acceptable.

Slip joints shall be made up by coating the male fitting with elastomer sealing materials, exercising care to prevent mastic from entering fitting bore, leaving only a thin annular mastic line exposed internally. Sheet metal screws shall be used to make assembly rigid, not less than four screws per joint, maximum spacing 6 inches. Pop rivets shall not be used. All joints shall be taped and heat sealed.

Bolt heads and nuts shall be hex-shaped, 5/16 inch diameter for ducts up to 50 inch diameter, and 3/8 inch diameter for 51 inch diameter ducts and larger.

Flanges shall be continuously welded to duct on outside of duct and intermittently welded with 1 inch welds every 4 inches on inside joint face. Excess filler metal shall be removed from inside face. Galvanized

areas that have been damaged by welding shall be protected with manufacturer's standard corrosion-resistant coating.

3.3.3.2 Duct Transitions

Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, the angle of the side of the transition piece from the straight run of duct connected thereto shall not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.3.4 Round, High Pressure, Sheet Metal Duct Installation

3.3.4.1 Joints

An inner coupling shall be provided to align the inner lining to maintain good airflow conditions equivalent to standard round high-pressure duct joints. Butt joints are not suitable for the inner liner. This alignment shall be accomplished by extending the liner of the fitting for slip joint into the pipe. For ducts over 34 inches inside diameter, provide a separate coupling for inner alignment, with the pressure shells joined by angle-ring flanged connections.

3.3.4.2 Insulation Ends

At the end of an uninsulated section or run where internally insulated duct connects to uninsulated spiral duct, fitting, fire damper or flexible duct, install an insulated end-fitting to bring the outer pressure shell down to nominal size.

3.3.5 Transverse Reinforcement Joints

Transverse reinforcements shall be riveted with solid rivets to duct sides 6 inches on center. Transverse reinforcement shall be welded at all corners to form continuous frames.

3.3.6 Joint Gaskets

Flanged joints shall be gasketed with chloroprene full-face gaskets 1/8 inch thick, Shore A 40 durometer hardness. Gaskets shall be one piece, vulcanized at joints.

3.3.7 Radius Elbows

Fabricate elbow proportions and radius elbows in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

3.3.8 Plenum Connections

Round duct connections shall be welded joint bellmouth type.

Rectangular duct connections shall be bellmouth type, constructed in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

3.3.9 Access Openings

Install access panels in ductwork adjacent to fire dampers.

Minimum size of access opening shall be 12 by 18 inches, unless precluded by duct dimension.

Access openings shall be framed by welded and ground miter joint, 1/8 inch thick angle iron, with 3/8 inch studs welded to frame. Cover plate shall be not less than16-gage, reinforced as necessary for larger sizes constructed of 12-gage metal.

In lieu of access doors, readily accessible flanged duct sections may be provided upon approval. Provide stable hanger supports for disconnected duct termini.

3.3.10 Duct Supports

Install duct support in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966. Duct hangers shall meet the minimum size specified in ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966. Provide two hangers where necessary to eliminate sway. Support attachment to duct surfaces, shall be by solid rivet bolt 4 incheson center.

Round, double-wall duct supports shall be as recommended by the manufacturer except that minimum hanger ring and strap size shall be 1-1/2 inches by 1/8 inch.

Selection of hanging system shall be at the Contractor's option, and shall take into account the location and precedence of work under other sections, interferences of various piping and electrical conduit, equipment, building configuration, structural and safety factor requirements, vibration, and imposed loads under normal and abnormal service conditions. Support sizes, configurations, and spacings are given to show the minimal type of supporting components required. If installed loads are excessive for the specified hanger spacing, hangers, and accessories heavier-duty components shall be provided or hanger spacing shall be reduced as needed. After system startup, any duct support device which, due to length, configuration, or size, vibrates or causes possible failure of a member, shall be replaced or the condition shall otherwise be alleviated. Special care shall be exercised to preclude cascade-type failures.

Hanger rods, angles, and straps shall be attached to beam clamps. Concrete inserts, masonry anchors, and fasteners shall be approved for the application.

Hardened high-carbon spring-steel fasteners fitted onto beams and miscellaneous structural steel are acceptable upon prior approval of each proposed application and upon field demonstration of conformance to specification requirements. Fasteners shall be made from steel conforming to AISI Type 1055 , treated and finished in conformance with SAE AMS 2480, Type Z (zinc phosphate base), Class 2 (supplementary treatment). A 72-hour load-carrying capacity shall be verified by a certified independent laboratory.

Hanger spacing shall provide a 20-to-1 safety factor for supported load.

Maximum load supported by any two fasteners shall be 100 pounds.

Friction rod assemblies are not acceptable.

Ductwork and equipment shall not be hung from roof deck, piping, or other ducts or equipment. Maximum span between any two points shall be 10 feet, with lesser spans as required by duct assemblies, interferences, and permitted loads imposed.

There shall be not less than one set of hangers for each point of support. Hangers shall be installed on both sides of all duct turns, branch fittings, and transitions.

Hangers shall be sufficiently cross braced to eliminate sway vertically and laterally.

Rectangular ducts up to 36 inches shall be supported by strap-type hangers attached at not less than three places to not less than two duct surfaces in different planes.

Perforated strap hangers are not acceptable.

Rectangular ducting, 36 inches and larger, shall be supported by trapeze hangers. Strap is allowed for duct less than 36 inches Ducts situated in unconditioned areas and required to have insulation with a vapor-sealed facing shall be supported on trapeze hangers. Hangers shall be spaced far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside the trapeze. Use trapeze hangers to support externally insulated ductwork with weight bearing inserts. Duct hangers shall not penetrate the vapor-sealed facing.

Where trapeze hangers are used, the bottom of the duct shall be supported on angles sized as follows:

WIDTH OF DUCT, INCHES	MINIMUM BOTTOM ANGLE SIZE, INCHES
30 and smaller	1-1/4 by 1-1/4 by 1/8
31 to 48	1-1/2 by 1-1/2 by 1/8
49 to 72	1-1/2 by 1-1/2 by 3/16
73 to 96	2 by 2 by 1/4
97 and wider	3 by 3 by 1/4

Where ductwork system contains heavy equipment, excluding air-diffusion devices and single-leaf dampers, such equipment shall be hung independently of the ductwork by means of rods or angles of sizes adequate to support the load.

Ducting, when supported from roof purlins, shall not be supported at points greater than one-sixth of the purlin span from the roof truss. Load per hanger shall not exceed 400 pounds when support is from a single purlin or 800 pounds when hanger load is applied halfway between purlins by means of auxiliary support steel provided under this section. When support is not halfway between purlins, the allowable hanger load shall be the product of 400 times the inverse ratio of the longest distance to purlin-to-purlin spacing.

When the hanger load exceeds the above limits, provide reinforcing of purlin(s) or additional support beam(s). When an additional beam is used, the beam shall bear on the top chord of the roof trusses, and bearing shall be over gusset plates of top chord. Beam shall be stabilized by connection to roof purlin along bottom flange.

Purlins used for supporting fire-protection sprinkler mains, electrical lighting fixtures, electrical power ducts, or cable trays shall be considered fully loaded, and supplemental reinforcing or auxiliary support steel shall be provided for these purlins.

Duct supports shall be vibration isolated from structure at points indicated. Refer to Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.

Provide vibration isolators in discharge ducting system for a distance not less than 50 feet beyond the air handling unit. Deflection of duct and equipment mountings shall be coordinated.

For round ducts 24 inches diameter or smaller, use single hanger. Round Duct Strap Bracket by Ductmate Industries may be used up to 24" diameter.

For round ducts 25 inches diameter or larger, use 2 minimum 3/8 inch rods, with trapeze in accordance with the following schedule:

Duct Size	Trapeze (Half Round)
25 inches through 36 inches	1-1/2 inches by 1-1/2 inches by 1/8 inch
37 inches through 48 inches	1-1/2 inches by 1-1/2 inches by 1/4 inch or 2 inch by 2 inches by 1/8 inch
49 inches through 60 inches	2 inches by 2 inches by 1/4 inches
61 inches through 84 inches	2-1/2 inches by 2-1/2 inches by 1/4 inch

Refer to Section 23 07 00 THERMANL INSULATION FOR MECHANICAL SYSTEMS, for ductwork insulation, weight bearing inserts and insulation protection shield requirements.

Support ducts located on roof as detailed. Include support details for ductwork on roof and coordinate with Architect/Structural Engineer.

Support vertical ducts at every floor, but not exceeding 12 feet.

Support flexible duct at manufacturer's recommended intervals but at least every 5 feet. Maximum sag shall be 0.5 inch per foot between supports. Hanger or saddle material in contact with flexible duct shall be minimum 1.5 inch wide.

The following upper attachments, upper attachment devices, lower hanger attachments, hanger devices, and/or hanger attachments are not allowed except where specifically indicated:

Hook or loop
Nailed pin fasteners
Expansion nails without washers

Powder charged or mechanically driven fasteners (forced entry anchors). Forced entry anchors may be used for upper attachments of flexible ductwork supports.
Beam or "C" clamps without retaining clips or friction clamps (provide retaining clips for "C" clamps)
Friction clamps for ductwork over 12"
Non-factory manufactured upper attachments for metal pan deck including wire coil and double circle (Items 16 and 17 of Fig 5-4 of SMACNA HVAC Duct Construction Standards 2005)
Wire hanger
Cable support systems
Trapeze hangers supported by wires or straps
Rods, straps or welded studs directly attached to metal deck
Drilled hole with attachment to structural steel
Lag screw expansion anchor
Rivets
Non-metallic hangers or straps

Unless Architectural Documents indicate the required framing, provide angle iron framing around roof opening where duct penetrates through roof decking, to maintain roof decking structural integrity in accordance with roof decking manufacturer's recommendations. This is not required for concrete decking. For concrete decking, consult with the Project Structural Engineer for location and size of opening prior to execution of Work.

3.3.11 Flexible Connectors For Steel Metal

Air-handling equipment, ducts crossing building expansion joints, and fan inlets and outlets shall be connected to upstream and downstream components by treated woven-cloth connectors. Install duct flexible connections between ductwork and fans or equipment casing containing fans not internally isolated. Installed width shall be suitable for specific application but shall not be less than 4 inches. Install flexible connections in accordance with SMACNA Standards with double lock or "Grip Loc" connection. Duct flexible connections are not allowed for fan connection serving kitchen hood or dishwasher exhausts.

Install connectors only after system fans are operative and all vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkles caused by misalignment or fan reaction. Width of surface shall be curvilinear.

3.3.12 Insulation Protection Angles

Galvanized 20-gage sheet, formed into an angle with a 2 inch exposed long leg with a 3/8 inch stiffening break at outer edge, and with a variable concealed leg, depending upon insulation thickness, shall be provided.

Install angles over all insulation edges terminating by butting against a wall, floor foundation, frame, and similar construction. Fasten angles in place with blind rivets through the protection angle, insulation, and sheet metal duct or plenum. Install angles after final insulation covering has been applied.

3.3.13 Duct Probe Access

Provide holes with neat patches, threaded plugs, or threaded or twist-on caps for air-balancing pitot tube access. Provide extended-neck fittings

where probe access area is insulated.

3.3.14 Openings In Roofs And Walls

Building openings are fixed and provide equipment to suit.

3.3.15 KITCHEN HOOD EXHAUST DUCT CONSTRUCTION

Above ceilings and to end of system, use 18 ga or heavier stainless steel sheet with continuous external welded joints and seams watertight. Use bell-type joint with maximum 2" overlapping. Refer to Code requirements for fire resistive enclosure.

For ductwork below ceilings and exposed in kitchen and for non-insulated ductwork, use 18 ga or heavier stainless steel sheet with continuous external welded, ground and polished joints and seams. Use bell-type joint with maximum 2 inches overlapping.

Use elbows and tees with centerline radius to width or diameter ratio of at least 1.5. Construct branch takeoffs with 45 degree maximum entry fitting. No square edge 90 takeoff fittings, turning vanes, splitter dampers, extractors or manual volume dampers shall be installed.

Apply bracing and reinforcement to outside of duct to prevent breathings, rattlings, vibration and sag.

Use duct-supporting steel not lighter than duct gauge. Support at not greater than 5 foot intervals. Secure hangers to duct without penetrating duct. Sheet metal screws are not allowed on supports; use nuts and bolts, rivets or welding.

Install ductwork without forming dips, sag or traps, which might collect residue. Verify pitch requirements of the applicable code. Show pitch direction arrow on plans. Pitch horizontal ducts in accordance with Code requirement.

Provide access doors at minimum spacing of 20 feet on center for horizontal ducts and at each change in direction. Provide residue trap at base of each vertical riser with provisions for cleanout. Locate access doors on side of duct and not less than 1-1/2 inches from bottom of duct. Size access doors as large as possible to allow inspection and cleaning, however, doors larger than 24 inches in any dimension are not required. Construct access doors and residue traps of the same material and thickness as duct and grease-tight when in place. Make fire protection enclosure removable at each access door and clean-out.

3.3.16 Bath Or Shower Exhaust Duct Construction

Use G90 galvanized steel duct for bathrooms or shower rooms with only one shower head. Seal galvanized steel duct per pressure class requirements.

Use aluminum duct where indicated on drawings or as specified below, with joints and seams sealed with duct sealant or welded for water tightness for exhaust from bath or shower rooms if they contain more than one bath tub or more than one shower head. Aluminum duct shall extend from individual exhaust grilles to exhaust main. Fabricate exhaust fan discharge ductwork of aluminum or galvanized steel.

Seal or weld aluminum exhaust duct for water tightness.

3.3.17 DISHWASHER EXHAUST DUCT CONSTRUCTION

Above ceilings and to end of system, use 18 ga or heavier 304 stainless steel sheet with joints and seams butt-welded or soldered watertight.

Below ceilings and exposed in dishwashing area, use 18 ga or heavier 304 stainless steel sheet with externally welded, ground and polished joints and seams.

Use fittings, reinforcement, supports, etc., as specified for low pressure duct construction.

3.4 FIELD QUALITY CONTROL

3.4.1 Fire Damper Tests

Perform operational tests on each fire damper in the presence of the Contracting Officer by enervating fusible link with localized heat. Provide new links and install after successful testing.

3.4.2 Ductwork Leakage Tests

Contractor shall conduct complete leakage test of new ductwork in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and the Duct Pressure Class, Material and Leakage schedule in the mechanical drawings. Tests shall be performed prior to installing ductwork insulation.

3.4.2.1 Ductwork Leakage Tests for Welded Ducts

Welded ductwork shall be air and watertight and shall have no air leakage with allowance stated below:

a. When using test apparatus and procedure described in SMACNA HVAC Air Duct Leakage Test Manual, 1st Edition, Chapter 5 (modified for negative pressure), the following losses can be expected during testing and are acceptable:

(1) 1 cfm per 1 inch WG of static pressure is allowed for the test equipment and test connections (e.g. 3 CFM when testing at 3 inches WG).

(2) 0.10 cfm per inch of diameter of temporary caps, regardless of pressure (e.g. 1 cfm for a cap on 10 inches diameter duct).

b. To the extent possible, walk and observe welded ductwork under test to check for cracked or hissing welds. All leaks in welded sections of ductwork shall be reported to the Contracting Officer and repaired by welding. No caulking or sealing is allowed.

3.4.3 Damper Acceptance Test

Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Test each fire damper equipped with fusible link by having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with

the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.

3.4.4 Inspection

Ductwork shall be inspected in accordance with SMACNA 1987.

3.5 DUCTWORK CLEANING PROVISIONS

Open ducting shall be protected from construction dust and debris in a manner approved by the Contracting Officer. Protect ductwork during construction against entry of foreign matter and construction dirt. Keep ductwork capped when work is complete for the day or when duct is not being worked on or added to. Use of polyvinyl (VISQUEEN) with duct tape wrap is an adequate measure as long as it is secure with no openings or tears in product. Dirty assembled ducting shall be cleaned by subjecting all main and branch interior surfaces to airstreams moving at velocities two times specified working velocities, at static pressures within maximum ratings. This may be accomplished by: filter-equipped portable blowers which remain the Contractor's property; wheel-mounted, compressed-air operated perimeter lances which direct the compressed air and which are pulled in the direction of normal airflow; and other means approved by the Contracting Officer. Compressed air used for cleaning ducting shall be water- and oil- free. After construction is complete, and prior to acceptance of the work, construction dust and debris shall be removed from exterior surfaces. SMACNA 1987. Return fans are not allowed to operate during construction to avoid intake of construction dirt/dust into return air ductwork

3.6 FLEXIBLE DUCT

Install flexible ducts in accordance with manufacturer's installation instructions and SMACNA Standards, except as modified in this Section of Specifications.

In supply air systems without air terminal devices, flexible ducts may be used for final connections to diffusers, grilles, and registers. Flexible ducts shall be of minimum length required to make connections, but shall not be greater than 6 ft in length, unless noted otherwise.

In supply air systems with air terminal devices, flexible ducts shall be used for duct connections to diffusers, grilles, and registers for sound attenuation purposes, except above non-accessible ceilings. Flexible ducts shall be minimum 6 ft long and maximum 8 feet long.

In return and general exhaust air systems without air terminal devices, flexible ducts shall be used for final connections to return grilles and registers and general exhaust grille and registers for sound attenuation purposes, except above non-accessible ceilings. Flexible ducts shall be minimum 6 feet long and maximum 8 feet long.

In return and general exhaust air systems with air terminal devices, flexible ducts shall be used for duct connections to grilles and registers for sound attenuation purposes, except above non-accessible ceilings. Flexible ducts shall be minimum 6 ft long and maximum 8 ft long.

Centerline radius of bends shall not be less than one duct diameters.

Support flexible ductwork at a maximum of 3 feet on center and at elbow, with no portion lying on ceiling supporting system.

Individual sections of flexible ductwork shall be of one-piece construction. Splicing of short sections is not allowed.

Connect flexible duct liner to collars with draw bands. If collars have beads, position draw bands behind beads.

Pull insulation and vapor barrier jacket over liner connection and secure with draw band. For terminations at externally insulated ductwork, fittings, grilles, diffusers, etc., secure flexible duct jacket to ductwork insulation jacket with compatible vapor barrier tape.

Flexible ducts are not allowed above non-accessible ceilings.

Flexible ducts are not allowed in high pressure ductwork.

Flexible ducts are not allowed for special exhaust systems, such as fume hood exhaust, shower room exhaust, kitchen hood exhaust, dishwasher exhaust, etc.

Flexible ducts are not allowed to pass through any partition, wall, floor or ceiling.

3.7 Instrument Test Holes

Provide instrument test holes at air entering and air leaving side of all internal air handling system components and sections for static pressure differential (Delta P) or temperature differential (Delta T) measurements.

Provide ductwork instrument test holes as shown on drawings, or as directed by TAB personnel, or Engineer.

3.8 Barrier Security Grilles

Install the assemblies where shown in the design drawings. Coordinate the installation with the construction of the barrier wall and the associated ductwork.

Provide a duct access door on the inside of the security perimeter to allow visual inspection of the bars or grille at each installation.

3.9 OPERATION AND MAINTENANCE

Contractor shall submit 6 copies of the operation and maintenance manuals 30 calendar days prior to testing the medium/high pressure ductwork systems. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

-- End of Section --

SECTION 23 36 00.00 40

AIR TERMINAL UNITS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR DIFFUSION COUNCIL (ADC)

ADC Standards Manual	(5th Edition) Flexible Duct Performance Installation Standards

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 880	(2011) Performance Rating of Air Terminals

ASTM INTERNATIONAL (ASTM)

ASTM C665	(2012) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 181	(2005; Reprint Oct 2008) Factory-Made Air Ducts and Air Connectors
UL 486A-486B	(2003; Reprint Feb 2010) Wire Connectors

1.1.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Records of Existing Conditions

SD-02 Shop Drawings

Variable Volume Single-Duct Supply Air Terminal Units

Variable Volume Exhaust Or Outside Air Terminal Devices

Record Drawings; G

SD-03 Product Data

Variable Volume Single-Duct Supply Air Terminal Units; G

Variable Volume Exhaust Or Outside Air Terminal Devices; G

Spare Parts

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.3 GENERAL REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Submit itemized lists for all materials, equipment, and fixtures to be incorporated in the work 30 days prior to commencement of work. Lists must include manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. Submit product data for each type of air terminal unit indicated, including rated capacities, furnished specialties, sound-power ratings, and accessories:

a. Variable Volume Single-Duct Supply Air Terminal Units

Submit records of existing conditions consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes acceptance of existing conditions.

Submit shop drawings which detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished. Include wiring diagrams to show power, signal, and control wiring.

Provide units with the configuration, capacity, and static-pressure characteristics indicated.

Ensure dimensional data stated constitutes nominal sizing, which has been adjusted by the manufacturer when necessary to accommodate acoustic material thickness.

Ensure units proposed are identical to units having at least 2 years of proven satisfactory field service.

Provide certification that units and spare parts are ADC Standards Manual tested and rated.

1.4 QUALITY ASSURANCE

Indicate drawings size, profiles, and dimensional requirements of air terminal units which are based on the specific system indicated.

Conform to NFPA 70, Article 100 for electrical components, devices, and accessories: List and label as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

Ensure Air Terminals are certified under the AHRI 880 Certification Program and carry the ARI Seal.

Install air terminals units according to NFPA 90A.

1.5 COORDINATION

Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, communication and security systems, and partition assemblies.

PART 2 PRODUCTS

2.1 VARIABLE VOLUME SINGLE-DUCT Supply AIR TERMINAL UNITS

2.1.1 Design Criteria

Where any of air terminal devices are indicated on drawings to control space conditions in conjunction with reheat coil, that reheat coil may be furnished as integral part of or standard accessory to devices specified below.

When air terminal devices are furnished with reheat coils, either integrally or remotely mounted, control panels of terminal devices shall be mounted on the same side of air terminal device as reheat coil piping connection or electric reheat coil control panel.

Unless otherwise stated, units shall be system pressure independent and maintain air volume within ± 5% of required airflow regardless of system air pressure. Inlet velocity pressure sensor shall be multi-point center averaging type and be capable of amplifying pressure signals.

Unless otherwise stated, unit casings shall be constructed of galvanized steel or aluminum meeting SMACNA or ASHRAE Standards, but not lighter than 22 ga.

Joints and seams of air terminal devices shall be sealed with appropriate sealant to minimize casing air leakage. Seal joints and seams not factory sealed in field as specified.

Unit performance shall be certified in accordance with AHRI Standard 880 including sound rating data certified for both casing discharge and

radiated sound levels from 125 through 4000 Hz.

Supply air units shall be capable of operating from minimum inlet static pressure scheduled to 3" WG.

Air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3" WG inlet pressure.

Casing leakage rates shall not exceed the following maximum values:

Unit Size	0.5" Ps	1.0" Ps
4, 5, 6	2	3
7, 8	2	3
9, 10	2	3
12	2	3
14	2	3
16	2	3

Provide supply air units with internal thermal insulation faced with minimum 0.001" thick aluminum foil. Insulation shall be compressed glass fiber with minimum 3/4" thick, 4 lb/ft3 density with R-value of 3.5. Insulation and facing shall meet requirements of UL 181 (Air Erosion, Mold growth and Humidity), and NFPA 90A (Flame 25/Smoke 50) and ASTM C665 (Fungi Resistance). Secure liner with full-seam-length, galvanized steel angles or Z-strips, which enclose and seal all edges. Tape or adhesive will not be acceptable. Liner assembly shall be similar to Titus Steri-Loc.

Provide each supply air terminal with an extended section sound attenuator.

Additional sound attenuators, where specified or required to meet sound performance specified for air terminal devices, shall be constructed of all metal or sound attenuating fiber material with erosion protection liner as required to meet sound requirement specified.

Analyze sound of VAV boxes carefully toward the desired NC level in the spaces.

Unit manufacturer or manufacturer's designated representative will be required to verify air terminal device performance and adjust or replace device within warranty period when it is determined that problem exists in area served by device.

Room sound levels due to discharge and/or casing radiation from units when operating from minimum pressure scheduled to 2" WG inlet static pressure shall not exceed noise criteria (NC) values in any spaces as indicated below. If units exceed sound level specified, provide terminal sound attenuators to comply with the noise criteria stated below.

Type of Room	Noise Criteria (NC)
Offices and All spaces unless otherwise indicated	35
Computer Rooms	40
Libraries and Conference Rooms	30

2.1.2 Controls Coordination

Unit manufacturer shall provide unit inlet flow sensor, pneumatic tubing and control enclosure for Control Contractor's use.

Control Contractor shall furnish all actuators, linkages if required, differential pressure transmitters, controllers and any other devices required for unit control that are not provided by unit manufacturer for unit manufacturer's factory mounting. Unit manufacturer and Control Contractor shall coordinate for proper factory installation.

Unit manufacturer shall factory install devices furnished by Control Contractor to result in complete functioning unit. Unit manufacturer shall be responsible for reviewing compatibility of devices furnished by Control Contractor with units being provided.

Unit manufacturer shall perform preliminary calibration based on scheduled airflow rates.

Control Contractor shall be responsible for calibrating actuators and controllers through TAB work for scheduled airflow rates.

Control Contractor's field mounting will be acceptable, provided Control Contractor coordinates proper installation with unit manufacturer. Control Contractor shall be responsible for complete functioning unit.

2.1.3 Product Information

Manufacturers: Titus, Price, Krueger, Enviro-Tec (ETI), Nailor, Trane, JCI or Carrier. Units shall be similar to Price Model SDV.

Units shall be suitable for 24 V electric control system. Control Contractor shall be responsible for wiring from control panels to each terminal unit.

Furnish units with reheat coils having capacities as indicated in schedules.

Provide access doors for all air terminal devices with reheat coils at inlet side of coils. for access doors. Unit manufacturer's standard access doors are acceptable, provided that access doors are appropriately sized and internally lined with same materials as unit casing. If access doors are provided in separate sections as extension of units, these sections shall be internally lined in same manner as units.

Provide access doors for all boxes with reheat coils at inlet side of coils.

Refer to specification section 23 82 00.00 20 TERMINAL HEATING AND COOLING UNITS for electric reheat coil specifications.

2.1.4 Variable Volume Exhaust Or Outside Air Terminal Devices

Units shall be suitable for 24 V electric control system. Control Contractor shall be responsible for wiring from control panels to each terminal unit. Units shall be similar to Price Model SDV.

Units shall be capable of modulating to full closed position with maximum leakage of 1%.

Unit casing shall be minimum 22 ga galvanized steel unless otherwise specified.

Casing leakage shall not exceed 3 cfm for inlet sizes 8 and smaller and 5 cfm for inlet sizes 9 and larger at 1.5" WG differential static pressure.

Damper shall be heavy gauge steel. Shaft shall be steel with bronze iolite self-lubricating bearings. Damper shall incorporate mechanical stop to prevent overstroking and synthetic seal to limit close-off leakage to 4 cfm at 1.5" WG differential pressure.

Units shall not be provide with the extended length sound attenuator section.

Unit shall incorporate multi-point, center averaging velocity sensor. Sensor shall provide signal measurable by controller at inlet velocities of 500 fpm. Sensor shall provide control signal accuracy of ±5%, with the same size inlet duct at any inlet condition.

2.2 SOURCE QUALITY CONTROL

2.2.1 Identification

Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

2.2.2 Verification of Performance

Rate air terminal units according to AHRI 880.

PART 3 EXECUTION

3.1 INSTALLATION

Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

Install units as shown on drawings, mechanical drawing details and according to manufacturer's installation instructions.

Install units with sufficient service space to unit control, actuators and access panels.

Seal joints and seams of units not factory sealed to meet allowable leakage rate specified for low pressure ductwork.

Provide minimum length of 3 times box inlet diameter of straight rigid duct at box inlet.

Use only removable (Ductmate Quick-Sleeve or approved equal) drawbands to connect the terminal inlets to the supply, return, exhaust or outside air ducts as shown in the mechanical drawing details; permanent duct connections to the terminal inlet will not be allowed. The drawband inlet connection must removeable to allow terminal cleaning and maintenance.

Provide a removable access door at the duct connection adjacent to the air flow sensor on all exhaust, return or outside air VAV terminal boxes for the inspection and cleaning of the air flow sensor.

Provide access doors for terminal devices with reheat coils at inlet side of coils.

Provide access panels compatible with ceiling for all units located above non-accessible ceilings.

3.2 CONNECTIONS

Connect ducts to air terminal units.

Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.3 OPERATION AND MAINTENANCE

Submit 6 copies of the operation and maintenance manuals 30 calendar days prior to testing the following items. Data must be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion. Concurrently, submit record drawings providing current factual information, including deviations and amendments to the drawings, and concealed and visible changes in the work.

3.4 FIELD QUALITY CONTROL

Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

Perform the following field tests and inspections and prepare test reports.

After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

3.4.1 Operational Test

After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

Engage a factory-authorized service representative to perform startup service.

Complete installation and startup checks according to manufacturer's written instructions and do the following:

a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.

b. Verify that controls and control enclosure are accessible.

c. Verify that control connections are complete.

d. Verify that nameplate and identification tag are visible.

e. Verify that controls respond to inputs as specified.

3.6 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

-- End of Section --

SECTION 23 37 13.00 40

DIFFUSERS, REGISTERS, AND GRILLS
05/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 113	(2009) Method of Testing for Room Air Diffusion
ASHRAE EQUIP IP HDBK	(2008; Errata 1 2010) Handbook, HVAC Systems and Equipment (IP Edition)
ASHRAE FUN IP	(2009; Errata 2010) Fundamentals Handbook, I-P Edition

1.2 GENERAL REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

1.2.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.3 PERFORMANCE REQUIREMENTS

Certify air diffusion devices having been tested and rated in accordance with ASHRAE EQUIP IP HDBK, Chapter 17; ASHRAE FUN IP, Chapter 31; and ASHRAE 113, where such certification is required.

Submit equipment and performance data for air-diffusion devices consisting of sound data in terms of Noise Criteria (NC) index for the capacity range of the device with sound data in terms of sound-power level in octave bands second through eighth and Noise Criteria (NC) index for the capacity range of the device. Where space or sound data are not specified or indicated, assume NC35.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL

PROCEDURES:

SD-01 Preconstruction Submittals

Submit the following in accordance with this section.

Material, Equipment, and Fixture Lists; G

SD-02 Shop Drawings

Submit Fabrication Drawings for air-diffusion devices in accordance with this section.

Submit Installation Drawings; G for air-diffusion devices in accordance with the paragraph entitled, "Installation," of this section.

SD-03 Product Data

Submit Equipment and Performance Data; G for air-diffusion devices in accordance with paragraph entitled, "Performance Requirements," of this section.

SD-04 Samples

Submit Manufacturer's Standard Color Chart; G in accordance with this section.

SD-10 Operation and Maintenance Data

Provide manuals for the following air-diffusion devices:

PART 2 PRODUCTS

2.1 AIR-DIFFUSION DEVICE CONSTRUCTION

Preclude flutter, rattle, or vibration on air-diffusion device construction and mounting. Refer to Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for vibration isolation considerations. Modify devices and provide accessories necessary for mounting in indicated surface construction.

Select color from manufacturer's standard color chart which indicate the manufacturer's standard color selections and finishes for air-diffusion devices.

Provide color as indicated on drawings.

Include within the material, equipment, and fixture lists the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Submit fabrication drawings for air-diffusion devices consisting of fabrication and assembly details to be performed in the factory.

Diffusers shall be aluminum or steel as scheduled, unless otherwise indicated, and furnished with frame type appropriate to installation.

Diffuser models, sizes and finishes shall be as shown on drawings and/or

as scheduled. Unless noted otherwise, diffusers shall have a powder coat finish.

Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

2.2 TYPES OF AIR-DIFFUSION DEVICES

2.2.1 Type CD-2

Provide type CD-2 supply diffuser, round with three expanding cones to provide discharge air paths fully adjustable for horizontal or vertical discharge. Provide a powder coat finish (Price RCDA, basis of design).

2.2.2 Type LD-1 and Type LG-1

Provide type LD-1 supply diffuser and LG-1 return grille, linear slot type, extruded aluminum construction. Supply diffusers shall have fully adjustable integral air pattern and volume control vanes that deflect air pattern from horizontal along ceiling to straight down, or any intermediate setting and a pattern control element that permits complete blanking-off of slot. Provide matching return grilles without pattern controllers. Provide a factory fabricated, externally-insulated plenum that is also designed to accommodate the connection to hard ducts and flexible ducts. (Price SDS supply, and Price SDR return, basis of design)

Slot width: 3/4 inch.

Provide number of slots per unit run as scheduled.

Align butts in continuous runs for hairline joints.

Provide end caps where slot terminates.

Provide exposed-to-view part of frame with aluminum white powder finish, and all interior exposed-to-view components with a black matte finish.

2.2.3 Type CD-1

Provide type CD-1 supply diffuser, square with four expanding flared members to provide radically diffused discharge air. Arrange flared members to provide a minimum of four air paths which simultaneously diffuse air at 20 to 50 fpm. Include pattern adjustments horizontal, vertical projection, and an intermediate position or range. (Price SCDA, basis of design).

Provide a powder coat finish.

2.2.4 Type SG-1

Provide type SG-1 supply grill double deflection type with adjustable face bars parallel to short dimension and adjustable rear bars parallel to long dimension. (Price 520, basis of design)

Provide a powder coat finish.

Provide integral extended surface to fit into module of lay-in ceiling.

2.2.5 Type G-1 and G-3

Provide type G-1 and G-3 return or exhaust grills, single deflection type with fixed face bars for ceiling or sidewall installation, refer to schedules.

Provide grills with face bars set at 45 degrees.

Steel construction.

Provide a powder coat finish.

Provide integral extended surface to fit into module of lay-in ceiling where required. (Price 530, basis of design).

2.2.6 Type G-2

Provide type G-2 return or exhaust grills, single deflection type with fixed face bars for ceiling or sidewall installation, refer to schedules.

Provide grills with face bars set at 45 degrees.

Aluminum construction.

Provide a powder coat finish.

Provide integral extended surface to fit into module of lay-in ceiling where required. (Price 630, basis of design).

2.2.6.1 Wire Mesh Grilles

Grilles shall be furnished with 2 by 2 mesh (1/2 inch by 1/2 inch) galvanized steel or aluminum hardware cloth that is mounted in a spot welded galvanized steel frame with a minimum 1-1/2 inch width around the entire grille perimeter.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment as indicated and specified and in accordance with manufacturer's recommendations.

Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar sizes. Where diffuser or grille has square neck, provide round-to-square duct transition to allow connection of flexible duct.

Seal connections between ductwork drops and diffusers/registers/grilles air tight.

Blank off unused portion of linear diffusers and grilles.

Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

Protect diffusers, registers and grilles from construction dirt. Clean or replace those soiled or stained prior to turnover to Client.

Submit installation drawings for air-diffusion devices. Indicate on drawings overall physical features, dimensions, ratings, service requirements, and equipment weights.

3.1.1 Operations and Maintenance Manuals

Provide operation and maintenance manuals consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

-- End of Section --

SECTION 23 41 13.00 40

PANEL FILTERS
05/10

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

Provide panel filters complete with all components and accessory equipment as specified in this section.

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Submit Manufacturer's Catalog Data, including physical characteristics and performance data for panel filters.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2007; Addenda B 2008; Errata 2009, Errata 2010; INT 2010; Errata 2011) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM D92	(2012) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-F-29177	(1985; Rev A; CANC Notice 1) Filter, Air-Extended Area, Initial Installation
MIL-STD-282	(2012a - Controlled Distribution Document) Filter Units, Protective Clothing, Gas-Mask Components and Related Products: Performance-Test Methods

UNDERWRITERS LABORATORIES (UL)

UL 900	(2004; Reprint Feb 2012) Standard for Air Filter Units

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Installation Drawings; G in accordance with the paragraph entitled, "Holding Frame Installation", of this section.

SD-03 Product Data

Submit Physical Characteristics; G and Performance Data; G for air filters in accordance with paragraph entitled, "General Requirements", of this section.

Submit Manufacturer's catalog data for the following items:

Air Filters; (LEED NC); G

Filter Gages; G

Manometers; G

SD-06 Test Reports

Submit Test Reports; G for air filters in accordance with paragraph entitled, "Tests", of this section.

SD-07 Certificates

Submit certificates for the following items showing conformance with the reference standards contained in this section.

Air Filters; G

Filter Gages; G

Manometers; G

1.4 GENERAL REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Submit physical characteristics information and performance data for air filters consisting of use life, system functional flows, safety features, and mechanical automated details. Also submit curves indicating tested and certified equipment responses and performance characteristics.

1.4.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the products specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

PART 2 PRODUCTS

2.1 FILTERS

Provide air filters with a net effective filtering area and a face area to provide the required airflow at the indicated initial pressure-drop as shown in the Filter and Filter Housing Schedule in the mechanical drawings.

Provide sufficient clearance for maintenance and operation in and around filter assembly.

Construct filter-holding frames of extruded aluminum type 300 corrosion-resistant steel or corrosion-resistant coated 16-gage (minimum) steel with not less than 16-gage galvanized carbon steel conforming to ASTM A653/A653M with not less than 1.25 ounces of zinc per square foot of two-sided surface . Provide frame assemblies and fasteners of corrosion-resistant type 300 steel to preclude surface degradation.

Make viscous-impingement framed panel filter gaskets from a material inert to filter impregnates, with a minimum thickness after compression of 1/8 inch.

Provide dry filter gaskets of closed-cell foamed neoprene or urethane elastomer of sufficient hardness to compress to not more than 40 percent of original thickness when filter is in position.

2.1.1 Filters, Disposable Type

Listed below is the minimum acceptable performance for the air filter:

DIMENSIONS (INCHES)	INITIAL RESISTANCE (INCH WG)	ARRESTANCE (PERCENT)	DUST-HOLDING CAPACITY (GM/SQ FT)
14 by 20 by 1	0.04	65	145
16 by 20 by 1	0.04	65	145
16 by 25 by 1	0.04	65	145
20 by 20 by 1	0.04	65	145
20 by 25 by 1	0.04	65	145
16 by 20 by 2	0.08	75	190
16 by 25 by 2	0.08	75	190
20 by 20	0.08	75	190

DIMENSIONS (INCHES)	INITIAL RESISTANCE (INCH WG)	ARRESTANCE (PERCENT)	DUST-HOLDING CAPACITY (GM/SQ FT)
by 2			
20 by 25 by 2	0.08	75	190

For all sizes of filters, ensure the final resistance value is 0.50 inch, with air volume of 1,200 cubic feet per minute, and airflow velocity of 300 feet per minute.

2.1.2 Filters, Replaceable Type

Provide filters conforming to MIL-F-29177, Type I or Type II. Base filter efficiency on ASHRAE 52.2. Efficiency, by definition, is dust-spot efficiency using atmospheric dust. Arrestance is weight efficiency using test dust. Provide type III filter arrestance efficiencies in accordance with MIL-STD-282 DOP test.

Provide each air filter with a permanent corrosion-resistant holding frame and a replaceable factory-assembled filter element. Supply permanent holding frame with suitable gaskets designed to maintain a positive pressure seal between the frame and the filter element(s).

Design and construct air filters to facilitate field maintenance. Make adjustments and ensure replaceable accessories are readily accessible. Conditions which may be hazardous to personnel or deleterious to equipment is not permitted.

Provide antiallergenic and nontoxic filter element, with no detectable odor, which have no adverse effect on the health of personnel handling or served by the filter element.

Use adhesive coatings on filters with a flashpoint of not less than 325 degrees F conforming to ASTM D92.

Provide Type I, Grade A filters with 30 percent (MERV 7) commercially rated efficiency conforming to UL 900, Class 2, and requirements specified herein. Provide filters, when operated at rated capacity of cfm, have an initial pressure drop of not more than 0.3inch wg, and final pressure drop not exceeding 0.6 inch wg at 500 FPM. Ensure filter initial efficiency is not less than 20 percent, and the average efficiency not less than 25 percent. Verify dust-holding capacity (grams per square foot), at a rated air flow (cubic feet per minute) is not less than 600 at 1,500 , respectively.

Provide Type I, Grade B filter with 40 percent (MERV 8) commercially rated efficiency conforming to UL 900, Class 2, and requirements specified herein. Provide filters, which when operated at rated capacity of cfm, have an initial pressure drop of not more than 0.3 inch wg and final pressure drop not exceeding 0.6inch wg at 500 FPM. Ensure filter initial efficiency is not less than 20 percent, and the average efficiency not less than 35 percent, with dust-holding capacity (grams per square foot), at a rated air flow (cubic feet per minute) of not less than 500 at 1,500 , respectively.

Provide Type II, Grade C filter with 85 percent (MERV 13) commercially

rated efficiency minimum of 58 percent per ASHRAE 52.2 using atmospheric dust conforming to UL 900, Class 2 or Class 1 and requirements specified herein. Provide filters, when operated at rated capacity of cfm, having an initial pressure drop of not more than 0.4 inch wg, and final pressure drop not exceeding 0.8 inch wg, with initial filter efficiency of not less than 58 percent, and an average efficiency not less than 76 percent. Verify dust-holding capacity (grams per square foot), at a rated air flow (cubic feet per minute) is not less than 300 at 1,500 , respectively.

Provide Type II, Grade D filter with 95 percent (MERV 14) commercially rated efficiency minimum of 78 percent per ASHRAE 52.2 using atmospheric dust conforming to UL 900, Class 2 Class 1 and requirements specified herein. Provide filters, when operated at rated capacity of cfm, having an initial pressure drop of not more than 0.5 inch wg, and final pressure drop not exceeding 1.0 inch wg. Verify filter initial efficiency is not less than 80 percent, and the average efficiency not less than 90 percent, with dust-holding capacity (grams per square foot), at a rated air flow (cubic feet per minute) of not less than 220 at 1,500 , respectively.

2.2 FILTER GAGES AND MANOMETERS

Provide air-filter gages or manometers for each type filter assembly.

Provide dial-indicator type gages, graduated to read 0 to 2 inches wg, except that gages for HEPA filters are to read 0 to 3 inches wg. Provide manometers measuring from minus0.5 to 3 inches wg, equipped with a built-in indicator bubble. Connect gage or manometer to static-pressure ports of approved design and located so that resistance to airflow will be correctly indicated.

PART 3 EXECUTION

3.1 FILTER INSTALLATION

Coordinate filter supports and retention elements to provide a substantial, structurally sound, leakproof installation. Filters and filter frames when installed and under maximum flow operation provide shall seal completely filter to filter and filter to frame without allowing any filter bypass.

Provide all necessary filter gaskets and holding clips where required.

3.2 HOLDING FRAME INSTALLATION

Provide installation drawings in accordance with referenced standards in this section.

Gasket holding frames on perimeter, or caulked to each other, to supplementary steel, or to closures with elastomeric compounds recommended by the filter manufacturer. Prepare substrate in accordance with the elastomer manufacturer's instructions, including the priming of surfaces in areas where the elastomer is not confined.

3.3 TESTS

Submit test reports in accordance with ASHRAE 52.2.

-- End of Section --

SECTION 23 52 00

HEATING BOILERS
04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13/CSA 4.9	(2010; Addenda A 2010) Gas-Fired Low Pressure Steam and Hot Water Boilers

ASME INTERNATIONAL (ASME)

ASME B31.1	(2012; INT 2-6, 8-10, 13, 15, 17-25, 27-31 and 42-46) Power Piping
ASME BPVC SEC IV	(2010) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME CSD-1	(2012) Control and Safety Devices for Automatically Fired Boilers

HYDRONICS INSTITUTE DIVISION OF GAMA (HYI)

HYI-005	(2004) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011; Errata 2012) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2012) National Fuel Gas Code
NFPA 85	(2011; Errata 2011) Boiler and Combustion Systems Hazards Code

UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir	(2011) Flammable and Combustible Liquids and Gases Equipment Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Materials and Equipment; G
Energy Star; G
Manufacturer's name and model number
Capacities / ratings
Dimensions and weights
Temperature and pressure ratings
ASME Construction and Stamp
Wiring Diagrams
Manufacturer's installation instructions
Spare Parts; G
Water Treatment System; G
Boiler Water Treatment; G
Heating System Tests; G
Fuel System Tests; G
Welding; G
Qualifications; G
Field Instructions; G
Tests; G

SD-06 Test Reports

Heating System Tests; G
Fuel System Tests; G
Water Treatment Testing; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions; G
Water Treatment System; G

1.3 QUALITY ASSURANCE

WELDING: Submit a copy of qualified welding procedures and a list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations. Boilers and piping shall be welded and brazed in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests, and the tests shall be performed at the work site if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made as a permanent record.

Manufacturer shall provide services of factory trained field representative to approve installation; start-up, test and adjust for

proper operation; and instruct and train Owner's representative in operation and maintenance of equipment.

Upon completion of this service, submit complete report, signed by manufacturer's service representative, including start-up and test log.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and no later than 2 months prior to the date of beneficial occupancy. Submit Detail Drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of guides and anchors, the load imposed on each support or anchor (not required for radiant floor tubing), and typical support details. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function as a unit and to show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

1.6 COORDINATION

Design and drawings are based on one of acceptable manufacturers listed in this Specification. Where requirements of equipment provided differs from equipment on which design is based, this Contractor shall be responsible for coordinating requirements of equipment with other Contractors involved. This Contractor shall be responsible for any additional cost incurred due to such requirements

1.7 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a

service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Submit manufacturer's catalog data included with the detail drawings for the following:

a. Data showing model, size, options, etc., that are intended for consideration. Data submitted shall be adequate to demonstrate compliance with contract requirements. Data shall include manufacturer's written installation instructions and manufacturer's recommendations for operation and maintenance clearances for the following:

1) Boilers
3) Fuel Burning Equipment
4) Combustion Control Equipment
5) Pumps
6) Fittings and Accessories
8) Water Treatment System

2.1.2 Asbestos Prohibition

Asbestos and asbestos-containing products will not be allowed.

2.1.3 Nameplates

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number. Also, display an ENERGY STAR label as applicable. Each pressure vessel shall have an approved ASME stamp.

2.1.4 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS05 51 33 METAL LADDERS.

2.2 BOILERS

Each boiler shall have the output capacity in British thermal units per hour (Btuh) as indicated when fired with the specified fuels. The boiler shall be furnished complete with the gas burning equipment, boiler fittings and trim, automatic controls, forced draft fan, electrical wiring, insulation, piping connections, and protective jacket. The boiler shall be completely assembled and tested at the manufacturer's plant. Boiler auxiliaries including fans, motors, drives, and similar equipment shall be provided with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, the boiler safety devices shall not be sized for a 10 percent excess capacity. The boiler and its accessories shall be designed and installed to permit ready accessibility for operation, maintenance, and service. Boilers shall be designed, constructed, and equipped in accordance with ASME BPVC SEC IV. Each boiler shall be of the condensing type and designed for water service as specified herein. The boiler capacity shall

be based on the ratings shown in HYI-005 or as certified by the American Boiler Manufacturers Association, or American Gas Association.

2.2.1 Condensing Boiler

Each boiler shall be a self-contained packaged type, complete with accessories, mounted on a structural steel base or a steel base which is integral to the boiler shell. Each boiler shall conform to the commercial design used by the manufacturer and shall permit free thermal expansion without placing undue stress on any part of the boiler. Each boiler which experiences the formation of condensate within the flue gas shall be specifically designed for condensing application. Each boiler shall withstand the corrosive effects of condensate for each part which may be in contact with the condensate at all possible operating conditions. Each boiler shall be provided with a separate air intake, exhaust, and corrosion resistant condensate drain and condensate neutralization system. Each boiler shall be designed to withstand the water temperature differentials anticipated at the required operating conditions without experiencing any damage due to thermal shock. Near Condensing boilers are not allowed.

2.2.1.1 General

Provide packaged condensing type hot water boiler-burner units. Units shall be one of the following manufacturer's models with capacity and operating characteristics indicated on schedules.

Manufacturers: Aerco Benchmark, Lochinvar Crest AO Smith XP boilers. Near Condensing boilers are not allowed.

Furnish units complete with boiler, burner, forced draft fan, direct vented sidewall intake and vertical exhaust vent, combustion and safety controls, Lonworks BMS Gateway, wiring, insulated jacket, boiler trim, drain valve, condensate drain and neutralization accessories, and assembled on structural steel base frame. Unit shall be ready for connection to fuel, electrical sources, and water piping.

2.2.1.2 Boiler

Boilers shall be constructed and stamped in accordance with the latest ASME Code for 150 psig working pressure and must be inspected by Authorized Boiler Inspection Agency and registered with National Board.

Combustion chamber shall be sealed and completely closed with ceramic fiberboard insulation.

Boiler shall operate at minimum 93.7% thermal efficiency at 100 F return water temperature when fire tested at 100% of rated capacity and at a minimum of 95.4% thermal efficiency at 100 F return water temperature when fire tested at 20% of rated capacity.

The hot water heating boiler shall be capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity shall be the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency.

2.2.1.3 Burner

The boiler burner shall be capable of a minimum 20:1 turndown ratio of the firing rate without loss of combustion efficiency.

Factory mounted and constructed of stainless steel or ceramic.

Sealed combustion type suitable for firing natural gas. All fuel trains and controls shall conform to UL requirements, shall be designed in accordance with FM, GE GAP and IRI and be factory assembled, wired, mounted and tested.

Gas pressure at meter will be 14" WG. Unit manufacturer shall provide pressure regulators at burners to reduce pressure suitable to burner operation.

Fans conforming to AMCA 801 forced-draft shall be furnished as an integral part of boiler design. Each fan shall be sized for output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner, leakages, temperature, and elevation corrections for worst ambient conditions, all at full combustion to meet net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against a 20 percent static overpressure. Noise levels for fans shall not exceed 85 decibels in any octave band at a 3 foot station.

2.2.1.4 Emissions

1.1 Boiler burner shall produce NOX emissions level of no more than 20 mg/L(ppm) corrected to 3% O2. Boiler shall be designed to burn natural gas . Each boiler shall comply with Federal, state, and local emission regulations.

2.2.1.5 Electrical and Controls

Furnish unit with electrical entrance cabinet, NEMA 1A, to accept single service of 120 V, 1 Ph, 60 cycle power to accommodate motors and control circuit power. If manufacturer does not offer 120 V, 1 Ph system, provide all necessary electrical changes required for the alternate boiler voltage. Stepdown transformer shall be included to provide control circuit power. Furnish unit with control cabinet, NEMA 1A enclosure with lock and exterior resets for blower motor starter and flame failure.

Boiler controls shall comply with ASME CSD-1-2002.

Provide break-glass switches for mounting near each boiler room door, outside of boiler room. Switches shall be wired to provide emergency shutdown of both boiler-burner units, disconnect all power to the burner controls, and immediately shut off the fuel supply to the boilers. Provide all wiring, terminal blocks, dry contacts, and manually operated shutdown switches as required by ASME CSD-1.

Control cabinet to include magnetic motor starters with thermal overload protection, electronic flame safeguard, programming timer for pre-purge and post-purge, burner switch, control circuit switch and fuse, necessary switching relays, low water and flame failure alarm, manual automatic selector switch, indicating lights for major operations, numbered terminal strips, numbered wiring and engraved nameplates.

Controls shall include high limit (manual reset), operating limit (auto reset), frost control, high and low gas pressure switches, blocked condensate drain switch and combustion air switch.

Control to be interlocked to cause 100% automatic shut-off of fuel flow to burner in event of failure of electric power, burner flame, pilot flame, low water, combustion air, or any other condition, which might prove hazardous.

Furnish unit with all necessary controls for fully-modulated firing with proved low fire start.

Provide controls to restart automatically on emergency power or power restoration after power outage.

Provide digital communication Lonworks BMS Gateway for communications with the building automation system.

Furnish unit with lead-lag sequence control panel with selector switch, capable of controlling at least three boilers.

Control shall include assured low fire cutoff.

Furnish temperature sensor required for boiler capacity control and flow sensor required for lead-lag control.

A packaged boiler controller shall sequence lead-lag boilers in response to firing rate. The controller shall be capable of sequencing at least three boilers. Operating boilers shall be controlled to maintain supply water temperature setpoint of 120 degrees F (user-adjustable) and a 100 degrees F return water temperature. Boiler lead-lag controller shall operate as many boilers as necessary to meet load conditions. Boilers shall be staged on, operating in parallel to maintain hot water supply temperature setpoint. Each boiler shall be sequenced off/on and its associated isolation valve closed/open by the boiler controller. When the lead boiler reaches a firing rate of 80 percent (user-adjustable), controller shall lower its firing rate to 40 percent (user-adjustable) and turn on the next boiler at 40 percent (user-adjustable)firing rate. The two boilers shall then modulate at the same rate. As the load increases further and both boilers ramp up to a firing rate of 80 percent (user-adjustable), it lowers the firing rate of the first two boilers to 53 percent (user-adjustable) and brings the next boiler on at 53 percent (user-adjustable). The three boilers shall then modulate together. As the load decreases and the boilers reach a firing rate of 10 percent (user-adjustable), the last boiler shall turn off and the controller shall increase the firing rates of the remaining boilers to maintain a consistent total output.

The boiler controller shall also provide Data Logging of operating conditions (hours running, modulation rates, ignition attempts, and last 10 lockouts).

The boiler controls shall provide System Optimization Controls (night setback, anti-cycling, outdoor reset curve, ramp delay, boost temperature and time).

2.2.1.6 Insulation and Jacket

Furnish units with factory installed enameled steel jacket over 2 inches

thick fiberglass blanket.

2.2.1.7 Combustion Air Intake and Venting

Individual boilers air intake will be direct vented through the mechanical room sidewall as indicated with galvanized steel duct. Seal duct joints and seams with a silicone caulk approved for use in galvanized surfaces. Refer to mechanical details and specification section 23 31 13.00 40 METAL DUCTS for galvanized steel duct requirements. Provide the boiler manufacturer's inlet duct transition as required for the connection to the combustion air inlet.

Exhaust venting shall be through the roof above the boilers. Vent system shall be factory-built double wall type with minimum 5/32 inch air space between walls. Vent shall be listed by UL 1738/ULS S636 listed for continuous operation at 550 degree F. Inner pipe shall be AL-29-4C superferritic stainless steel in 0.015 inch minimum thickness for sizes through 12 inch ID and 0.024 inch minimum for sizes over 14 through 24 inch ID. Diameter of exhaust venting is shown in the mechanical plans.Outer jacket shall be Type 304 or Type 430 stainless steel, minimum 24 gauge thickness. The exhaust vent shall be sloped 1/4 inch/ ft toward the boiler's flue gas condensate collection point.

Provide stack system complete with all necessary accessories including flashing, counterflashing, storm collar, ventilated roof thimbles, fitting, cleanout and drain section, base anchor lugs and necessary supports.

Stack Vent Manufacturers: Metal-Fab, HeatFab, ProTech Systems or Schebler equal to HeatFab SAF-T Vent CI Plus.

Both the air intake and exhaust vents shall be sized and located as indicated on the drawings and as recommended by the boiler manufacturer. A separate combustion air intake vent and exhaust vent shall be provided for each boiler. A galvanized metal duct combustion air intake shall be connected between the boiler and the outdoors. The minimum sealed combustion air duct size for each boiler is shown in the mechanical duct plans with the final duct size and fittings selected to not exceed boiler vent pressure limits. Air ducts connecting the direct vent fan units with the plenum chamber shall be designed to convey air with a minimum of pressure loss due to friction. Ductwork shall be galvanized sheet metal conforming to ASTM A653/A653M. Ducts shall be straight and smooth on the inside with laps made in direction of air flow. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with operating temperatures up to 230 degrees F, positive pressure, condensing flue gas service. UL listed vents of Al 29-4C stainless steel must be used with boilers.

2.2.1.8 Boiler Trim (Each Boiler)

Furnish complete water trim including:

a. ASME Water Relief Valve set at 125 psi

b. Combustion pressure-temperature gauge

c. Operating temperature controls

d. High limit control

e. Low Water Cut Out - LWCO to be operationally testable

f. Stack thermometer

g. Air pressure switch

h. Water flow switch

i. High gas pressure switch

j. Low gas pressure switch

k. Blocked condensate drain switch

2.2.2 Modular Configuration

Modular boilers shall be of the condensing type. Modular boilers shall have the capability of independent operation. Upon failure of any module, the remaining modules shall be capable of operating at their designed capacity. The size of the individual modules shall be as indicated.

2.3 CONTROL EQUIPMENT

2.3.1 Electrical controls

Electrical control devices shall be rated at 120 volts and shall be connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.3.2 Water Temperature Controller

The controller shall be of sturdy construction and shall be protected against dust and dampness. The thermostatic element shall be inserted in a separable socket installed in the upper part of the boiler near the water outlet. Modulating controllers shall control the fuel burning equipment to maintain set boiler water temperature within 2 percent. Controller shall be furnished with necessary equipment to automatically adjust the setting to suit the outside weather conditions. The outside air reset controller shall be operated in such a manner that the operating temperatures required by the boiler manufacturer are not compromised.

2.3.3 Boiler Plant Master Controller

A boiler plant master controller, sensitive to a temperature transmitter in the return water header for the boiler shall be furnished to provide anticipatory signals to all boiler controllers. Boiler controllers shall react to anticipatory signals from the plant master controller as necessary in response to the boiler temperature indication to maintain the preset temperature . Automatic controls shall be provided to allow the sequence of boiler loading to be varied to distribute equal firing time on all boilers in the plant. The plant master controller shall load the boilers one at a time as the plant load increases.

2.3.4 Combustion Safety Controls and Equipment

Combustion safety controls and equipment shall be UL listed, microprocessor-based distributed process controller. The system shall include mounting hardware, wiring and cables, and associated equipment. The controller shall be mounted completely wired, programmed, debugged,

and tested to perform all of its functions. The controller shall process the signals for complete control and monitoring of the boiler. This shall include maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. The program shall be documented and include cross references in description of coils and contacts. Microprocessor shall be able to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Controllers for each boiler shall be mounted on a separate, free standing panel adjacent to the boiler or for packaged boilers on the boiler supporting structure. Control systems and safety devices for automatically fired boilers shall conform to ASME CSD-1. Electrical combustion and safety controls shall be rated at 120 volts, single phase, 60 Hz and shall be connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. A 4 inch diameter alarm bell shall be provided and shall be located where indicated or directed. The alarm bell shall ring when the boiler is shut down by any safety control or interlock. Indicating lights shall be provided on the control panel. A red light shall indicate flame failure, and a green light shall indicate that the main fuel valve is open. The following shutdown conditions shall require a manual reset before the boiler can automatically recycle:

a. Flame failure.

b. Failure to establish pilot flame.

c. Failure to establish main flame.

d. Low-water supplementary low-water cutoff.

e. High temperature cutoff .

2.3.4.1 Water Flow Interlock

Hot water boiler limit controls shall be provided to include protection for low boiler water flow and high boiler water temperature. The limit controls shall be interlocked with the combustion control system to effect boiler alarm and shutdown. The controls shall not allow boiler startup unless hot water flow is proven.

2.4 PUMPS

2.4.1 Hot Water and Boiler Circulating Pumps

Refer to section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.5 COLD WATER CONNECTIONS

Connections shall be provided which includes consecutively in line a strainer, reduced pressure principle backflow preventers, and water pressure regulator in that order in the direction of the flow. The reduced pressure principle backflow preventers shall be provided as indicated and in compliance with Section 22 00 00 PLUMBING, GENERAL PURPOSE. Cold water fill connections shall be made to the water supply system as indicated. Necessary pipe, fittings, and valves required for water connections between the boiler and cold water main shall be provided as shown. The pressure regulating valve shall be of a type that will not stick or allow pressure to build up on the low side. The valve shall be

set to maintain a terminal pressure of approximately, lately 5 psi in excess of the static head on the system and shall operate within a 2 psi tolerance regardless of cold water supply piping pressure and without objectionable noise under any condition of operation.

2.6 FITTINGS AND ACCESSORIES

Boiler fittings and accessories shall be installed with each boiler in accordance with ASME BPVC SEC IV, unless otherwise specified.

2.7 ELECTRICAL EQUIPMENT

Electric motor-driven equipment shall be provided complete with motors, motor starters, and necessary control devices. Electrical equipment, motor control devices, motor efficiencies and wiring shall be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motors which are not an integral part of a packaged boiler and which are integral in size shall be the premium efficiency type in accordance with NEMA MG 1. Motors which are an integral part of the packaged boiler shall be the highest efficiency available by the manufacturer of the packaged boiler. Motor starters shall be provided complete with properly sized thermal overload protections and other appurtenances necessary for the motor control specified. Starters shall be furnished in general purpose enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices but not shown shall be provided.

2.7.1 Motor Ratings

Motors shall be suitable for the voltage and frequency provided. Motors 1/2 hp and larger shall be three-phase, unless otherwise indicated. Motors shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating on the motor.

2.7.2 Motor Controls

Motor controllers shall be provided complete with properly sized thermal overload protection. Manual or automatic control and protective or signal devices required for the operation specified and any wiring required to such devices shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Solid state variable speed controllers shall be utilized for fractional through 10 hp ratings. Adjustable frequency drives shall be used for larger motors.

2.8 INSULATION

Shop and field-applied insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.9 BOILER WATER TREATMENT

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

3.2 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

Boiler and auxiliary equipment shall be installed in accordance with manufacturer's written instructions. Boiler supports shall permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. Boiler breeching shall be as indicated with full provision for expansion and contraction between all interconnected components, and for complete draining of internal condensate back to the stack drain.

The boiler manufacturer shall review the design of the boiler combustion air system and the exhaust venting system for each boiler and confirm within the boiler submittal documents that the boilers will function properly for the designs shown for combustion and exhaust venting.

3.3 PIPING INSTALLATION (REFER TO SECTION 23 64 26)

3.4 GAS FUEL SYSTEM

Gas piping, fittings, valves, regulators, tests, cleaning, and adjustments shall be in accordance with the Section 23 11 25 FACILITY GAS PIPING. Submit proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing. NFPA 54 shall be complied with unless otherwise specified. Burners, pilots, and all accessories shall be listed in UL Gas&Oil Dir. The fuel system shall be provided with a gas tight, manually operated, UL listed stop valve at the gas-supply connections, a gas strainer, a pressure regulator, pressure gauges, a burner-control valve, a safety shutoff valve suitable for size of burner and sequence of operation, and other components required for safe, efficient, and reliable operation as specified. Approved permanent and ready facilities to permit periodic valve leakage tests on the safety shutoff valve or valves shall be provided.

Pipe vents from gas train to atmosphere. Size of each vent shall not be less than connection size to device.

Install gas pressure gauges at downstream of gas pressure regulators.

3.5 COLOR CODE MARKING AND FIELD PAINTING

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS. Ferrous metal not specified to be coated at the factory shall be cleaned, prepared, and painted as specified in Section 09 90 00 PAINTS AND COATINGS. Exposed pipe covering shall be painted as specified in Section 09 90 00 PAINTS AND COATINGS. Aluminum sheath over insulation shall not be painted.

3.6 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified to supervise the installing, adjusting, and testing of the equipment.

3.7 TEST OF BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assemblies shall be tested in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.8 HEATING SYSTEM TESTS

Submit the Qualifications of the firms in charge of installation and testing as specified. Submit a statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section. Before any covering is installed on pipe or heating equipment, the entire heating system's piping, fittings, and terminal heating units shall be hydrostatically tested and proved tight at a pressure of 1.5 times the design working pressure, but not less than 100 psi. Submit proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

a. Before pressurizing system for test, items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure shall be blanked off or replaced with spool pieces.

b. Before balancing and final operating test, test blanks and spool pieces shall be removed; and protected instruments and equipment shall be reconnected. With equipment items protected, the system shall be pressurized to test pressure. Pressure shall be held for a period of time sufficient to inspect all welds, joints, and connections for leaks, but not less than 2 hours. No loss of pressure will be allowed. Leaks shall be repaired and repaired joints shall be retested.

c. System shall be drained and after instruments and equipment are reconnected, the system shall be refilled with service medium and maximum operating pressure applied. The pressure shall be held while inspecting these joints and connections for leaks. The leaks shall be repaired and the repaired joints retested.

Upon completion of hydrostatic tests and before acceptance of the installation, submit test reports for the heating system tests. Upon completion of testing complete with results, balance the heating system in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS and operating tests required to demonstrate satisfactory functional and operational efficiency. The operating test shall cover a period of at least 24 hours for each system, and shall include, as a minimum, the following specific information in a report, together with conclusions as to the adequacy of the system:

a. Certification of balancing.

b. Time, date, and duration of test.

c. Outside and inside dry bulb temperatures.

d. Temperature of hot water supply leaving boiler .

e. Temperature of heating return water from system at boiler inlet.

f. Quantity of water feed to boiler.

g. Boiler make, type, serial number, design pressure, and rated capacity.

h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.

i. Circulating pump make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.

j. Flue-gas temperature at boiler outlet.

k. Percent carbon dioxide in flue-gas.

l. Grade or type and calorific value of fuel.

m. Draft at boiler flue-gas exit.

n. Draft or pressure in furnace.

o. Quantity of water circulated.

p. Quantity of fuel consumed.

q. Stack emission pollutants concentration.

Indicating instruments shall be read at half-hour intervals unless otherwise directed. Furnish all instruments, equipment, and personnel required for the tests and balancing. Operating tests shall demonstrate that fuel burners and combustion and safety controls meet the requirements of ASME CSD-1, ANSI Z21.13/CSA 4.9, NFPA 85

3.8.1 Water Treatment Testing (REFER TO SECTION 23 25 00)

3.9 CLEANING

3.9.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, the piping system shall be thoroughly cleaned by filling the system with a solution consisting of either 1 pound of caustic soda or 1 pound of trisodium phosphate per 50 gallons of water. The proper safety precautions shall be observed in the handling and use of these chemicals. The water shall be heated to approximately 150 degrees F and the solution circulated in the system for a period of 48 hours. The system shall then be drained and thoroughly flushed out with fresh water. Strainers and valves shall be thoroughly cleaned. Prior to operating tests, air shall be removed from all water systems by operating the air vents.

After piping system has been flushed, clean and flush boilers using chemical and procedure as recommended by boiler manufacturer. Perform cleaning and flushing under supervision of boiler manufacturer's representative.

Manufacturer shall verify in writing that boilers have been cleaned according to their recommendations and are ready for operation.

Isolate boilers from piping system during boiler cleaning and flushing.

Pipe boiler drains to nearest floor drains.

3.10 FIELD TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests.

a. The field instructions shall cover all of the items contained in the approved operation and maintenance manuals, as well as demonstrations of routine maintenance operations and boiler safety devices.

b. Submit system layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, these items shall be posted where directed.

c. Submit six complete operation and maintenance instructions listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

d. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.11 FUEL SYSTEM TESTS

Submit test reports for the fuel system tests, upon completion of testing complete with results.

3.11.1 Gas System Test

The gas fuel system shall be tested in accordance with the test procedures outlined in NFPA 54.

-- End of Section --

SECTION 23 64 26

CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS
08/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(1999; Addenda A 2000, Addenda B 2001; R 2004) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2009) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2009) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2011) Specification for Filler Metals for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel
AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME B1.1	(2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2010) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.4	(2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250

ASME B16.11	(2011) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2012) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2012) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2011) Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.26	(2011) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.1	(2012; INT 2-6, 8-10, 13, 15, 17-25, 27-31 and 42-46) Power Piping
ASME B31.9	(2011) Building Services Piping
ASME B40.100	(2005; R 2010) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A105/A105M	(2011a) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A194/A194M	(2012) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A197/A197M	(2000; R 2011) Standard Specification for Cupola Malleable Iron
ASTM A234/A234M	(2011a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A307	(2012) Standard Specification for Carbon

	Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2003; R 2009e1) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B584	(2012a) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B32	(2008) Standard Specification for Solder Metal
ASTM B42	(2010) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75	(2002; R 2010) Standard Specification for Seamless Copper Tube
ASTM B813	(2010) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM D3308	(2006) PTFE Resin Skived Tape
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D596	(2001; R 2011) Reporting Results of Analysis of Water
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011) Standard Classification System for Nonmetallic Gasket Materials
ASTM F1199	(1988; R 2010) Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2008) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-25	(2008) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2011) Butterfly Valves
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2011) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2008) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2011; Errata 2012) Motors and Generators
NEMA MG 11	(1977; R 2007) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

1.2 SYSTEM DESCRIPTION

Provide the water systems having the minimum service (design) temperature-pressure rating indicated. Provision of the piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the required and advisory provisions of ASME B31.9 except as modified or supplemented by this specification section or design drawings. This specification section covers the water systems piping which is located within, on, and adjacent to building(s) within the building(s) 5 foot line.

1.2.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work and products specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Calibrated Balancing Valves; G

Automatic Flow Control Valves; G

Pump Discharge Valve; G

Water Temperature Mixing Valve; G

Water Temperature Regulating Valves; G

Water Pressure Reducing Valve; G

Pressure Relief Valve; G

Combination Pressure and Temperature Relief Valves; G

Flexible Expansion Loops; G

Pumps; G

Proposed pump submittal information to include, but not limited to the following:

a. Manufacturer's name and model number

b. Identification as referenced in the documents

c. Capacities/ratings

d. Pump curves with operating point clearly indicated. For parallel pump applications, indicate operating point of combined case as well as operating point of only one pump.

e. Motor data

f. Seals

g. Materials of construction

h. Dimensions and weights

i. Manufacturer's installation instructions

j. All other appropriate data.

Combination Strainer and Pump Suction Diffuser; G

Expansion Tanks; G

Air Separator Tanks; G

Heat Exchangers (Plate and Frame Type); G

Flushing and Cleaning of Piping Systems; G

Water Treatment Systems; G

Proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in paragraph "Water Analysis", a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

SD-06 Test Reports

Piping welds NDE report

Pressure tests reports; G

Report shall be provided in bound 8-1/2 by 11 inch booklets. In the reports, document all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results.

SD-07 Certificates

Employer's Record Documents (For Welding); G

Welding Procedures and Qualifications; G

SD-08 Manufacturer's Instructions

Lesson plan for the Instruction Course; G

SD-10 Operation and Maintenance Data

Requirements for data packages are specified Section 01 78 23

OPERATION AND MAINTENANCE DATA, except as supplemented and modified by this specification section.

Submit spare parts data for each different item of equipment specified, with operation and maintenance data packages. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Submit a list of qualified permanent service organizations with operation and maintenance data packages. Include service organization addresses and service area or expertise. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Water Treatment Systems; G

An operation manual in bound 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown. Include testing procedures used in determining water quality.

A maintenance manual in bound 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide.

Calibrated Balancing Valves, Data Package 3; G

Automatic Flow Control Valves, Data Package 3; G

Pump Discharge Valve, Data Package 2; G

Water Temperature Mixing Valve, Data Package 3; G

Water Temperature Regulating Valves, Data Package 3; G

Water Pressure Reducing Valve, Data Package 3; G

Pressure Relief Valve, Data Package 2; G

Combination Pressure and Temperature Relief Valves, Data Package 2; G

Flexible Expansion Loops, Data Package 2; G

Pumps, Data Package 3; G

Combination Strainer and Pump Suction Diffuser, Data Package 2; G

Expansion Tanks, Data Package 2; G

Air Separator Tanks, Data Package 2; G

Heat Exchangers (Plate and Frame Type); G

1.4 MODIFICATIONS TO REFERENCES

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

When used in this section, the term Chilled Water shall include medium temperature chilled water (Chilled Beam Water) as well as chilled water.

1.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.5 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter. Any porous materials found to be contaminated with mold or mildew will be replaced at the Contractor's expense. Non-porous materials found to be contaminated with mold or mildew will be disinfected and cleaned prior to installation.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any

discrepancy before performing any work.

1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.7.3 Accessibility

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

The two year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures.

Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. System components shall be environmentally suitable for the indicated locations.

The equipment items shall be supported by service organizations. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.2 STEEL PIPING

Water piping shall be steel pipe or copper tubing. Provide steel piping with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

2.2.1 Pipe

Steel pipe, conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

2.2.2 Fittings and End Connections (Joints)

Piping and fittings 1 inch and smaller shall have threaded connections.

Piping and fittings larger than 1 inch and smaller than 3 inches shall have either threaded, or welded connections. Piping and fittings 3 inches and larger shall have welded, or flanged connections. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

2.2.2.1 Threaded Connections

Use threaded valves and pipe connections conforming to ASME B1.20.1. Used threaded fitting conforming to ASME B16.3. Use threaded unions conforming to ASME B16.39. Use threaded pipe nipples conforming to ASTM A733.

2.2.2.2 Flanged Connections

Flanges shall conform to ASME B16.1, Class 150. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. These gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.1.

2.2.2.3 Welded Connections

Welded valves and pipe connections (both butt-welds and socket-welds types) shall conform to ASME B31.9. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11. Welded fittings shall be identified with the appropriate grade and marking symbol.

2.2.2.4 Dielectric Waterways and Flanges

Provide dielectric waterways with a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Provide dielectric waterways constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Provide dielectric flanges with the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

2.3 COPPER TUBING

Provide copper tubing and fittings with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

2.3.1 Tube

Use copper tube conforming to ASTM B88, Type L or M for aboveground tubing, and Type K for buried tubing.

2.3.2 Fittings and End Connections (Solder and Flared Joints)

Wrought copper and bronze solder joint pressure fittings, including unions ands flanges, shall conform to ASME B16.22 and ASTM B75. Provide adapters as required. Cast copper alloy solder-joint pressure fittings , including unions and flanges, shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and

ASTM B62. ASTM B42 copper pipe nipples with threaded end connections shall conform to ASTM B42.

Copper tubing of sizes larger than 4 inches shall have brazed joints.Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

Extracted brazed tee joints may be used if produced with an acceptable tool and installed in accordance with tool manufacturer's written procedures.

2.3.3 Solder

Provide solder in conformance with ASTM B32, grade Sb5, tin-antimony alloy. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

2.3.4 Brazing Filler Metal

Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.4 HEATING HOT WATER

2 inches and Smaller

Pipe: ASTM B88 seamless, Type L, hard temper copper tube

Fittings: ASME B16.22, wrought copper solder joint

Joint: ASTM B32, lead free solder, Bridgit, Silvabrite, Silverflow or Canfield

Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for line sizes 3/4 inch and smaller. Unions shall be used for line sizes over 1 inch.

Flanges: ASME B16.24, Class 150, cast copper alloy

Use solder joints for valves and piping specialties in copper piping

2-1/2 inches and Larger:

Pipe: ASTM A53/A53M, Grade B, Type E or S, standard weight, carbon steel

Fittings: ASTM A234/A234M Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld

Flanges: Class 150. Refer to Unions and Flanges in this Section

2.5 CHILLED WATER

2 inches and Smaller:

Pipe: ASTM B88 seamless, Type L, hard temper copper tube

Fittings: ASME B16.22, wrought copper solder joint

Joint: ASTM B32, lead free solder, Bridgit, Silvabrite, Silverflow or Canfield

Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for lines sizes 3/4 inch and smaller. Unions shall be used for line sizes over 1 inch.

Flanges: ASME B16.24, Class 150, cast copper alloy.

Use solder joints for valves and piping specialties in copper piping.

Contractor may use carbon steel as specified below in lieu of copper pipe for 2 inches and smaller:

Pipe: ASTM A53/A53M, Grade B, Type E or S, standard weight, carbon steel

Fittings: ASME B16.4, Class 125, cast iron, threaded or ASME B16.3, Class 150, malleable iron, threaded.

Unions: ASME B16.39, malleable iron, Class 250. Refer to Unions and Flanges in this Section

2-1/2 inches through 24 inches:

Pipe: ASTM A53/A53M, Grade B, Type E or S, standard weight, carbon steel

Fittings: ASTM A234/A234M Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld

Flanges: Class 150. Refer to Unions and Flanges in this Section

2.6 CHEMICAL TREATMENT

Closed Water System (Hot Water, Chilled Water, etc.):

Use pipe and fittings as indicated for the system to which chemical treatment piping is connected.

2.7 VENTS AND RELIEF VALVES

Use pipe and pipe fittings as indicated for the system to which relief valve or vent is connected.

2.8 PRESSURE GAUGES AND TAPPINGS

Use pipe and pipe fittings as indicated for the system to which pressure gauge or tapping is connected. Use "Threadolets", "Sockolets" or tee fittings for tappings.

2.9 COOLING COIL CONDENSATE DRAIN

Piping shall be:

Pipe: ASTM B88, Type M, hard temper copper tubing

Fittings: ASME B16.22 wrought copper fittings

Joint: ASTM B32, 95-5 tin-antimony solder, Bridgit or Silvabrite

2.10 DIELECTRIC UNIONS, FLANGES AND FITTINGS

Copper to Steel Pipe:

2 inches and Smaller: Use ball valves specified in this section for dielectric purpose.

ASTM A197/A197M/ASME B16.1, equal to Stockham Figure 693-1/2, Watts Series 3000 or Wilkins (Zurn) Model DU series dielectric unions with EPDM dielectric gasket, 250 psi at 180 degrees F.

Clearflow Dielectric Waterway fittings (Victaulic Style 47) may be used in lieu of dielectric unions for pipe sizes 2 inches and smaller.

a. Clearflow fittings shall be ASTM A53/A53M electro zinc-plated steel pipe with high temperature polyolefin polymer liner, suitable for continuous use at temperatures up to 230 degrees F and pressures up to 300 psig.

b. 2-1/2 inches and Larger: Watts dielectric flange fittings Series 3100/3110 with dielectric gasket, 175 psi at 210 degrees F.

c. Clearflow Dielectric Waterway fittings (Victaulic Style 47) may be used in lieu of dielectric unions for pipe sizes 2-1/2 inches and larger.

Steel to Steel Pipe:

(1 inch) and Smaller: Similar to Epco model HA-B with dielectric gasket, 1720 kPa(250 psi) at 210 degreesF 1-1/2 inch and Larger: Similar to Epco model W with bolt insulators, dielectric gasket, bolts and nuts, 175 psi at 210 degree F. Pikotek model VSC dielectric gasket with viton sealing element, G-10 sleeve and double washers, suitable to 350 degrees F, may be used with specified flange.

2.11 UNIONS AND FLANGES

2.11.1 Unions

2 inches and Smaller: Malleable iron, ASME B16.39 with ground joint, bronze or brass to iron. Provide black malleable iron for carbon steel piping and galvanized malleable iron for galvanized steel piping. Unless otherwise specified, pressure class and joint type of union shall be equal to that specified for fittings of respective piping service. Minimum pressure class of unions shall be Class 250.

(2 inches) and Smaller: Forged steel, ASTM A105/A105M Grade 2, ASME B16.11, 3000 lb WOG with steel to steel seats. Joint type shall match that specified for fittings of respective piping service.

2.11.2 Flanges

2-1/2 inches and Larger: ASTM A105/A105M, ASME B16.5, hot forged steel, welding neck pattern. Slip-on pattern are not allowed. Bore dimension of welding neck flange shall match inside diameter of connected pipe.

Use raised face flanges for mating with other raised face flanges with self-centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full face gaskets.

Flange pressure class indicated in respective piping service is minimum required. Mating flange pressure class shall match pressure class of connected device, such as valves and piping specialties.

2.11.3 Flange Gaskets

General - Gasket material shall be asbestos free and suitable for pressures, temperatures and fluid of respective piping system. Non-metallic gaskets shall be in accordance with ASME B16.21 and ASTM F104.

Service Temperature (through 249 degrees F) - Garlock, Klingersil or J.M. Clipper, similar to Garlock 5500. Gaskets similar to Garlock Style 3000 may be used for hydronic piping. Unless otherwise indicated or recommended by manufacturer, gaskets shall be compressed inorganic fiber with nitrile binder 1/16 inch thick for flanges 12 inches and smaller and 1/8 inch thick for flanges 14 inches and larger.

2.11.4 Bolting

Bolts, bolt studs, nuts and washers shall have zinc plated finish.

Thread shall be in accordance with ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse-thread series except that alloy steel bolting 1/8 inch and larger in diameter shall be 8 pitch thread series.

Threaded rods are not allowed as fastening elements.

For Class 150 and Class 300 flanges not exceeding 400 degrees F temperature, use carbon steel bolts or stud bolts conforming to ASTM A307, Grade B with nuts conforming to ASTM A194/A194M.

2.12 THREADED JOINT SEALANT

Paste type for brush application or cord type. Products shall be non-toxic, chemically inert, non-hardening, rated for -50 degrees F to 400 degrees F and up to 10,000 psi (liquids) and 3000 psi (gases), certified by UL, CSA, and NSF.

Use sealant similar to Loctite Model 54531 for piping handling oil or petroleum products.

2.13 WELD BRANCH OUTLET FITTINGS (WELDOLETS, THREADOLETS AND SOCKOLETS)

Weld branch outlet fittings shall conform to MSS-SP-97, ASME B16.9 for weldolets, ASME B1.20.1 for threadolets and ASME B16.11 for sockolets.

Materials shall match material of header piping and wall thickness of outlet or branch end shall match wall thickness of branch pipe.

2.14 VALVES

Provide valves with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

General:

Valves 2 inches and smaller, in steel piping shall have threaded ends.

Valves 2 inches and smaller, in copper piping shall have solder ends.

Provide valve stem extensions with sufficient length to allow for insulation where insulation is specified.

2.14.1 Shut Off Valves

(2 inches) and Smaller: ball valves as specified in this Section

(2-1/2 inches) and Larger: butterfly valves as specified in this Section

2.14.2 Gate Valve

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 Class 125 and shall be bronze with wedge disc, rising stem and threaded, soldered, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70, Class 125, cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.14.3 Globe and Angle Valve

Globe and angle valves 2-1/2 inches and smaller shall conform to MSS SP-80, Class 125. Globe and angle valves 3 inches and larger shall conform to MSS SP-85, Class 125.

2.14.4 Spring Loaded Check Valve

Check valves 2 inches and smaller shall conform to MSS SP-80, bronze or iron body, Class 125 (200 psi WOG), Nibco Figure T(S)-480, Mueller Figure 303-AP or Metraflex No. 700.

Check valves 2-1/2 inches and larger shall conform to MSS SP-71, Class 125, cast iron body, wafer type, 316 stainless steel spring, aluminum bronze or carbon steel disc, Buna-N seat, Class 125 (200 psi WOG), Nibco Figure W-910, Milwaukee 1400, Metraflex No. 700, Stockham Figure WG-970, Mueller Sure Check Model No. 71, or Crane Duo-Check II. For valves 8 inches and larger, provide lifting lugs or threaded holes for lifting eye bolts.

2.14.5 Butterfly Valve

Butterfly valves shall conform to MSS SP-67, Type 1 and shall be either the wafer or lug type. Valves smaller than 8 inches shall have throttling handles with a minimum of seven locking positions.

2-1/2 inches and Larger:

Manufacturers: DeZurik, Keystone, Nibco, Milwaukee, Bray, Kitz or Centerline

Cast iron or ductile iron body, stainless steel shaft, bronze disc, aluminum-bronze disc, cast or ductile iron disc with welded nickel edge disc, electroless nickel plated ductile iron disc, or

Nylon coated ductile iron disc, upper thrust bearing, EPDM resilient seat, rated at minimum 175 psi CWP for sizes through 12 inches and 150 psi CWP for sizes 14 inches and larger, suitable for continuous operation at temperature up to 225 degrees F, compatible to ANSI B16.1 Class 125/150 flange standards, conforming to MSS SP-67.

Dead end pressure rating shall be minimum 150 psi with no downstream flange/piping attached.

For valves 6 inches and smaller, provide 10-position lever actuators with locking devices. For valves 8 inches and larger, provide rotary hand wheel operators with adjustable position stop and position indicators. Size hand wheel operators with no higher than 40 lb rim pull at full valve pressure rating.

Valve necks shall be of sufficient length to allow for insulation where insulation is specified. Wheel shaft shall be sufficient length so wheel does not touch insulation.

Provide full lug type valves permitting removal of down stream piping while using valve for system shut-off.

Furnish valves used for balancing with adjustable memory stops.

2.14.6 Butterfly Valves (High Performance)

Manufacturers: DeZurik Type BHP, Xomox, Jamesbury, Bray Series 40, or Posi-Seal

Carbon steel or stainless steel body, ANSI Class 150 design rated for 275 psi at 100 degrees F, bubble-tight shut off with pressures in either direction to 275 psi, threaded lug type, upper and lower body bearings with thrust bearings, one piece single or double offset shaft of 316 stainless steel and centerless ground and polished to minimize bearing and packing wear, PTFE seats, PTFE adjustable V-ring packing, capable of service in temperature ranges of -100 to 300 degrees F, 316 stainless steel discs and totally enclosed, factory lubed, handwheel rotary actuator with external disc position indication. Size the hand wheel operators with no higher than 40 lb rim pull at full valve pressure rating. Orient the location of the hand wheel operator on isolation valves in valve boxes for convenient operator operation. Size the hand wheel operators with no higher than 40 lb rim pull at full valve pressure rating. Orient the location of the hand wheel operator on isolation valves in valve boxes for convenient operator operation.

Dead end pressure rating shall be 275 psi without downstream flanging.

2.14.7 Plug Valve

Plug valves 2 inches and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 2 inches and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valve shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valve shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valve shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valve shall a weatherproof operators with mechanical position indicators.

2.14.8 Ball Valve

Full port design. Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be cast iron or bronze with threaded, soldered, or flanged ends. Ball valves may be provided in lieu of gate valves.

(2 inches) and Smaller: ASTM B584 bronze body, chrome plated brass/bronze or stainless steel ball, full port for 3/4 inch and smaller and conventional port for 1 inch and larger, Teflon seat rings, blowout-proof stem, 2-piece construction, 600 psi WOG, 150 psi SWP.

2.14.9 Square Head Cocks

Provide copper alloy or cast-iron body with copper alloy plugs, suitable for 125 psig water working pressure.

2.14.10 Calibrated Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts. Provide valve calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valve shall have an integral pointer which registers the degree of valve opening. Valve shall function as a service valve when in fully closed position. Valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation.

Provide valve bodies with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable differential pressure meter connections to verify the pressure differential. Provide metal tag on each valve showing the gallons per minute flow for each differential pressure reading.

2 inches and Smaller: calibrated balancing valves:

Variable orifice with multiple turn valve type as manufactured by Armstrong Series CBV or ABV, Tour & Andersson (Victaulic) Series 786 or 787, NIBCO 1709 or 1710, or fixed orifice with ball valve type as manufactured by Flow Design Inc. (FDI), Preso, Gerand, Nexus, HCi or Taco. Bronze or brass body, 250 psi maximum working pressure, 250°F maximum operating temperature. Furnish valve with adjustable memory stop and quick disconnect taps with built-in check valve for pressure differential measurement, integral valve setting index and memory locking device.

Valves shall measure down to 0.3 gpm with accuracy of ± 3%.

Valves shall be leak-tight at full rated working pressure.

Unless otherwise indicated, size balancing valves so that at design flow rate, pressure drop across balancing valve with valve approximately 50% open will be at minimum 25% of reading range of meter used for balancing.

2-1/2 inches and Larger: Armstrong Series CBV or Tour and Anderson (Victaulic) Series 788/789, ductile iron body, ASME/ANSI B16.42 Class 150 flange, 250 psi maximum working pressure, 250 degrees F maximum operating

temperature. Fixed orifice with ball valve or butterfly valve as manufactured by FDI, Presco or Gerand, Class 150 flange, 225 psi maximum working pressure, 250 degrees F maximum operating temperature will be acceptable up to 4 inch size. Butterfly valves, as specified in this Section, together with averaging Pitot tube flow sensors, as specified in this section, under Flow Sensors and Meters between check valve and butterfly valve may be used when sizes for Armstrong or T/A valves are not available. Furnish butterfly valves with adjustable memory stops to limit return of valves to preset open position after shut-off.

Furnish portable meter kit within durable case similar to Gerand Model "R". Furnish meter with minimum 4-1/2 inch diameter aluminum or brass body/brass internals with reading range of either 0 inches to 50 inches or 0 inches to 100 icnhes water column differential as appropriate,200 degrees F maximum temperature,300 psi working pressure. Meter accuracy shall be ± 2 percent full scale. Provide in kit: equalizing valves,10 foot purge hose and size devices specified. Meter shall become property of Owner.

Contractor shall furnish meter for calibration and shall retain meter after final calibration.

Terminal Unit Valve Assembly

Terminal unit valve assembly may be used instead of individual valve and other components, provided each valve and component meets specified requirements.

HCi, Nexus or FDI are acceptable.

Inlet assembly shall be combination of isolation ball valve, strainer, union, and PT readout port similar to HCi Terminator Y, and outlet assembly shall be combination of isolation ball valve, union, PT readout ports and venturi flow meter similar to HCi Terminator B.

2.14.11 Automatic Flow Control Valves

Valve shall automatically maintain the constant flow indicated on the design drawings. Valve shall modulate by sensing the pressure differential across the valve body. Valve shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Provide valve that controls the flow within 5 percent of the tag rating. Valve materials shall be the same as specified for the ball or plug valves.

Provide valve that are electric type as indicated. Valve shall be capable of positive shutoff against the system pump head, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings and differential meter, suitable for the operating pressure specified. Provide the meter complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer.

2.14.12 Pump Discharge Valve

Combination Shut-off, Check and Balancing Valves shall shall perform the functions of a nonslam check valve, a manual balancing valve, and a

shutoff. Valve shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Provide an integral pointer on the valve which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 2 inches shall have NPT connections. Valves 2 inches and larger shall have flanged end connections. Valve design shall allow the back seat for the stem to be replaced in the field under full line pressure. 2-1/2 inches and larger - cast iron or semi-steel body, flanged, stainless steel stem and spring, replaceable bronze disc with EPDM seat, calibrated balancing adjustment with memory bank, backseating valve stem, maximum working pressure of 175 psi at 250 degrees bF, Bell and Gossett, Thrush-Amtrol, Armstrong or Taco.

Valve design to be straight pattern unless otherwise indicated and constructed to permit repacking under full line pressure.

Valves to be equipped with brass readout valves with integral check valve for taking differential pressure readings across orifice.

2.14.13 Water Temperature Mixing Valve

Valve, ASSE 1017 for water service.

2.14.14 Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended service.

2.14.15 Water Pressure Reducing Valve

Valve, ASSE 1003 for water service, copper alloy body, automatic re-seating, with test lever.

2.14.16 Pressure Relief Valve

Valve shall prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Valve, ANSI Z21.22/CSA 4.4 and shall have cast iron bodies with corrosion resistant internal working parts. The discharge pipe from the relief valve shall be the size of the valve outlet unless otherwise indicated.

2.14.17 Combination Pressure and Temperature Relief Valves

ANSI Z21.22/CSA 4.4, copper alloy body, automatic re-seating, test lever, and discharge capacity based on AGA temperature steam rating.

2.14.18 Drain Valves

Valves, MSS SP-80 gate valves. Valve shall be manually-operated, 3/4 inch pipe size and above with a threaded end connection. Provide valve with a water hose nipple adapter. Ball valve as specified above with threaded hose adapter and cap. Provide 3/4 inch minimum drain valve for piping larger than 1/2, except strainer blowdown valves shall be blowdown connection size. Provide 1/2 inch drain valve for 1/2 inch piping. If 3-piece ball valves are specified, use 2-piece ball valves with same construction.

2.14.19 Air Venting Valves

Manually-operated general service type air venting valves, brass or bronze valves are to be furnished with threaded plugs or caps. Automatic type air venting shall be the ball-float type with brass/bronze or brass bodies, 300 series corrosion-resistant steel float, linkage and removable seat. Air venting valves on water coils shall have not less than 1/8 inch threaded end connections. Air venting valves on water mains shall have not less than 3/4 inch threaded end connections. Air venting valves on all other applications shall have not less than 1/2 inch threaded end connections.

2.14.19.1 Manual Air Vents:

Manufacturers: Bell & Gossett Model 4V, 125 psig at 210 degrees F or approved equal. Use 1/2 inch ball valve for main pipes.

2.14.19.2 Automatic Air Vents:

Manufacturers: Amtrol, Watson McDaniel, B&G, or Hoffman

Metal construction, non-corrosive working parts, 150 psig WP at 240 degrees F

Normal capacity vent shall be similar to B&G Model 87

High capacity vent shall be float actuated and shall have minimum air elimination rate of 10 cfm at 100 psig, similar to B&G Model 107A.

2.14.20 Vacuum Relief Valves

ANSI Z21.22/CSA 4.4

Kadant Johnson Series VB-8 with brass body, stainless steel ball, EPR seat, stainless steel spring, suitable for pressures to 300 psig at 365 degrees F, or Sarco Model VB-14

2.14.21 Gauge Valves

Unless otherwise indicated, gauge valves for steam, steam condensate and feedwater services shall be gate valves. Gauge valves for all other services shall be needle valves, brass body, 2000 psig, 300 degrees F, similar to Trerice Model 735. Gauge valve size shall match gauge pipe size as specified in this section.

2.14.22 Water Pressure Regulating Valves

Manufacturers: Thrush, Watts, Cash-Acme, Taco, or B & G

Brass or bronze body, spring and diaphragm operated, pressure adjustable with check valve and inlet strainer and designed for maximum working pressure of 125 psig and maximum operating temperature of 160 degrees F.

2.14.23 Chain Wheel Operators

Similar to Babbitt cast iron or ductile iron adjustable sprocket rims and chain guides. Use galvanized or brass chain and chain closure links to form continuous loop of chain at each operator.

2.14.24 Flow Elements (Measuring Stations) and Meters

2.14.24.1 Averaging Pitot Tube Flow Elements (2-1/2 inch and Larger):

Manufacturers: Dieterich Standard, or Preso

Elements shall be averaging differential pressure type consisting of sensing tube with 2 internal chambers; one for sensing upstream pressure and one for sensing downstream pressure.

Furnish each flow measuring station complete with safety shut-off valves, quick coupling connections and permanent metal tag showing designed flow rates, meter readings for designed flow rates, metered fluid, line size and tag, station or location number. Annular measuring element shall be constructed of stainless steel. Stations shall be nipple section or weld insert type and be rated to 250 psi at 250 degrees F.

Hot tap type flow stations shall include isolation valve and packing gland retraction assembly. Connection shall be flange type. Station shall be rated to 250 psi at 250 degrees F.

Portable differential pressure meter set shall be of totally dry single diaphragm type with min. 4-1/2 inches dial pointer indicator, 0 inches to 50 inches WG reading range, accuracy of ± 3.0 percent full scale, and wetted metal parts of brass or stainless steel. Meter shall include variable pulsation dampening control, integral equalizing valve, and 2 bleed valves.

Furnish meter set complete with master chart for direct conversion of meter readings to gpm rust proof carrying case, two minimum 10 foot rubber test hoses, with brass valves for quick connections to flow sensor. Meter shall become property of Owner.

Furnish elbow mounted Pitot tube measuring stations at locations where manufacturer's recommended straight pipe lengths are not available for straight pipe mounted measuring stations.

2.14.24.2 Venturi Flow Elements:

Manufacturers: Hyspan, Gerand, or Preso

Elements shall be flanged ends for 2-1/2 inches and larger and threaded ends 2 inches and smaller. Furnish tubes with quick disconnect taps and shut off valves, suitable for 125 psig WP. Select tubes for size and pressure drop as scheduled and tag for mark number, flow and pressure drop as specified.

Provide portable meter kit within durable case. Furnish with 6 inches diameter forged brass meter having dial range from 0 inches to 50 inches WG. Provide in kit equalizing valves, vent hose and size devices specified. Meter shall become property of Owner.

Contractor shall furnish meter for calibration and shall retain meter after final calibration.

2.14.24.3 Orifice Plate Flow Elements:

Daniel or Precision Flow Products, factory calibrated bores and

companion flanges complete with pressure taps, bolts, nuts, gaskets and jack screws. Furnish element with threaded connections for piping 2 inches and smaller and butt welded necks for 2-1/2 inches and larger. Furnish pressure tappings with quick disconnect taps and shut-off valves, suitable for 125 psig WP. Select orifice plates for size and pressure drop as scheduled and tagged for mark number, flow and pressure drop as specified.

Furnish portable meter kit with durable case with 6 inches diameter forged brass meter having dial range from 0 inches to 50 inches WG. Furnish in kit, equalizing valves, vent hose and size devices specified. Meter shall become property of Owner.

Contractor shall furnish meter for calibration and shall retain meter after final calibration.

2.14.25 Straightening Vanes

Manufacturers: Daniel Industries, Inc., Houston, Texas or approved equal

Straightening vane assembly shall consist of series of carbon steel pipes firmly welded together and to line size pipe. Furnish vanes with class 150 psi flanges for insertion into piping system.

2.15 PIPING ACCESSORIES

2.15.1 Strainer

Strainer, ASTM F1199, except as modified and supplemented in this specification. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. Strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. The bodies shall have arrows clearly cast on the sides indicating the direction of flow.

Provide strainer with removable cover and sediment screen. The screen shall be made of minimum 22 gauge monel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

Manufacturers: Metraflex, Mueller Steam Specialty, Hoffman, Eaton (formally Hayward), Sarco, Keckley, Armstrong, Wheatley, Conbraco or Streamflo

Liquid System:

2 inches and Smaller: full pipeline size, Y-type, with removable screen caps, cast iron, Class 250 400 psi/150 degrees F WOG, threaded ends for carbon steel piping and bronze, Class 150 200 psi/150 degrees F WOG,solder ends for copper piping. Screen caps shall have threaded blowdown connection.

2-1/2 inches and Larger: full pipeline size, Y-type, Class 125 200 psi/150 degrees F WOG, cast iron, flanged ends. Furnish strainer with bolted screen retainer and off-center blowdown connection.

Liquid Service Screens: stainless steel with screen perforation as indicated below. For strainers serving equipment where manufacturer

requires specific screen perforation, provide per manufacturer requirements. Maximum pressure drop shall be 4 feet WG through clean strainer.

Pipe Size	Closed System	Open System
2 inches and smaller	1/32 inch (20 mesh)	1/8 inch
2-1/2 inches to 4 inches	1/16 inch	1/8 inch
5 inches and over	1/8 inch	1/8 inch

Cast steel body with Class 150 150 psi flanged ends, full pipeline size with bolted covers. Furnish stainless steel baskets with 1/8 inch perforations. Provide valved drain connection from each blowdown tapping.

2.15.2 Water Filters

Manufacturers: Pall Corporation, Ronningen-Petter, Graver Technologies (Consler), FSI, Filterite or Parker Hannifin

Housing shall be constructed of carbon steel for 150 psi WP, constructed in accordance with ASME Code, painted with manufacturer's standard paint.

Filter access shall be with bolted and gasketed steel or cast iron head, threaded for 2 inches and smaller, flanged for 2-1/2 inches and larger.

2.15.2.1 Cartridge Filter Media:

Construct filter cartridges of disposable media with minimum media area of 4-1/2 sq ft per cell.

Cartridges to be capable of proper operation at pressure differentials up to 75 psig and temperature to 230 degrees F.

Furnish 3 sets of filter cartridges, 2 sets capable of removing 98% of solid particles 5 microns or larger and one set capable of removing 98 percent of solid particles 75 microns or larger. Use 75 microns filters at initial start-up. When loaded up, replace with 5 microns filters.

To insure against by passing, provide positive seal on each cartridge stack consisting of internal tie rod and seal nut arrangement, or equivalent. Single continuous cartridge per stack to be used.

2.15.2.2 Bag Filter Media:

Disposable type bag filters may be used in lieu of cartridge filters. Filter media to be capable of proper operation at pressure differentials up to 75 psig and temperature to 250 degrees F.

Furnish 3 sets of filter media, 2 capable of removing 98 percent of solid particles 5 microns or larger and one capable of removing 98 percent of solid particles 75 microns or larger.

2.15.3 Combination Strainer and Pump Suction Diffuser

Angle type body with removable strainer basket and internal straightening

vanes, a suction pipe support, and a blowdown outlet and plug. Strainer shall be in accordance with ASTM F1199, except as modified and supplemented by this specification. Unit body shall have arrows clearly cast on the sides indicating the direction of flow.

Strainer screen shall be made of minimum 22 gauge monel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Flow shall be into the screen and out through the perforations. Provide an auxiliary disposable fine mesh strainer which shall be removed 30 days after start-up. Provide warning tag for operator indicating scheduled date for removal.

Casing shall have connection sizes to match pump suction and pipe sizes, and be provided with adjustable support foot or support foot boss to relieve piping strains at pump suction. Provide unit casing with blowdown port and plug. Provide a magnetic insert to remove debris from system.

Manufacturers: Armstrong, Mueller Steam Specialty or Wheatley

Cast iron or ductile iron body with angle pattern flow straightening vanes and combination diffuser-strainer-orifice cylinder with (3/16 inche) diameter openings, (175 psig) WP, at (250 degrees F). Threaded ends for (2 inches) and smaller and flanged ends for (2-1/2 inches) and larger. Orifice cylinder shall have free area of at least 5 times cross section area of pump suction opening. Furnish each unit with disposable fine mesh start-up strainers, gauge tappings, blow down connection, and adjustable support foot to carry weight of suction piping.

2.15.4 Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braidunless otherwise indicated. Provide end fitting type and pressure ratings for the flexible pipe connectors that are consistent with requirements of the specific the piping system in which they are to be used as specified in this section. Pressure rating shall not be less than that of the ANSI/ASME Class service rating for the pipe type used in the specific piping system.Equip flanged assemblies with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.15.5 Pressure and Vacuum Gauges

Gauges, ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Provide gauges with 4.5 inch dial, brass or aluminum case, bronze tube, and siphon. Gauge shall have a minimum of with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.15.6 Temperature Gauges

Temperature gauges, shall be the industrial duty type and be provided for the required temperature range. Provide gauges with fixed thread connection, dial face gasketed within the case; and an accuracy within 2

percent of scale range. Gauges shall have Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 to 7 feet above the finished floor or in locations indicated. Remote element type temperature gauges shall be provided in thermal wells located 7 feet above the finished floor or in locations indicated.

2.15.6.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column. Pipeline mounted thermometers: 230 mm(9 inches) scale cast aluminum case and frame, clear acrylic plastic window front, permanently stabilized glass tube with mercury free indicating fluid, adjustable angle stem, extended neck suitable for insulated piping as required, and compatible with sockets as specified herein.

Range of thermometers shall be:

Service	Scale Range	Increment
Chilled Water	0 F to 100 F	1 F
Heating Hot Water	30 F to 240 F	2 F

2.15.6.2 Bimetallic Dial

Bimetallic dial type case shall be not less than 3-1/2 inches, stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment.

2.15.6.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill shall be non-mercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.15.6.4 Thermal Well

Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

2.15.7 Pressure Gauges

Manufacturers: Ashcroft, U.S. Gauge, Marsh, Trerice, Miljoco, Marshalltown, Weksler, Winters or Weiss equal to Trerice 600 Series

Minimum 4-1/2 inch diameter die cast aluminum case, glass or acrylic

plastic window, phosphor bronze bourdon tube with bronze bushed movement, recalibration from front of gauge dial and 1/4 inch NPT forged brass socket.

Gauge accuracy shall meet ANSI B40.100 Grade 1A (±1 percent full scale).

Select gauge range so that normal operating pressure is at midpoint of gauge.

Reading range of gauges shall be:

Service	Scale Range
Chilled Water	0 to 100 psig
Heating Hot Water	0 to 100 psig

Pressure Snubbers:

(1/4 inch or 1/2 inch) size, matching gauge pipe size as specified in this section, (1000 psig) WP. Brass for carbon steel pipe or copper pipe. Stainless steel for stainless steel pipe.

Coil Syphons:

(1/4 inch or 1/2 inch) size, matching gauge pipe size as specified in this section, (500 psig) WP. Material shall match gauge pipe material.

2.15.8 Pressure/Temperature Test Stations

Pete's plugs made by Peterson Equipment Company, Sisco, Super Seal by Flow Design Inc. (FDI), or approved equal.

Test plugs shall be (1/4 inch or 1/2 inch) NPT, brass body and cap, (1-1/2 inches) length for non-insulated pipe and (3 inches) length for insulated pipe, with Nordel self-closing valve cores, rated at (500 psig at 275 degrees F), and shall receive either temperature or pressure probe with (1/8 inch) OD.

Furnish portable test kit within durable case containing the following:

A compound pressure gauge, (3-1/2 inches) dial,(30 inches) Hg - (100 psi), field calibration screw, surge protector and stainless steel gauge adapter with (1/8 inch) diameter probe (2% accuracy of mid range).

Two pocket testing thermometers, (1-3/4 inches) dial, (5 inches) long stainless steel stem, (0 - 220 degrees F) and (25 - 125 degrees F) ranges with external calibration (1 percent accuracy of entire scale).

2.15.9 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports: to MSS SP-58 and MSS SP-69.

2.15.9.1 Design Criteria

Materials and application of pipe hangers and supports shall conform to latest requirements of ANSI/ASME Code for Pressure Piping B31.1 and MSS

Standard Practice SP-58 (Materials, design and Manufacture), SP-69 (Selection and Application), and SP-89 (Fabrication and Installation Practices), except as supplemented or modified herein.

Support materials shall be steel or stainless steel unless specifically indicated.

Support devices shall be factory fabricated by manufacturers and have published load ratings.

Unless otherwise indicated, design structural support members and support devices, including couplings, rods, trapeze supports and strut systems, with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.

Determine maximum deflection using the following equation.

$$D = \frac{H \text{ or } L}{250}$$

Where D = Max deflection in millimeters(inches)
H = Member height in millimeters(inches)
L = Member length in millimeters(inches)

Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard black, primed, galvanized or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application and corrosive atmospheres. Coat cut edges, welds or any damaged finish with galvanized paint.

Corrosive atmospheres include the following locations:

a. Exterior locations

b. Chemical storage and hazardous waste storage rooms

c. Food service/kitchen areas

d. Locker/shower rooms

e. Meter Pits

f. Utility tunnels

Material in contact with pipe shall be compatible with piping material so that neither shall have deteriorating action on the other. If materials such as copper, stainless steel or other materials are not compatible, provide nonmetallic separation between uninsulated piping and metal supports. Plastic coated steel supports are acceptable.

Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish. Paint type shall be approved by Architect/Engineer.

This Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe. Coordinate with Contractor performing work specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

In addition to hangers specified in this Section, piping connected to pumps, compressors, and similar rotating or reciprocating equipment shall have vibration isolation hangers or supports for distance of 100 pipe diameters or (50 feet) away from equipment, whichever is greater.

Piping connected to coils, which are in assembly mounted on vibration isolators, shall have vibration supports as indicated above. Piping connected to coils, which are in equipment where fan assembly is separately isolated by vibration isolators and duct flexible connections, does not require additional spring vibration supports. Refer to Section 23 05 48.00 40 VIBRATION AND SIESMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for flexible connections, vibration isolators and additional requirements.

Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.

Unless otherwise indicated, continuous insert channels are not allowed.

Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.

Application of concrete inserts and concrete anchors shall be reviewed and approved by Structural Engineer prior to installation.

Any proposed weld attachments to building structure shall be reviewed by Structural Engineer prior to execution of work. This review may result in use of other welding codes or standards, which may apply to "structural work". Execution of this work may be assigned to General Trades responsible for building structural steel. Cost for this work, however, will remain the responsibility of this Contractor.

Fasteners including concrete anchors for seismic application shall have ICC Evaluation Service Report (ESR) and meet requirements of local authorities.

2.15.9.2 Pipe Hangers and Supports (Metallic)

Manufacturers: Anvil (formerly Grinnell), Erico, Tolco, National Pipe Hanger Corporation, or B-Line, equal to Anvil figures listed. Corresponding MSS type is indicated where applicable.

Hangers/supports for copper pipe where supports directly contact to pipe shall be either copper plated or PVC coated.

For insulated pipe supports, refer to Insulated Pipe Supports in Part 3 of this Section.

Clevis and Roller Type Hangers:

System	Pipe Size	Clevis	Roller
Hot Pipes with Insulation (120 F and above)	2 inches and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2 inches to 6 inches	---	171 (MSS Type-41), 181 (MSS Type-43)
	8 inches and larger	---	171 (MSS Type-41)
Ambient Bare Pipes (60F to 119F)	2 inches and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2 inches and larger	260 (MSS Type-1), 216 (MSS Type-4)	---
Cold Pipes with Insulation (33F to 59F)	2 inches and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2 inches and larger	260 (MSS Type-1), 295 (MSS Type-3)	---
Cold Pipes with Insulation (32F and below)	2 inches and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2 inches to 6 inches	260 (MSS Type-1)	171 (MSS Type-41), 181 (MSS Type-43)
	8 inches and larger		171 (MSS Type-41)

For pipe size 2-1/2 inches and larger, where there is transverse movement at support points due to thermal expansion/contraction, clevis type hangers similar to Anvil Figure 260 (MSS Type-1) may be used if vertical angle of hanger rod is less than 4.

Flat Surfaces (Trapeze, Rack Type):

Use structural steel members such as struts, angles, channels and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Refer to Part 1 for design criteria. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers or slides indicated below at each support point.

System	Pipe Size	Straps or Clamps	Rollers	Slides
Hot Pipes with Insulation (120F and above)	2 inches and smaller	243, 244	---	---
	2-1/2 inches to 6 inches	---	177, 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement of piping.
Ambient Bare Steel Pipes (60 to 119F)	6 inches and smaller 8 inches and larger	B-Line BVT 137 (MSS Type-24)	---	---
Ambient Bare (Copper) pipes (60 to 119F)	all sizes	B-Line BVT		
Cold Pipes with Insulation (33F to 59F)	10 inches and smaller	137 (MSS Type-24)	---	---
	12 inches and larger	432	---	---
Cold Pipes with Insulation (32F and below)	2 inches and smaller	243, 244		
	2-1/2 inches and larger		171 (MSS Type-41), 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement of piping.

2.15.9.3 Insulation Protection Shields

Anvil Fig. 167 (MSS Type-40) constructed of galvanized carbon steel. Per the latest edition of Standard MSS SP-58, select shield to accommodate outer diameter of insulation. Shield length and gauge for insulation compression strength not less than 15 psi, shall be as follows:

Pipe Size	Length	Gauge
1/4 inch thru 3 inches	12 inches	18
4 inches	12 inches	16
5 inches and 6 inches	18 inches	16
8 inches thru 14 inches	24 inches	14
16 inches thru 24 inches	24 inches	12

2.15.9.4 Insulation Protection Saddles

Anvil Fig. 160 Series (MSS Type-39) constructed of carbon steel or alloy steel plate. Select saddles to accommodate insulation thickness specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15.9.5 Weight Bearing Insulation Inserts

Insert thickness shall match pipe insulation thickness. Pipe insulation jackets shall be continuous through sections containing inserts.

Minimum length of inserts shall be 12 inches or 2 inches longer than insulation protection shields, whichever is longer. Quantity and placement of inserts shall be based on weight of pipe and fluid plus 1.5 safety factor.

Cold Pipes (59 degrees F and below):

Cellular glass insulation (Type G) similar to Pittsburgh Corning Foamglas, maximum compression strength 100 psi, Koolphen K insulation by Kooltherm Insulation, 5 lb/ft3, maximum compression strength 50 psi, or HAMFAB H-Block by ICA Inc., maximum compression strength 30 psi. H-Block inserts shall be coated with vapor barrier coating similar to CADALAR 670 by SKIRGES Corp

2.15.9.6 Pre-Insulated Pipe Supports

Pipe Shields, Inc., Bergen Pre-Insulated Pipe Supports, Rilco or Tri-State Industries equal to Pipe Shields models listed

Insulation shall consist of water-resistant calcium silicate of same thickness as adjoining pipe insulation, thermal conductivity not more than 0.38 at 75 degrees F mean temperature, minimum density of 13 lb/ft3, and compressive strength not less than 100 psi.

Structural inserts shall be water-resistant, high-density calcium silicate with minimum density of 32 lb/ft3 and minimum compressive strength of 600 psi. Structural inserts shall be used as recommended by manufacturer to meet load ratings.

Use vapor barrier steel jacket around insulation. Insulation jackets shall be galvanized steel conforming to ASTM A-527. Hanger bearing surface shall consist of galvanized sheet metal insulation protection shield or casing.

When recommended by manufacturer, use double layer insulation protection shield at support bearing surface. Insulation shall extend 1 inch beyond insulation protection shield to maintain vapor barrier integrity.

Pre-insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following Codes and Standards: ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.

Load tests shall be made on both supporting materials and configurations. All tests shall be performed by independent testing laboratory. Results of pertinent tests shall be available on request.

Unless otherwise indicated, pre-insulated pipe supports shall be as indicated in the following schedule. Model numbers are based on Shaw Pipe Shields, Inc.:

Pipe supported on hangers: Models A2000, A4000, A9000, D3000 and D3200

Pipe supported on flat surfaces: Models A2000, A4000, A6000, A7000, A7200, and A7400

Pipe supported on pipe rolls: Models A4000, A6000, A8000, A8200, and A8400

Pipe supported on slides: Model "B" Series

A1000, A3000 or A5000 may be used for hot pipes (120 degrees F and above)

Select proper model to conform to pipe service, support style, and support spacing.

Submit chart or table indicating selected model along with pipe sizes, rated loads, support device types and support spacing for each piping system.

Pipe support spacing shall be in accordance with manufacturer's recommendations, but in no case shall exceed maximum spacing indicated under Hanger and Support Spacing in Part 3 of this Section.

2.15.9.7 Hanger Rods (Metallic)

Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.

Rods shall have electroplated zinc or hot dip galvanized finish.

Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule. Rod size may be reduced one size for double rod hangers. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated:

Bolts, Nuts, Studs and Washers

ASTM A307, electroplated zinc finish

Rod Attachments

Anvil Fig. 290 (MSS Type-17), galvanized finish

U-Bolts

Anvil Fig. 137 (MSS Type-24), galvanized finish

Beam Clamps

Beam Clamps: Anvil Fig. 133/134 (MSS Type-21), 218 (MSS Type-30), 228 (MSS Type-28 or 29) and 292 (MSS Type-28 or 29)

Top Beam Clamps: Anvil Fig. 227 (MSS Type-25)

C-Clamps: Anvil Fig. 86, 92 or 93 (MSS Type-19 or 23) with set screw and lock nut.

Adjustable Pipe Saddle Supports

Anvil Fig. 264 (MSS Type-38)

Riser Clamps

Anvil Fig. 261 (MSS Type-8), galvanized finish

Anvil Fig. CT-121, copper plated carbon steel, plastic coated in area at pipe contact, for bare copper tubing.

Proset system, proseal plug and fire-fill for sleeved and cored holes.

Concrete Inserts (Wooden Formed Concrete)

Anvil Fig. 281 or 282 (MSS Type-18), suitable for rod diameter and weight supported

Concrete Inserts (Metal Deck Formed Concrete)

Anvil Fig. 284, Tolco No. 109 A, B-Line Fig. B3019, Powers Fasteners "Bang-It", or MSCO No. MX34

Concrete Anchors (Static/Gravity Loads Only, Not for Seismic Loads)

Manufacturers: Hilti, Powers Fasteners or Red Head

Anchors shall meet ICC Acceptance criteria, and ICC-ESR reports shall specifically list the current applicable codes.

Anchors shall be designed and detailed by Structural Engineer registered in project's jurisdiction. Calculations and drawings shall be submitted.

Flush or shell type, meeting description in Federal Specification FF-S-325, Group VIII, Type 1 for expansion shield anchors, similar to Hilti Kwik Bolt TZ, Powers Power-Stud+SD1, Power-Stud+SD2, or Snake+. Anchors shall be zinc plated in accordance with ASTM B633.

Select anchors with load ratings based on cracked concrete conditions.

Anchors installed in hardened concrete for purpose of transmitting

structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ESR report demonstrating anchors have met requirements of AC 193 for mechanical anchors.

Pipe Mounting Pedestals

Equal to Roof Products & System Corporation consisting of equipment rail, "U" shaped mounting brackets, galvanized threaded rod and cast iron pipe rollers. Rail shall have built-in raised cant to match roof deck insulation.

Equipment Rails

Manufacturers: Roof Products & Systems, ThyCurb, Custom Curb, Inc. or Vent Products equal to Roof Products & Systems Model ER-4 with raised cant style. Mounting rails shall be galvanized steel with integral base plate, continuous welded corner seams, factory installed 2 x 4 wood nailer and 18 ga galvanized steel counter flashing.

Mounting rail gauge shall be selected to support equipment adequately but shall be not less than 18 ga.

Height shall be as detailed, but not less than 8 inches above finished roof.

Equipment rails shall span minimum of 2 joists and not cantilever more than 6 inches where joists are used. Rails shall be level at top with pitch built in when deck slopes 1/4 inch per foot or greater.

Pipe Roof Penetration Protections

Manufacturers: Roof Products & Systems, ThyCurb or Vent Products equal to Roof Products & Systems "RPS-Pipe Portals" consisting of 12 inches OD prefabricated roof curb, laminated acrylic coated ABS plastic curb cover with EPDM protective rubber cap and stainless steel clamp.

Pipe Guides

Unless otherwise indicated, guides shall be Pipe Shields, Bergen Pre-Insulated Pipe Supports or Rilco equal to Pipe Shields "B" Series B3000, B4000, B7000, B8000, selected by load and movement.

Pipe Anchors

Unless otherwise indicated, anchors shall be no-moment type, Shaw Pipe Shields or Rilco equal to Shaw Pipe Shields Insulated Positive Pipe Anchor Model C3000 or C4000 Series, sized to meet anchor forces shown with minimum safety factor of 3.0.

Contractor may fabricate anchors of steel sections suitable for location of installation and for withstanding anchor forces shown with minimum safety factor of 3.0

2.15.10 Escutcheons

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Secure plates in place by internal

spring tension or set screws. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.15.11 Flexible Expansion Loops

Vanufacturers: Metraflex

Flexible expansion loops shall be Metraflex Metraloop consisting of 2 flexible sections of hose and braid, two 90 degrees elbows, and a 180 degrees return, with factory supplied, center support nut located at bottom of 180 degrees return and drain/air release plug. Flexible expansion loops shall be designed to accommodate minimum 1-1/2 inches of expansion.

Flexible loops shall impart no thrust loads to system support anchors or building structure

Unless otherwise indicated, material of construction, end fitting type and pressure ratings shall be consistent with pipe material, pipe connection fittings and pressure rating as specified.

Hose and braid material shall be 316L.

2.16 PUMPS

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.2. Pumps shall be selected at or within 5 percent of peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall conform to NEMA MG 1, be totally enclosed, and have sufficient horsepower for the service required. Pump motors shall be Premium Efficiency motors. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover or a variable frequency drive as scheduled and specified in section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS. Each VFD driven pump motor shall be furnished with a shaft grounding brush similar to AEGIS SGR to prevent bearings from shaft current.

2.16.1 Pump General Design Criteria

Pump sizes, capacities, pressures and operating characteristics shall be as scheduled.

Pumps shall meet or exceed operating efficiencies scheduled.

Furnish pumps complete with motors, impellers, drive assemblies, bearings and accessories as hereinafter specified. Furnish pump couplings with OSHA compliant coupling guards.

Where pump is indicated for parallel operation, scheduled conditions are for that pump with two pumps operating; i.e., total system flow rate is twice that scheduled for single pump. When only one of two pumps is operating, operating point of that pump must fall within manufacturer's

recommended operating range.

Select motor with sufficient hp rating for non-overloading operation over entire pump curve.

Furnish each motor with shaft grounding brush similar to AEGIS SGR to prevent bearing from shaft current.

Furnish each pump and motor with nameplate giving manufacturer's name, serial number of pump, capacity in GPM and head in feet at design condition, hp, voltage, frequency, speed and full load current.

Test pumps hydraulically at 150% of rated pressure per Hydraulic Institute Standards, clean and paint before shipment. Manufacturer shall certify all pump ratings.

Pumps shall operate without objectionable noise or vibration.

After completion of balancing, if water balancing results in pump discharge balancing valve being closed 50% or more, replace or trim impeller so that balancing valve is opened at least 75% to maintain design flow rate. Where pumps are driven by VFDs, balancing should be performed with pumps at design speed.

Furnish one spare seal for each pump to Owner.

Head for pumps submitted for pumping through evaporators and condensers of chillers, heat exchangers and water coils shall be increased, if necessary, to match the equipment approved for the project.

2.16.2 Required Pump Submittal Information

Manufacturer's name and model number

Identification as referenced in the documents

Capacities/ratings

Pump curves with operating point clearly indicated. For parallel pump applications, indicate operating point of combined case as well as operating point of only one pump.

Motor data

Seals

Materials of construction

Dimensions and weights

Manufacturer's installation instructions

All other appropriate data.

2.16.3 Factory Testing

Pump manufacturer shall conduct factory performance testing of completely assembled pump, drive line, motor, and frame base plate unit before shipment for all water system pumps above 25 hp.

Factory performance testing shall be in accordance with Hydraulic Institute, ANSI/HI 1.6-2000, American National Standard for Centrifugal Pump Tests for Acceptance Level A.

For pumps provided with variable speed drives, test shall include operating the assembled unit over the entire variable speed range, variable head, and variable flow performance range contained on submitted pump Shop Drawing performance curves performance window formed between minimum flow and maximum flow limitations established by submitted NPSHR curve. Test each pump at 50 rpm intervals between 100 rpm and maximum design performance rpm specified.

After testing is complete and before pump is shipped, manufacturer shall submit to Engineer for final acceptance, 6 original test reports which present all measured test data. Each original report shall be signed by authorized factory pump Design/Pump Test Engineer.

Signed test reports shall include the following statement:

> "Provided that the pump being furnished is operated within the entire window of operating points between the tested speeds, heads, and flows, manufacturer shall warranty the pump against any performance loss, rotating part damage, stationary part damage, or structural damage caused by mechanically induced or fluid induced vibration occurring within the pump or within the foot print of the pump frame base plate." This warranty includes all materials and labor to repair the pump for a period extending 12 months after final acceptance of the system.

2.16.4 Construction

Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 125 psig. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Provide threaded suction and discharge pressure gage tapping with square-head plugs.

Impeller shall be statically and dynamically balanced. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water.

Close-coupled pump shall be provided with integrally cast or fabricated steel feet with bolt holes for securing feet to supporting surface. Close-coupled pumps shall be provided with drip pockets and tapped openings. Pump shall be accessible for servicing without disturbing piping connections. Shaft seals shall be mechanical-seals.

2.16.5 End Suction Centrigufal Pumps (Flexible Coupled)

Manufacturers: Taco, Armstrong, Peerless, Aurora, PACO or Goulds

Pumps shall be base mounted, end suction, flexible coupled, cast iron casing, bronze fitted with working pressure of 175 psi and continuous

operating temperature of 225 degrees F. Pump design shall allow for servicing of impeller and bearing assembly without disturbing piping, motor or requiring shaft realignment.

Casings shall have tapped and plugged openings for vent, drain, and suction and discharge gauge connections.

Impellers shall be single suction enclosed type made of bronze, hydraulically and dynamically balanced to ANSI/HI 1.1-1.5-1994, Section 1.4.6.1.3.1, Figure 1.106 Balance Grade G6.3, keyed and locked to pump shafts and protected by replaceable bronze shaft sleeves.

Pump shafts shall be high strength carbon steel, sealed and gasketed from pumped fluid.

Chilled water and hot water pumps shall be furnished with mechanical seals with carbon rotating faces, ceramic stationary seats, Buna-N elastomer and 316 SS spring, rated up to 225 degrees F continuous operation.

Bearing assemblies shall be cast iron with regreasable ball bearings.

Spacer type couplings or couplings with extended hubs shall be used to allow for pump servicing. Couplings shall be suitable for across-the-line starting as well as variable speed conditions associated with variable speed drives. Coupling basis of design: Woods Duraflex Coupler.

Pumps shall be furnished with groutable steel base plates.

2.16.6 Double Suction Vertical Split Case Centrifugal Pumps

Manufacturers: Taco, Armstrong, Peerless, PACO, Goulds, Aurora, Worthington, Ingersoll-Rand, Fairbanks Morse or Deming.

Pumps shall be base mounted, double suction, flexible coupled, vertical split case with cast iron casings, bronze fitted with working pressure of 175 psi and operating temperature of 225 degrees F continuous. Pump design must allow for servicing without disturbing piping, motor or requiring shaft realignment.

Casings shall be cast iron or ductile iron. Bearing housing supports and suction and discharge flanges shall be integrally cast with lower half of casings. Upper half of casings shall be removable without disconnecting suction and discharge piping.

Casings shall have tapped and plugged openings for priming, vent, drain, and suction and discharge gauge connections.

Impellers shall be double suction type made of cast bronze, enclosed double suction type, hydraulically and dynamically balanced to ANSI/HI 1.5-1994, Section 1.4.6.1.3.1, Figure 1.106 Balance Grade G6.3, keyed and locked to pump shafts. Impellers shall have removable bronze-wearing rings securely locked in place.

Pumps shall have easily removable casing rings designed such that hydraulic pressure seats them against shoulders in pump cases around entire periphery of wearing rings.

Rotating elements shall be mounted in heavy-duty regreasable ball bearings and shall be equipped with water slingers on the side next to pump glands.

Pump shafts shall be high strength carbon steel, or stainless steel, sealed and gasketed from pumped fluid. Shaft sleeve shall be stainless steel.

Chilled water and/hot water pumps shall be furnished with single inside, unbalanced mechanical seals with carbon rotating faces, ceramic stationary seats, Buna-N elastomer and 316 SS spring, rated up to 225 degrees F continuous operation. Seals shall be internally flushed.

Bearing assemblies shall be cast iron with regreasable ball bearings.

Spacer type couplings or couplings with extended hubs shall be used to allow for pump servicing.

Pumps shall be supplied with groutable steel base plates with drip pans and drain connections.

2.16.7 Fan Coil Unit Condensate Drain Pump Units - Above Ceiling Application

Manufacturers: Hartell, Little Giant or equal. Basis of Design is the Hartell Model A2X-165 Pump.

Dual Voltage 115V, 3.5A or 230V 1.7A. Coordinate condensate pump power supply with power supply available at the Fan Coil Unit.

The pump assembly must be "Plenum Rated" for a hard wired power connection and therefore provided from the factory without an electrical plug on the cord end. It is not acceptable to cut the plug off the cord since it will void the unit warranty and will not be a plenum rated assembly.

1/10 Hp motor at 3000 RPM.

Built in float control switch.

The unit must be provided with a disconnect switch. A "Motor Rated Toggle Switch" may be used for this application. The disconnect switch will be provide by Division 26 (Electrical).

Water reservoir to be aluminum 1-gallon capacity with (3) top 1-1/4 inch inlets and one 3/4 inch bottom inlet. Pump discharge is 3/8 inch FNPT.

Pump performance 185 GPH at 6.0 feet., 51 GPH at 20.0 feet, Max Lift 22.0 feet.

Refer to piping plans for discharge piping size and routing. To discharge to clear water waste piping system, provide back water check valves where connected to storm riser.

2.17 EXPANSION TANKS

Tank shall be welded steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Provide tanks precharged to the minimum operating pressure. Tank shall have a replaceable polypropylene or butyl lined diaphragm which keeps the air charge separated from the water; shall be the captive air type.

Tanks shall accommodate expanded water of the system generated within the

normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

Manufacturers: Amtrol, Taco, Bell and Gossett, Armstrong, Wheatley, or Wessels

Tanks shall be replaceable bladder type air pre-charged to initial fill pressure as scheduled. Furnish tank suitable for (125 psig) WP, constructed, tested and stamped in accordance with ASME Code, and sealed-in elastomer bladder suitable for operating temperature of (240 degrees F). Bladder shall be compatible with water and with ethylene and propylene glycol. Furnish mounting saddles for horizontal tanks and mounting base for vertical tanks. Furnish tanks with system connections; drain connections for floor-mounted tanks, and air charging valves.

2.18 AIR SEPARATOR TANKS

External air separation tank shall have an internal design constructed of stainless steel and suitable for creating the required vortex and subsequent air separation. Tank shall be steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Tank shall have tangential inlets and outlets connections, threaded for 2 inches and smaller and flanged for sizes 2-1/2 inches and larger. Air released from a tank shall be vented as indicated. Tank shall be provided with a blow-down connection.

Manufacturers: Amtrol, Armstrong or Taco

(1-1/2 inches) and Smaller: Cast iron construction with steel diffuser tube, bottom and side threaded inlet connections, bottom and top threaded outlet connections, threaded top connection for air elimination, designed for maximum (125 psig) WP.

(2 inches) and Larger

Centrifugal type, cast iron or carbon steel construction, flanged connection, threaded connections acceptable for 3 inches and smaller, perforated stainless steel air collector tube to direct air toward air elimination connection at top of unit, inlet and outlet connections tangential to vessel shell, bottom blow down connections, constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code for (125 psig) design pressure at (350 degrees F).

Vessel shell diameter shall be at least 3 times nominal inlet/outlet pipe diameter.

Manufacturer's data sheet shall include air collection efficiency and pressure drop at design flow scheduled

Where integral strainer is indicated on air separator schedule, furnish with removable galvanized steel system strainer with (3/16 inch) diameter perforations and free area not less than five times cross sectional area of connecting pipe

2.19 HEAT EXCHANGERS (PLATE AND FRAME TYPE)

Manufacturers: Mueller, APV, Graham or Alfa-Laval with size, capacity, and operating characteristics as scheduled.

Plate and frame type with removable gasketed plates constructed and stamped in accordance with the latest ASME Code. Each unit shall be registered with National Board of Boiler and Pressure Vessel Inspectors.

Common gasket materials; EPDM (up to 320 degrees F), NBR (nitrile) (up to 230 degrees F). Nitrile is compatible with glycol-water. If petroleum product involved, use NBR (not EPDM). Consider Hypalon and Viton for special application.

Heat exchangers shall be suitable for working pressure of 125 psi and test pressure of 250 psi.

Heat exchange plates shall be 304 stainless steel with gasketing material suitable for potable water systems and compatible with hot water heating system chemical treatment.

Furnish units with epoxy coated structural steel framework as required to adequately support assembled plates.

Construct nozzles of 304L stainless steel.

Unless otherwise indicated, fouling margin (extra heat exchange surfaces) shall be 10% minimum.

2.20 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing equivalent chromium (CPR) is prohibited.

2.20.1 Water Analysis

Conditions of make-up water to be supplied to the chilled water and heating hot water systems were reported in accordance with ASTM D596 and are as follows:

Date of Sample	_____
Temperature	_____ degrees F
Silica (Sino 2)	_____ pp (mg/1)
Insoluble	_____ pp (mg/1)
Iron and Aluminum Oxides	_____ pp (mg/1)
Calcium (Ca)	_____ pp (mg/1)
Magnesium (Mg)	_____ pp (mg/1)
Sodium and Potassium (Nan and AK)	_____ pp (mg/1)

Carbonate (HO 3)	_____ pp (mg/1)
Sulfate (SO 4)	_____ pp (mg/1)
Chloride (JCL)	_____ pp (mg/1)
Nitrate (NO 3	_____ pp (mg/1)
Turbidity	_____ unit
pH	_____
Residual Chlorine	_____ pp (mg/1)
Total Alkalinity	_____ PM (me/1
Non-Carbonate Hardness	_____ PM (me/1
Total Hardness	_____ PM (me/1
Dissolved Solids	_____ pp (mg/1)
Fluorine	_____ pp (mg/1)
Conductivity	_____ McMahon/cm

2.20.2 Chilled Water, Chilled Beam Water and Heating Hot Water

Water to be used in the chilled water system, chilled beam water and heating hot water shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

2.20.3 Water Treatment Services

The services of a company regularly engaged in the treatment of chilled and heating hot water systems shall be used to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall maintain the chemical treatment and provide all chemicals required for the chilled and heating hot water systems for a period of 1 year from the date of occupancy. The chemical treatment and services provided over the 1 year period shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Acid treatment and proprietary chemicals shall not be used.

2.20.4 Shot Feeders for Closed Loop Systems

A shot feeder shall be provided on the chilled water, chilled beam water, and heating hot water piping systems as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.21 ELECTRICAL WORK

Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be VFD rated. Pump motors shall be selected to provide non-overload capacity.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Use solid-state variable-speed controllers for motors rated 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS.

2.22 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

2.22.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. The factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be in accordance with ASTM B117, and for that test, the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the

test specimen.

If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

2.22.2 Shop Painting Systems for Metal Surfaces

Clean, retreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where hot-dip galvanized steel has been cut, resulting surfaces with no galvanizing shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

2.23 FACTORY APPLIED INSULATION

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84.

Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.24 NAMEPLATES

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, type or style, model or serial number on a plate secured to the item of equipment. The nameplate of the distributing agent will not be acceptable. Plates shall be durable and legible throughout equipment life and made of stainless steel. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.25 RELATED COMPONENTS/SERVICES

2.25.1 Drain and Make-Up Water Piping

Requirements for drain and make-up water piping and backflow preventer is specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.25.2 Field Applied Insulation

Requirements for field applied insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.25.3 Field Applied Insulation

Requirements for field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as supplemented and modified by this specification section.

2.25.4 Field Painting

Requirements for painting of surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00 PAINTS AND COATINGS.

2.25.4.1 Color Coding

Requirements for color coding for piping identification are specified in Section 09 90 00 PAINTS AND COATINGS.

PART 3 EXECUTION

3.1 INSTALLATION

Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove burrs by reaming, and fashion to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

Pitch horizontal mains up at 1 inch per 40 feet in direction of flow. Install manual air vents at all high points where air may collect. If vent is not in accessible location, extend air vent piping to nearest code acceptable drain location with vent valve located at nearest accessible location to pipe.

Main branches and runouts to terminal equipment may be made at top, side or bottom of main provided that there are drain valves suitably located

for complete system drainage and manual air vents are located as described above.

Unless otherwise indicated, for upfeed risers, use top or top 45 degrees connection to main and for downfeed risers use side or bottom 45 degrees connection to main. If side or bottom 45 degrees connection is not practical and bottom connection to main must be used, provide line size Y strainer with shut-off valve at each side at branch connection.

Use minimum of 3 elbows in each pipeline to terminal equipment to provide flexibility for expansion and contraction of piping systems.

Use eccentric fittings for changes in pipe sizes and for valves smaller than pipe sizes, in horizontal lines, with fittings installed for proper air venting (top of pipe straight). Concentric fittings may be used for changes in pipe sizes in vertical lines.

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.1 Welding

Provide welding work specified this section for piping systems in conformance with ASME B31.9, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, brazers, brazing operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

3.1.1.1 Employer's Record Documents (For Welding)

Submit for review and approval the following documentation. This documentation and the subject qualifications shall be in compliance with ASME B31.9.

a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.

b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.

c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

3.1.1.2 Welding Procedures and Qualifications

a. Specifications and Test Results: Submit copies of the welding procedures specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

b. Certification: Before assigning welders or welding operators to the

work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

3.1.1.3 Examination of Piping Welds

Conduct non-destructive examinations (NDE) on piping welds and brazing and verify the work meets the acceptance criteria specified in ASME B31.9. NDE on piping welds covered by ASME B31.9 is visual inspection only. Submit a piping welds NDE report meeting the requirements specified in ASME B31.9.

3.1.1.4 Welding Safety

Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

3.1.2 Directional Changes

Make changes in direction with fittings, except that bending of pipe 4 inches and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.

3.1.3 Functional Requirements

Pitch horizontal supply mains down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter, and with flanges for pipe 3 inches and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges.

Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

3.1.4 Fittings and End Connections

3.1.4.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint

compound applied to the male threads only. Not more than three threads shall show after the joint is made.

Threads of pipe and fittings shall conform to ASME B1.20.1.

Ream pipe ends after cutting and clean before erection. Apply thread sealants to cleaned male threads. Assemble joint to appropriate depth and remove any excess pipe joint compound from tightened joint.

3.1.4.2 Brazed Connections

Brazing, AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.4.3 Welded Connections

Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.9. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.4.4 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.4.5 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

Clean flange surfaces and align them parallel. Bolt holes of gaskets shall be cut slightly larger than bolt diameter. Gasket ID shall be slightly larger than flange ID.

Position gasket concentrically so compression is equally distributed over entire gasket surface.

Lubricate bolts and run nuts down by hand.

By using torque wrench, tighten nuts in the proper sequence so gasket is

compressed evenly, and to the appropriate torque specified by bolt manufacturer.

Re-torque bolts 12 to 24 hours after start up.

3.1.5 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

Install valves as shown on plans, details and according to manufacturer's installation recommendations.

After piping systems have been pressure tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust, replace packing or replace valves to stop leaks.

Install control valves furnished under Control Systems. Provide increaser and decreaser fittings as required.

Provide reducing fittings as requirement for valves smaller than pipe size.

Provide chain operators for manually operated valves (4 inches) and larger, located more than (6 feet) above equipment room floor.

3.1.6 Shut-Off Valves

Provide shut-off valves at all equipment, at riser take-offs at each floor, and at each automatic valve for servicing.

3.1.7 Balancing Valves

Provide balancing valves where indicated on drawings and as required for complete balancing of water systems.

Provide straight inlet and outlet pipe length in accordance with manufacturer's recommendation.

For buildings with multiple stories, provide balancing valve in return line at riser take-offs at each floor. Provide shut off valve in supply line at each riser take-off.

3.1.8 Pump Discharge Valve

Contractor is to provide a combination shut-off, check and balancing pump discharge valve on all pump discharge lines.

The pump discharge valve is to be installed per manufacturers recommendations for required inlet and outlet conditions.

3.1.9 Gauge Valves

Provide gauge valves at each pressure gauge as shown and at each pressure tapping where pressure sensing tubing is connected.

3.1.10 Drain Valves

Provide drain valves at all low points of piping systems for complete drainage of systems.

3.1.11 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system. Install automatic air vent at top of air separator and where shown on drawings. Provide shut-off valve to isolate air vent from system. Pipe automatic air vent to the nearest floor drain. Install high capacity automatic air vent at air separator

3.1.12 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.13 Flexible Pipe Connectors

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.14 Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch. Install thermometers in thermowells sockets in locations indicated. Install thermometer test wells in locations as shown and at each point where temperature-sensing device is required under Control Systems.

3.1.15 Pressure Gauges

Install gauges for services other than steam with pressure snubbers and gauge valves.

3.1.16 Pressure Gauge Tapping

Install tappings with gauge valves at each point where sensing device is required under Control Systems and at gauge locations as shown.

Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.1.17 Pressure/Temperature Test Stations

Pete's plug may be used in lieu of thermometer test well and pressure gauge tappings.

Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

Provide a pressure/temperature test station directly adjacent to each pipe mounted Controls System chilled water or heating hot water pressure and temperature sensor to allow for verification and sensor calibration. Provide the test stations as described even if they are not specifically shown on the mechanical drawing plans or details.

3.1.18 Pipeline Strainers

Provide drain valve at each strainer blowdown connection with hose threaded adapter and cap. Valve size shall be same as blowdown connection size.

Install strainers in water systems on suction side of all pumps, entering side of automatic control valves of heating and cooling coils of air handling units, and as indicated elsewhere.

3.1.19 Pump Suction Diffusers

Pipe blow down to the nearest floor drain with drain valve at unit.

Remove disposable fine mesh start-up strainers after start-up. Clean permanent strainer and replace after pipe cleaning process.

3.1.20 Flow Elements/Flowmeters

Flow elements/flowmeters located in common piping after multiple pump discharge lines shall be furnished with hot tap feature.

If flow elements/flowmeters are furnished by Control Contractor, this Contractor shall install them in accordance with manufacturer's installation instructions. Wiring of flowmeters will be provided by Control Contractor.

Provide proper inlet and outlet straight pipe lengths as required by the manufacturer for proper meter operation.

Provide straightening vanes where flow sensor manufacturer's installation instructions require greater length of straight upstream piping than can be obtained in available space.

3.1.21 Water Filters

Install water filter in by-pass arrangement across system pumps or per details. Allow clearance at top of filter for removal of cover and filter changes.

Install shut-off valves at filters and pressure gauges for measuring pressure drop across filters.

3.1.22 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as supplemented and modified in this specification section. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load.

Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

Coordinate hanger and support installation to properly group piping of all trades.

Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

Piping and ductwork shall be supported independently from other piping or ductwork.

Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

Do not support equipment, piping or ductwork from metal roof decking or ceiling grid.

Install adequate supports during erection of piping so as not to over stress either piping or equipment to which piping is connected.

3.1.22.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

Space pipe hangers and supports for horizontal pipe accordance with the following schedule, with exceptions as indicated herein.

Steel Pipe (Standard Weight and Extra Strong):

Pipe Size	Max Spacing
1-1/4 inches and smaller	7'-0"
1-1/2 inches	9'-0"
2 inches	10'-0"
2-1/2 inches	11'-0"
3 inches	12'-0"
4 inches	14'-0"

Pipe Size	Max Spacing
6 inches	17'-0"
8 inches	19'-0"
10 inches and larger	20'-0"

Copper Tube (Unless Otherwise Noted):

Pipe Size	Max Spacing
3/4 inch and smaller	5'-0"
1 inch to 1-1/4 inch	6'-0"
1-1/2 inches to 2-1/2 inches	8'-0"
3 inches and larger	10'-0"

PVC Pipe:

Pipe Size	Max Spacing
All sizes	4'-0"

Support plastic pipe at all changes of direction. Adequate consideration shall be given to piping expansion.

3.1.22.2 Condensate Drain Lines

Provide water seals in the condensate drain from all units that produce condensate from cooling coils or heat exchangers. Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the appropriate building water drain system as shown using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Refer to details for trap design.

3.1.22.3 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

Concrete insert application, size, loading, and placement shall be reviewed and approved by Structural Engineer prior to installation.

Coordinate with General Contractor for placement of inserts before

concrete pour. Minimize use of inserts and anchors after concrete pour.

3.1.22.4 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

Provide locknut for hanging rod at clamp.

C-clamps are allowed for rod size 3/8 inch and only for static loading such as air piping, cold water piping, fire protection piping and, other similar piping and ductwork. C-clamps are not allowed for hot water piping and steam and steam condensate piping, except hot water runouts to terminal heating devices.

3.1.22.5 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.22.6 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

Install insulation protection shields at support points as specified under Insulated Pipe Supports.

Use one shield (bottom) for clevis hanger.

Use 2 shields (top and bottom) for roller hanger/support or strap/clamp support. Apply 2 metal straps to hold top and bottom shields onto insulation jacket.

3.1.22.7 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

3.1.22.8 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

Insulated Piping and non-insulated piping (120 degrees F and above):

Unless otherwise indicated, support vertical piping as indicated below.

Support vertical piping at each floor of riser, secured and anchored to building structure. Provide guides on vertical piping. Use spring hangers when required at floors of riser and at take offs from riser at each floor. Use spring hangers for minimum 3 hangers away from top and bottom elbows and from each take off at riser.

Guide vertical piping 2 inches and smaller at every floor. Guide 2-1/2 inches and larger at every other floor. Spring hangers (Type 6) and guides (Type VSG).

Ambient Bare Piping:

Unless otherwise indicated, maximum vertical support spacing for ambient bare steel and cast iron pipes shall be 15 feet.

Maximum vertical support spacing for other piping including copper tubing and plastic piping shall be 10 feet.

Install riser clamps and intermediate supports as required.

Rest riser clamps on floor or on pipe sleeve.

3.1.22.9 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

Install where shown on drawings.

For manufactured expansion devices, install minimum of 2 pipe guides at each side of manufactured pipe expansion device. Locate first guide no more than 4 pipe diameters from expansion device and second guide at 14 pipe diameters from first guide. Install intermediate guides in accordance with guide spacing data recommended by manufacturer or the following table, whichever is more stringent:

MAXIMUM DISTANCE BETWEEN INTERMEDIATE GUIDES (FT)				
	Pipe Operating Pressure			
Pipe Size (inches)	0 to 50 psig	51 to 100 psig	101 to 150 psig	151 to 200 psig
3	21	19	17	16
4	35	29	25	22
6	57	44	37	32
8	66	52	45	40
10	91	69	58	51

MAXIMUM DISTANCE BETWEEN INTERMEDIATE GUIDES (FT)				
12	107	79	66	58
14	115	85	71	62
16	127	94	78	68

If anchor is located within 4 pipe diameters from expansion joints, guides need not be installed on anchor side.

3.1.22.10 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.22.11 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.22.12 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.1.23 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.24 Pipe Anchors

Anchors shall be provided where indicated. Unless indicated otherwise, anchors shall comply with the requirements specified.Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required.

Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the

weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.

Install anchors where shown on drawings or in conjunction with expansion joints, loops and swing joints as required to allow proper expansion and contraction of piping without damage to structure, equipment or piping.

Do not anchor piping to concrete block walls, wood, or partition walls.

3.1.25 Pipe Expansion Devices

Stretching of expansion joints or connectors to correct for piping misalignment is not allowed.

Install expansion loops, L-bends, Z-bends, and compensators where shown on drawings and as necessary to allow expansion and contraction in piping systems.

3.1.26 Equipment Rails

Use for all roof-mounted equipment, which is not curb mounted. Install bottom of equipment rail flat on roof deck. Insulate exterior of equipment rail.

Flashing will be by General Contractor. Provide counter flashing as specified and secure to wood nailer with stainless steel truss head screws.

3.1.27 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Except as indicated otherwise piping sleeves shall comply with requirements specified. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

3.1.27.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

3.1.27.2 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a .17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut.

   After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.27.3 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 00 FIRESTOPPING.

3.1.27.4 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.28 Access Panels

Access panels shall be provided where indicated for all concealed valves, vents, controls, and additionally for items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS Section 05 52 00 METAL RAILINGS.

3.1.29 Raw Water Makeup

Install piping where indicated, including valves, piping specialties and

dielectric unions required for functional system.

Raw water make-up piping for this Section is defined as fill line containing pressure reducing valve for water systems.

3.1.30 Chemical Treatment

Install piping as indicated on drawings, as detailed, and as recommended by supplier of chemical treatment equipment.

3.1.31 Cooling Coil Condensate Drain

Trap each cooling coil drain pan connection with trap seal of sufficient depth to prevent conditioned air from moving through piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes.

Pitch pipe down at 1/4 inch per one foot for proper drainage.

Where copper piping is allowed, joints and fittings may be secured with 95-5 tin-antimony solder or brazing alloys.

When above ceiling fan coil unit coil condensate drains are located in areas where there is not sufficient height to allow proper slope of the drain pipe, provide a condensate pump per specifications. The pump must be a hard wired, plenum rated design.

3.1.32 Dielectric Unions and Fittings

Install dielectric unions, flanges or fittings in main and branch piping of water systems at each point where copper to steel pipe connection occurs. Dielectric unions or fittings shall not be used at terminal device connections.

Concealed dielectric unions and fittings are not allowed.

Install steel to steel pipe dielectric unions or flanges in hot water and chilled water piping at each point where interior steel piping is connected to exterior underground steel piping.

3.1.33 Union and Flanges

Install union or flange at each automatic control valve and at each piping specialty or piece of equipment that requires tube pull or removal for maintenance, repair or replacement. If required, provide additional unions or flanges in order to facilitate removal of piping sections that interfere with tube pulls or equipment removal. Where valve is located at piece of equipment, provide flange or union connection on equipment side of valve.

Concealed unions or flanges are not allowed.

3.1.34 Installation of Pumps

Install pumps in strict accordance with manufacturer's instructions to avoid any stress and misalignment.

Set base mounted pumps on concrete bases, or concrete inertia base, level and bolt down prior to grouting. Fill entire base with non-shrinking

grout, pumps bases are to grouted in place per manufacturers recommendations. Use end caps during grouting to prevent overflow when end caps are not integral with base plates.

Fill under base plates of vertical turbine pumps with non-shrinking grout in accordance with manufacturer's recommendation and Hydraulic Institute Standards.

Align flexible coupled pumps after base grouting is complete. Align pump and motor in all four planes: vertical angular, horizontal angular, vertical parallel and horizontal parallel. Alignment shall be within the recommended value by manufacturer, but not over 1/64 inch for parallel alignment and 1/64 inch per inch of coupler radius for angular alignment. Record and submit all results of alignment procedure to Engineer. After alignment is complete, pin pump and motor to base.

Set close-coupled pumps on concrete bases using flush type anchors and cap screws to allow for pump servicing. Use of threaded rod will not be allowed.

Install full line size spring loaded check valve and balancing valve in pump discharge piping.

Where pump connection size and indicated line sizes are not identical, provide necessary concentric reducers/increasers for vertical piping at pump connection and eccentric reducers/increasers for horizontal piping at pump connection. Install eccentric reducers/increasers with top of pipe level. Valves and piping specialties shall be full line size as indicated on drawings.

3.1.35 Start Up of Pumps

Verify that piping system has been flushed, cleaned and filled.

Prime pump, vent air from casing and verify that rotation is correct. To avoid damage to mechanical seals, never start or run pump in dry condition.

Verify lubrication of motor and pump bearings and lubricate properly in accordance with manufacturer's recommendation.

After several days' operation, verify removal of disposable startup strainer in suction diffuser and turn them over to Owner.

The pump and motor drive shafts and the drive couplings shall be field-aligned by the manufacturer's representative to meet manufacturer's requirements.

Perform field mechanical balancing, if necessary, to meet vibration tolerance specified in Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.

3.1.36 Plate and Frame Heat Exchangers

Provide structural floor or building support for the heat exchanger and water contents. Provide structural steel framework as required per manufacture's requirements.

Provide maintenance access on all sides for the heat exchangers including access for removing the end plates and replacing the internal plates and

components. The end plate opposite the piped end shall be removable for plate replacement; and plate replacement shall be achievable without the removal of the piping connections to the piped end.

Provide a complete thermal insulation system with vapor barrier per specifications for the heat exchangers.

3.2 ELECTRICAL INSTALLATION

Install electrical equipment in accordance with NFPA 70 and manufacturer's instructions.

3.3 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.4 FIELD TESTS

Field tests shall be conducted in the presence of the QC Manager or his designated representative to verify systems compliance with specifications. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor.

3.4.1 Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the tests shall be properly isolated.

3.4.2 Pressure Tests

Each chilled water piping system (including underground chilled water piping systems) shall be hydrostatically tested at a pressure not less than 188 psig for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a currently calibrated test pressure gauge. Leaks shall be repaired and piping retested until test requirements are met. No leakage or reduction in gage pressure shall be allowed.

Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

Submit for approval pressure tests reports covering the above specified piping pressure tests; describe the systems tested, test results, defects found and repaired, and signature of the pressure tests' director. Obtain approval from the QC Manager before concealing piping or applying insulation to tested and accepted piping.

Owner and/or Owner's representative may elect to witness pressure test. Notify Owner and/or Owner's representative at least 3 days in advance.

Conduct pressure test prior to flushing and cleaning of piping systems.

Conduct hydrostatic (HYDRO) test in accordance with ASME B31.1 137.4. Test pressure shall be in accordance with ASME B31.1, but shall not be lower than the minimum test pressure listed above.

If leaks are found, repair with new materials and repeat test until leaks are eliminated. Caulking will not be acceptable.

Pressure tests may be made of isolated portions of piping systems to facilitate general progress of installation. Any revisions made in piping systems require retesting of affected portions of piping systems.

No systems shall be insulated until it has been successfully tested. If required for additional pressure load under test, provide temporary restraints at expansion joints or isolate them during test. Unless otherwise noted, minimum test time shall be 4 h plus such additional time as may be necessary to conduct examination for leakage.

No pressure drop shall occur during test period. Any pressure drop during test period indicates leakage.

Provide pumps, gauges, instruments, test equipment, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.

For hydrostatic tests, remove air from piping being tested by means of air vents. Measure and record test pressure at high point in system. Where test pressure at high point in system causes excessive pressure at low point in system due to static head, portions of piping system may be isolated and tested separately to avoid undue pressure. However, every portion of piping system must be tested at the specified minimum test pressure.

Contractor shall provide all pumps, gauges, instruments; test equipment, flow meters, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.

If piping system is drained after testing and left empty or untreated for more than 3 days, add Nalco 2572 at recommended dosages for dry system lay-up.

3.4.3 Flushing and Cleaning of Piping Systems

Notify Owner and/or Owner's representative at least 7 days in advance.

Provide a Flushing and Cleaning Plan for the mechanical chilled water and heating hot water systems that details methods for compliance with requirements of this section including:

a. Size, power source, and connection points of contractor provided pumps that will be used for flushing and cleaning.

b. Calculations, along with drawings or diagrams showing, sectioning or zoning of piping systems to achieve required velocities, location and means of temporary bypasses and returns.

c. Flushing schedule and drawings or diagrams that will be used for

inspection and sign off prior to and after procedure, at Owner's option.

d. Submit documents showing verification of flushing/cleaning following specified requirements and results

Flush new water systems thoroughly for 15 minutes or longer, as required to ensure removal of dirt and foreign matter from piping system. Bypass pumps and equipment and remove strainers from strainer bodies. Provide circulation by Contractor-supplied portable pumping apparatus.

Provide temporary piping or hose to bypass coils, control valves, heat exchangers, other factory-cleaned equipment, and any component that may be damaged.

Sectionalize system to obtain minimum velocity of 6 fps. Provide temporary piping to connect dead-end supply and return headers as necessary. Flush bottoms of risers.

For pipes 18 inches and larger, maintain velocity as close as 6 fps possible, but not below 5 fps.

After initial flushing of system, use portable pumping apparatus to circulate cold water detergent for water systems. Refer to Section 23 2514 - Chemical Treatment Systems for pipe cleaning.

After initial flushing of system, use portable pumping apparatus for continuous 24 h minimum circulation of cold water detergent similar to Nalco 2567 cleaner. Flush detergent clear with continuous draining and raw water fill for additional 12 h or until all cleaner is removed from system. Replace strainers and reconnect permanent pumping apparatus and all apparatus bypassed.

Refer to Section 23 25 00 CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS for water analysis.

Flush gas piping with clean, dry compressed air for one (1) h minimum. Open and clean drip legs. Repeat flushing until no debris is found in drip legs.

Flush compressed air piping with clean, dry compressed air for one (1) h minimum. Open and clean drip legs. Repeat flushing until no debris is found in drip legs.

3.4.4 Flushing Underground Chilled Water Piping Systems

Contractor shall visually inspect internal portion of each pipe segment during installation. Remove all dirt and foreign matter prior to installing additional segments.

After piping has been installed, flush pipeline system clean. Flush pipeline at minimum velocity of 6 fps. Flushing shall continue until water draining out of pipe is clear and clean, as determined by Owner's representative. Cleaning water drained from piping shall be collected and conducted to storm sewer.

Contractor shall provide all water for flushing.

Contractor shall provide all temporary piping from water source to piping

system and shall provide means for conducting cleaning water from underground piping system to storm sewer; i.e. pumps, piping, hoses, etc. Remove all temporary piping, pumps, hoses, etc. from site after flushing has been completed.

3.4.5 Pipe Painting

Exposed exterior carbon steel, black iron or other ferrous pipe and fittings shall be prepared and painted by qualified painters using corrosion inhibitive paints. Clean, pretreat, prime and paint metal surfaces. The cleaning process shall be done with environmentally friendly products that are all LEED compliant. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and degreasing with environmentally friendly products prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal. Pipe shall be prepared in accordance with paint manufacturer's instructions and primed (2 coats) and finish painted (2 coats), apply the second coat after the preceding coat is thoroughly dry. Paint type and color shall be approved by Architect/Engineer.

Protect piping from weather and paint promptly to prevent corrosion.

3.4.6 Related Field Inspections and Testing

3.4.6.1 Piping Welds

Examination of Piping Welds is specified in the paragraph above entitled "Examination of Piping Welds".

3.4.6.2 HVAC TAB

Requirements for testing, adjusting, and balancing (TAB) of HVAC water piping, and associated equipment is specified in Section 23 05 93 TESTING,ADJUSTING, AND BALANCING FOR HVAC. Coordinate with the TAB team, and provide support personnel and equipment as specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC to assist TAB team to meet the TAB work requirements.

3.5 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the chilled water, and heating hot waterpiping systems. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and maintenance manuals.

Conduct a training course for the operating staff and maintenance staff selected by the Contracting Officer. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be four continuous man-days. Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system.

- When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

-- End of Section --

SECTION 23 72 00.00 10

ENERGY RECOVERY SYSTEMS
01/08

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G

SD-03 Product Data

Spare Parts; G
Manufacturer's name and model number
Capacities/ratings/efficiencies
Pressure/temperature rating
Materials of construction
Dimensions and weights

SD-06 Test Reports

SD-10 Operation and Maintenance Data; G

Operation and Maintenance Manuals; G

1.2 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.3 EXTRA MATERIALS

1.3.1 Spare Parts

Submit spare parts data for each different item of equipment specified, after approval of the detail drawings and not later than three months before the date of beneficial occupancy. Include in the data a complete list of spare parts and supplies with current unit prices and source of supply.

1.4 OPERATION AND MAINTENANCE MANUALS

The manuals will be approved by the Contracting Officer before acceptance of the installed system. Submit 6 complete copies of operation manual for energy recovery system outlining the step-by-step procedures required for system startup, operation, and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and a brief

description of all equipment items and their basic operating features. Submit 6 copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide shall be provided. Include in the manuals piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.3 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located where personnel contact is possible. Provide items such as catwalks, operating platforms, ladders, and guardrails where shown and construct them in accordance with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS, 05 51 33 METAL LADDERS.

2.2 HEAT RECOVERY EQUIPMENT (AIR TO AIR HEAT EXCHANGERS (FIXED PLATE TYPE))

A heat recovery system shall be an integrated design package compatible with the cooling and exhaust systems in accordance with the drawings and data sheets. The heat exchanger is to be an air-to-air, fixed plate, total energy type in a unitary double wall insulated housing that is provided with outside air and exhaust air filtration.

Manufacturers: Venmar, RenewAire, or approved equal.

Unit's capacity, efficiency and operating characteristics to be as scheduled. Unit shall be capable of transferring sensible or total energy as listed in the equipment schedule.

The unit shall be capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstrem to the other, without exposing transfer media in succeeding cycles directly to the exhaust and then to the fresh air. Water vapor transfer shall be through molecular transport by hydroscopic resin and shall not be accomplished by porous plate mechanisms. Exhaust and fresh airstreams shall travel at all times in separate passages, and airstreams shall not mix. Airflow through the transfer media core shall be laminar over the entire operating flow range, avoiding deposition of particles on the interior of the energy exchange

plate material

Unit is designed to be used as a component in a dedicated HVAC system.

Flat plate heat exchanger to be factory installed in unit.

Energy transfer device shall be AHRI CertifiedTM to AHRI Standard 1060 and bear the AHRI CertifiedTM mark signature. AHRI published certifications shall confirm manufacturer's published performance for airflow, static pressure, temperature and total energy transfer and effectiveness, purge air (OACF) and exhaust air leakage (EATR). Units that are not currently AHRI Certified will not be accepted.

Airflow data shall comply with AMCA 210 method of testing.

The flat plate heat exchanger shall be a UL recognized component and shall be manufactured under ISO 9001-2000 certified quality procedures.

All units shall be run tested prior to shipment.

Unit shall be constructed in accordance with CSA C22.2 and UL 1812 and shall carry the ETL label of approval.

Insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.

Provide insulation for unit as specified for outside air duct.

Units to be capable of operating at temperatures from minimum of -60°F up to maximum of 200°F.

Entire unit must be capable of withstanding entrained moisture from outside air and also must withstand wash down of cleaning without harm to operation.

The heat transfer core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten years from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two years from the date of purchase.

2.2.1 PRODUCT DATA REQUIRED

Manufacturer's name and model number

Capacities/ratings/efficiencies

Pressure/temperature rating

Materials of construction

Dimensions and weights

2.2.2 Unit Construction:

The Energy Recovery Unit cabinet shall be manufactured to the same specified specifications as the Air Handling units specified in section 23

73 13.00 40 MODULAR INDOOR CENTRAL-STATION AIR HANDLING UNITS and may be provided by the same manufacturer as the air handling units. The unit cabinet shall be manufactured to the correct internal dimensions and duct connections to receive the energy recovery unit transfer modules with removable side access panels for the removal and replacement of the ERU modules. The cabinet shall be provided with exhaust and outside air filter racks, access doors as shown in the mechanical drawings, and coordinated duct connections to the ERU cabinet casing. Furnish all casings with minimum of 1-1/2" wide flange on each of 4 sides, both front and back for connecting ductwork.

The cabinet shall be suitable for pressure class indicated with leak tight joints, closures, penetrations, and access provisions. Provide cabinet that does not expand or contract perceptibly during starting and stopping of fans and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.002778 of unsupported span prior to acceptance by the Contracting Officer. Stiffen pulsating panels, which produce low frequency noise due to diaphragming of unstable panel walls, to raise natural frequency to an easily attenuated level. Provide enclosure that is fabricated from double wall construction, mill-galvanized minimum 16 ga G90 galvanized steel outside panel, minimum 20 ga G90 galvanized steel inner liner and insulation between panels. Provide mill-galvanized sheet metal that conforms to ASTM A653/A653M and that is coated with not less than 1.25 ounces of zinc per square foot of two-sided surface. Provide mill-rolled structural steel that is hot-dip galvanized or primed and painted. Corrosion protect edges, burns, and scratches in galvanized surfaces. Provide primed and painted black carbon steel cabinet construction that complies with this specification.

Provide removable panels to access the interior of the unit cabinet. Provide seams that are welded, bolted or gasketed and sealed with a high compression gasketing between each frame member and unit panel or door to prevent thermal bridging from interior to exterior of unit. Make entire floor as well as ceiling unit hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

Where cabinet size is such that personnel access is possible, strengthen cabinet floor to permit entry without damage to any component. The floor shall be double wall insulated contruction. Hinge and latch access doors and panels at a spacing sufficiently close to preclude leaks caused by distortion, and effectively gasket.

Provide double sloped, welded 304 stainless steel drain pans under both side of the energy recovery module within the ERU casing to collect all condensation water and to allow washdown of the ERU casing. Pipe pan drains to the nearest floor drain.

Access doors shall be double wall construction similar to casing, constructed of G90 galvanized steel, flush mounted to cabinetry, and provided with gasketed seal. Furnish doors with metal hinges, door latch and handle assembly.

Construction shall be similar to unit casing with hinged door and flush mounted. Access door shall be sufficient size for service, but not to be less than 16" wide.

Provide access section as shown and between components.

Make all door handles operable from inside the casing.

Casing leakage rate shall not exceed 3% of design air flow at 6" WG static pressure.

Interior surfaces of cabinets constructed of intact mill-galvanized steel require no further protection.

Provide cabinets with exterior surfaces constructed of mill-galvanized steel that are prepared by a phosphatizing treatment, and painted with two coats of manufacturer's standard enamel finish in color selected by the Contracting Officer.

Provide cabinets and casings that are double walled with 2 inch insulation. Provide interior wall that is galvanized . Insulation shall be glassfiber 2 inch thick, 3 lb per ft3 density or minimum 6.25 R-value foam insulated with minimum 2 pound/cubic foot foam. Thermal breaks shall be provided for all casing and door components. Cabinet casings are to be supported on a structural steel rail, tube or beam.

2.2.3 Access

Full size access door(s) to allow for periodic maintenance and inspections must be provided for all serviceable components. Doors shall be complete with heavy-duty hinges and compression type handles. Doors shall have an airtight compression seal using closed cell foam gaskets. Pressure taps, with captive plugs, shall be provided allowing cross-core pressure measurement allowing for accurate airflow measurement.

2.2.4 Filtration

Provide filter rack with 2" thick throwaway filter at entering side of unit for supply and exhaust air. Unit shall include minimum 2" thick fiberglass, disposable type air filters with Merv 8 efficiency in supply and return airstreams or filtration per schedule.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install equipment in accordance with manufacturer's instructions and recommendation. All pieces of equipment shall be bolted in place on foundations unless they are skid-mounted on the prime mover base skid. Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, drawings, and installation instructions. Include in the drawings complete ducting and wiring drawings, schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Also show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work

including clearances required for maintenance and operation. Flexible connectors shall be used to connect any ducting to the energy recovery unit housing duct connections.

Provide service clearances as indicated on the plans. Provide sufficient clearance space for the removal and replacement of the heat exchange core.

Install access doors in ductwork or plenum at each side of unit in both supply and exhaust for inspection and cleaning.

Install Dwyer Series 2000 magnehelic pressure gauge across unit in supply and exhaust air streams.

Install thermometer at each side of unit in both inlet and outlet supply and exhaust air streams (4).

3.3 FIELD TRAINING

Provide a field training course for designated operating staff members. Training shall be provided for a total of 8 hours of normal working time and shall start after the system is functionally complete, but prior to final acceptance tests. Field training shall cover all of the items contained in the approved operation and maintenance instructions.

3.4 RETESTING

If any deficiencies are revealed during test, such deficiencies shall be corrected and the tests reconducted at no additional costs to the Government.

3.5 FIELD PAINTING

Ferrous metal surfaces not specified to be coated at the factory shall be cleaned, prepared, and painted as specified in Section 09 90 00 PAINTS AND COATINGS. Exposed pipe covering shall be painted as specified in Section 09 90 00 PAINTS AND COATINGS. Aluminum lagging over insulation shall not be painted.

-- End of Section --

SECTION 23 73 13.00 40

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 211	(2005) Certified Ratings Programme - Product Rating Manual for Air Fan Performance
AMCA 300	(2008) Reverberant Room Method for Sound Testing of Fans
AMCA 99	(2010) Standards Handbook

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 430	(2009) Central-Station Air-Handling Units

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 51	(2007) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
ASHRAE 52.2	(2007; Addenda B 2008; Errata 2009, Errata 2010; INT 2010; Errata 2011) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; Cor 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011; Errata 2012) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 900	(2004; Reprint Feb 2012) Standard for Air Filter Units

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Equipment and Performance Data; G

Coil Removal Diagrams; G

Sample Warranty; G

SD-07 Certificates

Listing of Product Installations; G

Certificates of Conformance; G

Unit Cabinet; G

Fan; G

Drain Pans; G

Insulation; G

Air Handling Unit Inlet Plenums; G

Spare Parts; G

Warranty; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.3 QUALITY ASSURANCE

Submit listing of product installations for air handling units showing a minimum of 5 installed units, similar to those proposed for use, that have

been in successful service for a minimum period of 5 years. Provide list that includes purchaser, address of installation, service organization, and date of installation.

1.3.1 Certification of Conformance

Submit certificates of conformance for the following items, showing conformance with the referenced standards contained in this section:

a. Unit Cabinet

b. Fan

c. Drain Pans

d. Insulation

e. Air Handling Unit Inlet Plenums

f. Spare Parts

1.3.2 Sample Warranty

Submit sample warranty for the following items:

a. Unit Cabinet

b. Fan

c. Drain Pans

d. Insulation

e. Air Handling Unit Inlet Plenums

f. Spare Parts

1.4 DELIVERY, STORAGE , AND HANDLING

Deliver, handle, and store equipments and accessories in a manner that will prevent damage or deformity. Provide temporary skids under units weighing more than 50 pounds.

1.5 WARRANTY

Submit samples of warranty language concurrently with Certificates for review and approval by the Contracting Officer. Ensure Warranty is valid for a minimum of 2 years from the date of project closeout, showing Government as warranty recipient.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Submit equipment and performance data for air handling units in accordance with the specification. Provide data that consists of use life, total

static pressure and coil face area classifications, and performance ratings.

Submit drawings and manuals that include a spare parts data sheet, with manufactures recommended stock levels.

Shop Drawings including, but not limited to, the following:

Manufacturer's name and model number

Identification as referenced in the documents

Capacities/ratings

Fan curves

Materials of construction

Coils with computer calculated performance data

Drain pan material, construction, dimensions and drain connection location

Filters; size, efficiency

Sound power levels

Fans; type, bearings, drives

Motor data (refer to Section 20 0513 - Motors)

Vibration isolators furnish with units

Dimensions and weights

Manufacturer's installation instructions

All other appropriate data

Fan curves shall include a series of curves indicating relationship of cfm and static pressure for various rpm, brake horsepower curves, and selection range (surge curves, maximum rpm, etc).

Indicate operating point on fan curves at design air quantity and at 110% of design air quantity.

For variable air volume application, indicate operating points at 100, 80, 60, 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure and horsepower.

Coil Removal Diagrams shall be project-specific drawings with architectural floor plan that demonstrate the ability for each coil to be removed through the mechanical room door.

2.1.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

2.2 AIR HANDLING UNIT (AHU)

Provide central-station type, factory fabricated, and fully assembled air handling units (AHU) under this specification for AHUs 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 for the NASA Headquarters project. Provide AHU that includes components and auxiliaries in accordance with AHRI 430. Balance AHU fan and motor to ISO 1940-1-2005.

Provide total static pressure and coil face area classification that conform to AMCA 99.

Fans with enlarged outlets are not permitted.

Provide centrifugal fans as scheduled.

2.2.1 DESIGN CRITERIA

Furnish factory fabricated air handling units complete with fans, motors, variable pitch drives, coils, drain pans, filter sections, and damper sections, meeting configuration and as shown on drawings and/or as scheduled.

Air handling units shall have a horizontal draw-through fan configuration and discharge supply air horizontally. Refer to schedules and plans for design specifics.

Units shall be tested, rated, and certified in accordance with ARI Standard 430 and UL or ETL listed. All material shall meet NFPA 90A Flame Spread and Smoke Generation requirements.

Each fan and motor combination shall be capable of delivering 100% and 110% of scheduled air quantity at the scheduled static pressure.Provide performance data to show that the fan and motor system is capable of providing these capacities without operating in the motor safety factor.

Select each fan to operate at single stable operating point as predicted by fan curve. Fans having 2 potential operating points on fan curves are not acceptable.

Air handling unit static pressure shall take into consideration actual static pressure loss of components furnished within unit.

Motor furnished with fan shall not operate into motor service factor in any of these cases. Drive efficiency shall be considered in motor selection according to manufacturer's published recommendation, or according to AMCA Publication 203, Appendix L.

Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of the change and system effect factor calculations, indicating increased static pressure requirement as described in AMCA Publication 201. This Contractor shall be responsible for any motor; drive and/or wiring changes required as result of duct configuration changes at fan.

2.2.2 INSPECTION AND CERTIFICATION

Unit manufacturer's representative shall inspect and verify that installation is conforming to manufacturer's recommendations.

Submit report to Engineer in writing certifying that installation is in accordance with manufacturer's recommendations.

2.2.3 FIELD LEAKAGE TEST

After completion of unit's installation, unit manufacturer and installing contractor shall jointly perform field casing leakage test.

Leakage test shall verify that unit casing leakage is less than 3% of design air flow at 6" WG pressure.

Submit certified test data to Engineer for approval.

2.3 UNIT CABINET

Provide AHU cabinet suitable for pressure class indicated with leak tight joints, closures, penetrations, and access provisions. Provide cabinet that does not expand or contract perceptibly during starting and stopping of fans and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.002778 of unsupported span prior to acceptance by the Contracting Officer. Stiffen pulsating panels, which produce low frequency noise due to diaphragming of unstable panel walls, to raise natural frequency to an easily attenuated level. Provide enclosure that is fabricated from double wall construction, mill-galvanized minimum 16 ga G90 galvanized steel outside panel, minimum 20 ga G90 galvanized steel inner liner and insulation between panels. Provide mill-galvanized sheet metal that conforms to ASTM A653/A653M and that is coated with not less than 1.25 ounces of zinc per square foot of two-sided surface. Provide mill-rolled structural steel that is hot-dip galvanized or primed and painted. Corrosion protect edges, burns, and scratches in galvanized surfaces.

Provide removable panels to access the interior of the unit cabinet. Provide seams that are welded, bolted or gasketed and sealed with a high compression gasketing between each frame member and unit panel or door to prevent thermal bridging from interior to exterior of unit. Make entire floor as well as ceiling unit hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

Where cabinet size is such that personnel access is possible, strengthen cabinet floor to permit entry without damage to any component. Hinge and latch access doors and panels at a spacing sufficiently close to preclude leaks caused by distortion, and effectively gasket.

Access doors shall be double wall construction with gaskets and thermal breaks similar to casing, constructed of G90 galvanized steel, flush mounted to cabinetry, and provided with gasketed seal. Furnish all access doors with insulated double pane windows, metal hinges, door latch and handle assembly. Access doors shall swing freely without contacting any internal components such as fan frames or ultraviolet lights.

Construction shall be similar to unit casing with hinged door and flush mounted. Access door shall be sufficient size for service, but not to be

less than 24 inches wide x 62 inches tall.

Provide access section as shown and between components.

Provide duct connections to the AHU casing as dimensioned and located in the drawings. The duct connections shall be framed with angle irons for connection to ductwork. The openings shall be framed to receive the attachment of duct or dampers as shown. The openings shall be sized to provide a maximum opening velocity at 1,200 FPM at the maximum air flow rate scheduled. The AHU manufacturer shall also verify and coordinate the location and dimensions of the openings and include the openings provide in the unit internal air pressure loss calaculations.

Make all door handles operable from inside the casing.

Casing leakage rate shall not exceed 3% of design air flow at 6" WG static pressure.

Interior surfaces of cabinets constructed of intact mill-galvanized steel require no further protection.

Provide cabinets with exterior surfaces constructed of mill-galvanized steel that are prepared by a phosphatizing treatment, and painted with two coats of manufacturer's standard enamel finish in color selected by the Contracting Officer.

Provide cabinets and casings that are double walled with 2 inch insulation. Provide interior wall that is galvanized . Insulation shall be glassfiber 2 inch thick, 3 lb per ft3 density or minimum 6.25 R-value foam insulated with minimum 2 pound/cubic foot foam. Thermal breaks shall be provided for all casing and door components.

Dynamically and statically balance fan wheels at the factory. Provide fan with RPM that is 25 percent less than the first critical speed. Provide fan shaft that is solid, ground and polished steel and coated with a rust inhibitor. Provide V-belt driven fans that are designed for 50 percent overload capacity. For variable air volume air handling units that are provided with variable frequency drives, have their fans balanced over the entire range of operation (20 percent - 100 percent RPM). Balancing fans of only 100 percent design of RPM is not acceptable for air handling units to be used with variable frequency drives.

Mount fans on isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with 2-inch. Install flexible canvas ducts or vibration absorbent fan discharge seal between fan and casings to ensure complete isolation. Provide flexible canvas ducts that comply with NFPA 90A.

Weigh fan and motor assembly at air handling unit manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions.

Factory install all motors on slide bases to permit adjustment of belt tension.

Provide heavy duty, open drip-proof, operable at 460 volts, 60 hertz,

3-phase fan motors. Provide high efficiency motors. Refer to specification Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

Provide a marine-type, vapor proof service light in the fan segment. Provide 100 watt service light that is wired to an individual switch. Light requires 115 Volt, single phase, 60 Hertz service that is separate from the main power to the AHU. Provide a single 115 volt outlet at the light switch.

2.4 FAN

Provide an overall fan-section depth that is equal to or greater than the manufacturer's free-standing fan.

Provide single-wheel, unhoused, backward curved, plenum fans. Refer to specification section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION AND EXHAUST SYSTEMS for plenum fan specifications.

Locate fan inlet where it provides not less than one-half fan-wheel diameter clearance from cabinet wall or adjacent fan inlet where double wheels are permitted.

Install AHU fan motor and drive inside fan cabinet. Fans may be belt or direct driven as identified in the AHU schedule. Provide premium efficiency motors that conform to NEMA MG 1 and is installed on an adjustable base. Provide an access door of adequate size for servicing motor and drive. Provide a belt guard inside the cabinet, or interlock the access door with the supply fan so that power to the fan is interrupted when the access door is opened. Belt guards shall be OSHA Compliant with tachometer openings at shaft locations

For variable speed application, balance fan dynamically for entire range of operation. Fans shall be fastened securely to solid steel shafts and designed for continuous operation at maximum rated static pressure.

Fan bearings shall be self-aligning, pillow block regreasable ball type selected for average life of 200,000 hrs at design operation conditions in accordance with AFBMA. Bearings shall be mounted externally, or if internally mounted, furnish with extended grease line and fitting to allow servicing without dismantling of unit.

Fans shall be furnished with either variable-pitch or fixed-pitch V-belt sheaves for drives 3 HP and smaller and fixed-pitch sheaves for drives 5 hp and larger. When fixed-pitch sheaves are furnished, system air balancing shall be accomplished by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.

V-belt drives shall be designed for 150% of motor rating.

Fan motors shall be inverter rated, premium efficiency motors.

Fans, fan wheels, motors, VFDs, fan drives, bearings and all components shall all be compatible and be designed for above synchronous motor speed, up to 120 hertz.

Fan sections shall have hinged access doors that are not obstructed by the fan base or any internal components.

2.4.1 ELECTRICAL SERVICE

Provide single point of connection for appropriate voltage and phase for connection by Electrical Contractor.

2.5 DRAIN PANS

Provide intermediate-coil, 3-inch deep drip Type 304 stainless steel pans for each tiered coil bank.

Extend top pan 12 inches beyond face of coil, and extend bottom pan not less than 24 inches beyond face of coil. Where more than two pans are used, make pan extension proportional. Make adequate supports from the same type material as pans using angle iron with isolation at interface. Provide pan material that is 22-gage AISI Type 304 corrosion-resistant steel with all welded joints. Minimum size of drain opening is 1-1/4 inches. Pipe the drain pan to the indicated floor drain per requirements of specification section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER SYSTEMS. All coil blank off plates and fasteners are to be 304 stainless steel.

The drain pan shall extend from the upstream face or edge of the water-producing device or assembly and extend downstream to a distance equal to one half of the installed vertical dimension of the water-producing device or assembly.

Extend integral cabinet drain pan under all areas where condensate is collected and make watertight with welded or brazed joints, piped to drain, corrosion protect in condensate collection area, and insulate against sweating. Provide minimum 14-gage sheet metal, except that 16-gage double-drain-pan construction is acceptable.

Provide cooling coil ends that are enclosed by cabinet and are factory insulated against sweating or drain to a drain pan.

Provide drain pans that are double pan construction, thermally isolated from the exterior casing with minimum 1-inch thick fiberglass insulation. Provide drain pans that slope to drain and drain substantially dry by gravity alone when drains are open.

Provide pans that have a double slope to the drain point.

2.6 INSULATION

Provide unit that is internally fitted at the factory with a sound-attenuating, thermal-attenuating, glassfiber not less than 2 inch thick, 3 lb per ft3 density or minimum 6.25 R-value foam insulated with minimum 2 pound/cubic foot foam. Thermal breaks shall be provided for all casing and door components. Ensure insulation effectiveness precludes any condensation on any exterior cabinet surface under conditions normal to the unit's installed location. Provide acoustic treatment that attenuates fan noise in compliance with specified noise criteria. Apply material to the cabinet with waterproof adhesives and permanent fasteners on 100 percent coverage basis. Provide adhesive and insulating material in accordance with NFPA 90A.

2.7 AIR HANDLING UNIT INLET PLENUMS

Where shown, provide a field-fabricated AHU inlet plenums for each air

handler. The plenums shall be fabricated from factory fabricated, insulated, double-wall panels. Manufacturers: Industrial Acoustics Company, Semco, Vibro-Acoustics, Ruskin, or United McGill.

Provide AHU inlet plenum suitable for minimum 10 inches pressure class construction with leak tight joints, closures, penetrations, and access provisions. Provide cabinet that does not expand or contract perceptibly during starting and stopping of fans and that does not pulsate during operation.

Panels are to be minimum 2 inches thick panels fabricated of minimum 18 ga G90 galvanized steel on outer surface and minimum 22 ga G90 galvanized steel on inner surface. Inner panels shall be solid. Panels shall be reinforced with 18 ga galvanized steel stiffeners and filled with vermin proof, fire and mildew resistant acoustical-thermal insulating material of not less than 4 lb density. This fill shall be cut enough larger and thicker so as to require forcing into position and thus prevent voids due to settling from vibration, shocks, etc. All products shall possess flame spread rating of not over 25 and smoke developed rating of not over 50.

Panels shall have heat transfer factor not greater than 0.07 Btu/hr/sq ft/°F in conformance with ASTM Procedure C236.

Use solid inner surface for all sections.

Use 16 ga minimum solid outer and 10 ga inner surface construction for floor panels.

Wall and corner joiners shall be made of 16 ga, galvanized steel so formed as to prevent direct path for sound and/or air leakage. Roof angles shall be galvanized structural steel with one leg pre-felted with 3/16 inches thick felt. Floor channels shall be formed of 18 ga galvanized steel with bottom floor channels prepunched with holes spaced 24 inches on centers for attachment by round head bolts with expansion type insert.

Plenum structure shall be self-supporting. Panels shall not deflect more than 1/200 of longest span under positive or negative 10 inches WG. Where roof spans and wall loadings, or air pressure with housing requires additional structural strength it shall be furnished either by heavier roof and wall joiners, or additional structural members.

Openings for duct connections and connection to the air handling unit shall be provided at the size and location on the drawings and be suitably framed with angle iron for attachment to connecting sheet metal. Penetrations shall be in accordance with manufacturer's recommendations.

Provide access doors as shown on drawings. Access doors shall be minimum 24 inches wide by 72 inches high unless otherwise indicated and shall be same thickness as wall panel with overlap closure against single acoustical air pressure seal around entire periphery. Doors shall be furnished with 3 hinges and 2 wedge type latches with inside release handles for each door leaf. Make all door handles operable from inside the casing.Doors shall have galvanized sheet steel both sides with acoustical-thermal fill conforming to panel fill. Furnish all access doors with insulated double pane windows.

2.8 COILS

2.8.1 Coil Section

Provide coils that are factory tested, dehydrated, vacuum tested, purged with inert gas, and sealed prior to shipment to the job site.

Coils shall have supply and return connections on the same end.

Provide coil section that encases cooling coils and drain pipes. Arrange coils for horizontal air flow. Provide intermediate drain pans for multiple coils installation. Completely enclose coil headers with the insulated casing with only connections extended through the cabinet.

Unit heating and/or cooling coils shall be equal to sizes and capacities scheduled and in accordance with requirements of Section 23 82 16.00 40 AIR COILS.

Coils mounted in casing shall be accessible for service and to be removable from either side of unit without dismantling entire unit. Coil header and U-bends shall be fully enclosed within unit casing, with supply and return connections extending through casing. Support coils along their entire length within the casing and pitch for proper drainage.

Coil connections shall be factory sealed with grommets and sleeves where piping extends through unit casing to prevent air leakage.

Coil vents and drains shall be provided on coil connection outside unit casing; vent connections at highest point to assure proper venting and drain connections at lowest point to insure proper drainage.

Where multiple cooling coils are used in single stacked arrangement, intermediate drain pans shall be provided between each coil.

2.8.2 Coil Pressure and Temperature Ratings

Provide coils that are designed for the following fluid operating pressures and temperatures:

SERVICE	PRESSURE	TEMPERATURE
Hot Water	200 PSI	250 degrees F
Chilled Water	200 PSI	40 degrees F

Provide coils that are air-pressure tested under water at the following minimum pressures:

SERVICE	PRESSURE
Water (hot and chilled)	250 PSI

2.8.3 Drainable Coils

Provide drainable coils that are capable of being purged free of water with compressed air.

Provide self-draining coils that have a drain point at the end of every tube and are pitched to that point. Provide drain provisions that

include: drained headers; U-bends with integral plugs; or nonferrous plugs in cast-iron headers. Provide tubes that drain substantially dry by gravity alone when drains and vents are open.

2.9 FILTERS

2.9.1 Filter Housing

Provide factory fabricated filter section of the same construction and finish as unit casings. Provide filter sections that have filter guides and full height, double wall, hinged and removable access doors for filter removal. Provide air sealing gaskets to prevent air bypass around filters. Provide visible identification on media frames showing model number and airflow direction. Where filter bank is indicated or required, provide means of sealing to prevent bypass of unfiltered air. Performance shall be in accordance with ASHRAE 52.2.

2.9.2 Replaceable Air Filters

Provide filters as scheduled in the mechanical drawings.

UL 900, Class 1, those which, when cleaned, do not contribute fuel when attacked by flame and emit only negligible amount of smoke. Permanent frames with replaceable media, 1-inch thickness and size as indicated.

2.9.3 Disposable Cartridge Air Filters

Provide filters as scheduled in the mechanical drawings.

UL 900, Class 2, UL classified, and factory assembled. Provide media of ultra-fine glass fibers having 50-55 percent average dust spot efficiencies with maximum final resistance 0.75 inch water gage and maximum face velocity of 500 feet per minute. Construct filter frame of 18 gage galvanized steel or aluminum with welded or riveted joints. Caulk or gasket entire assembly to prevent air leakage around frames. Ensure minimum efficiency of filter is 60 percent per ASHRAE 52.2

2.9.4 Outside Air Filters

Provide filters as scheduled in the mechanical drawings.

The factory assembled air filters of the extended surface type with supported cartridges for removal of particulate matter in air conditioning, heating, and ventilating systems. Provide the extended surface type filter units fabricated for disposal when the dust-load limit is reached as indicated by maximum (final) pressure drop.

Filter Classification: UL approved for Class 1 or 2 conforming to UL 900.

Filter Grades, Nominal Efficiency and Application:

Grade B: 80-85 percent nominal efficiency outfitter

Grade D: 25-30 percent nominal efficiency prefilter

Filter Media: Grade B Supported (Rigid Pleated) Type: Provide media that is composed of high density glass fibers or other suitable fibers. Fastening methods used to maintain pleat shape, seal aluminum separators in a proper enclosing frame to ensure no air leakage for life or filter.

Staples and stays are prohibited.

Grade D Type: Provide media that is composed of synthetic/natural fibers. Bond a metal grid backing to the air leaving side of the media to maintain uniform pleat shape and stability for proper airflow and maximum dist loading. Provide a media frame that is constructed of high strength moisture resistant fiber or beverage board. Bond the pleated media pack on all four edges to ensure no air leakage of the life of the filter. Staples and stays are prohibited.

Filter section shall be suitable for installation of filters as indicated in Section 23 41 13.00 40 PANEL FILTERS. Filter section is to be furnished as part of air handling unit.

Filter Efficiency and Arrestance: Determine efficiency and arrestance of filters in accordance with ASHRAE 52.2 Standard Atmospheric dust spot efficiency and synthetic dust weight arrestance that is not less than the following:

	Initial Efficiency (Percent)	Average Efficiency (Percent)	Average Efficiency (Percent)
Grade B	58	79	98
Grade D	Less than 20	22	89

Maximum initial and final resistance, inches of water gauge, for each filter cartridge when operated at 500 feet per minute face velocity:

	Initial Resistance	Final Resistance
Grade B, Rigid Pleated	0.60	1.00
Grade D, 2 inches Deep	0.32	0.70

Dust Holding Capacity: When tested to 1.00 inch w.g. at 500 feet per minute face velocity, provide a dust holding capacity from each 24-inch by 24-inch (face area) filter at least equal to the values listed below. For other filter sizes, provide a dust holding capacity that is proportionally higher or lower.

Grade B, Rigid Pleated	6.17 ounces
Grade D, 2 inches Deep	2.29 ounces
Grade D, 4 inches Deep	10.58 ounces

Minimum Media Area: Provide minimum net effective area in square feet for each 24-inch by 24-inch (face area) filter at 500 feet per minute face velocity of at least the values listed below. For other filter sizes, provide a net effective media that is proportionally higher or lower.

Grade B, Rigid Pleated	57.0
Grade D, 2 inches Deep	14.8

2.9.5 Air Filter Gauges

Provide manometer air filter gauges of the inclined tube differential type, of solid acrylic plastic construction with built-in level vial and with an adjustable mirror-polished scale. Equip gauges with vent valves for zeroing and over-pressure safety traps. Provide adequate gauge range for the particular installation. Provide gauges manufactured by Dwyer or

approved equal.

Provide one (1) air filter gauge at each filter bank.

2.10 UV (ULTRA VIOLET) - C EMITTERS

A. Manufacturers: Steril-Aire, Sanuvox, Inc., UV Resource, or American Ultraviolet. Assembly shall be equal to Steril-Aire Model DE, SEN or SE Series as shown on Schedule.

B. Provide UVC emitters at downstream side of coiling coil in air handling units as scheduled.

C. Emitters shall comply with UL Standard 1995 as applicable to usage of UVC Emitters in HVAC equipment.

D. Emitters shall be independently tested under typical HVAC conditions and in accordance with ANSI/ASQCZ1.4. Total output per 1 inch arc length shall not be less than 9 microwatt/cm2 at one meter in 400 fpm airstream of 50 degrees F air.

E. UVC emitter and fixture shall consist of fixture, power source, reflector, emitter sockets and emitter tube and shall be constructed to withstand HVAC environments.

F. Fixtures shall be constructed of 304 stainless steel with 1/2 inch electrical knockouts on both ends to simplify gang wiring and wiring to power. It shall incorporate components into one integral assembly that maximizes serviceability and radiant flux.

G. Reflector shall be constructed of heavy gauge, spectral finished aluminum alloy with minimum 85 percent reflectance at 254 nm UVC energy.

H. Emitter shall be of high output, hot cathode, T5 (15 mm) diameter, medium bi-pin type, capable of producing 95% of energy at 254 nm in air flow velocity to 1000 fpm at temperature of 35-150 degrees F. UVC Emitters shall produce no ozone or other secondary contamination. Useful emitter life shall not be less than 9000 h, with no more than 20% output loss at end of one year of continuous use.

I. Irradiance: Provide UVC lamps and fixtures in sufficient quantity to irradiate coil surfaces and air stream with no shadows and with minimal UVC irradiance striking leading edge of all coil fins at not be less than 750 microwatt/cm2 with bulb mounted 12 inches off coil face in full cooling mode (at design cooling conditions).

J. UVC Monitoring: Provide NIST traceable UV Radiometer consisting of solid state photodiode UV sensor and externally mounted controller with visual indicators of UVC output and contacts for BAS communication. Controller must have ability to read real-time UVC energy levels by display module with minimum 3.5 inches digit LCD screen/panel. Irradiance range shall be 0-1999 (x10) microwatt/cm2 with resolution of 10 microwatt/cm2. Calibration wavelength shall be 254 nm with accuracy ±10 percent.

K. Electrical:

1. Power source shall be 115 V, with power factor of 0.95 and

power conversion of not less than 75 percent. It shall be designed to maximize photon production, radiance and reliability and suppress RF and line noise in airstreams of 41-132 degrees F and airflows to 1000 fpm.

2. Power consumption shall be no more than 13 watts/sf of treated, cross sectional plane.

3. Provide interlock switch on access doors to turn UVC off when access doors are opened. Provide additional manual on/off switch (electrical disconnect) for UVC system service purposes.

4. Startup and Calibration Service: UV supplier shall provide services to startup, calibrate, monitor, verify output and certify that UVC energy output meets specified requirements

PART 3 EXECUTION

3.1 AHU EQUIPMENT INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

Mount units at proper height above floor so that proper trap depth is provided in condensate drain line.

Protect openings on unit housings during construction against entry of foreign matter and construction dirt until ductwork is connected.

Provide installation drawings in accordance with referenced standards in this section.

Submit listing of product installations for air handling units showing a minimum of 5 installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Provide list that includes purchaser, address of installation, service organization, and date of installation.

3.2 UVC EMITTERS

A. Install UVC Emitters at outlet of cooling coils in accordance with manufacturer's instructions of installation, placement, wiring and testing.

B. Provide interlock switch on access door to UVC Emitters to turn emitters off when access door is opened.

C. Install Caution Labels furnished with units on access doors to Emitters.

3.3 VIBRATION ANALYZER

Use an FFT analyzer to measure vibration levels. The following characteristics are required: A dynamic range greater than 70 dB; a minimum of 400 line resolution; a frequency response range of 5 Hz-10 KHz(300-600000 cpm); the capacity to perform ensemble averaging, the capability to use a Hanning window; auto-ranging frequency amplitude; a minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB.

Use an accelerometer, either stud-mounted or mounted using a rare earth, low mass magnet and sound disk (or finished surface) with the FFT analyzer to collect data. Ensure the mass of the accelerometer and its mounting have minimal influence on the frequency response of the system over the selected measurement range.

3.4 ACCEPTANCE

Prior to final acceptance, use dial indicator gages to demonstrate that fan and motor are aligned as specified.

Prior to final acceptance, verify conformance to specifications using vibration analysis. Ensure maximum vibration levels are .075 in/sec at 1 times run speed and at fan/blade frequency, and .04 in/sec at other multiples of run speed.

3.5 AHU TESTING

Performance test and rate AHU and components in accordance with AMCA 211, AMCA 300, and ASHRAE 51. Provide AHU ratings in accordance with AHRI 430.

Provide final test reports to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

Perform air handling unit start-up in the presence of the Contracting Officer.

Unit manufacturer and installing contractor shall jointly perform field casing leakage test on each completed housing assembly as previously specified and shall be responsible for repair of all leaks. Submit certified test data to Engineer for approval.

Temporary sealing of access doors, condensate drains, etc. is not allowed during field testing except to troubleshoot leakage points

3.6 OPERATION AND MAINTENANCE

Submit operation and maintenance manuals prior to testing the air handling units. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

3.7 COORDINATION

Coordinate the size and location of concrete equipment pads, variable frequency drives, control and electrical requirements.

3.8 TEMPORARY CONSTRUCTION FILTERS

Have temporary construction filters in place during normal building construction whenever the air handling units are run for general ventilation, building dehumidification, and for other purposes during construction. Install two (2) layers of blanket filter at a time. Replace temporary construction filters as required during construction and after completion of duct system cleaning.

After systems have been cleaned and temporary construction filers are

removed, and before test and balance operations are started, install set of final filters. Do not have final filters in place while general building construction is taking place, to avoid unnecessary loading with construction dust. Clean permanent filter bank before testing and balancing.

Submit all required installation, Fabrication and Connection drawings and obtain approval prior to the start of work detailed on these drawings.

3.9 ACCEPTANCE

Final acceptance is dependent upon providing Warranty, based on approved sample warranty, to the Contracting Officer, along with final test reports. With Warranty and final test reports, provide a cover letter/sheet clearly marked with the system name, date, and the words "Equipment Warranty" - "Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.10 INSTRUMENT TEST HOLES

Provide instrument test holes at air entering and air leaving side of all internal air handling unit components for static pressure differential or temperature measurements. Refer to Section 23 31 13.00 40 METAL DUCTS, for instrument test holes.

-- End of Section --

SECTION 23 82 00.00 20

TERMINAL HEATING AND COOLING UNITS
11/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D1654	(2008) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211	(2013) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
NFPA 54	(2012) National Fuel Gas Code
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2012) Standard for the Installation of Warm Air Heating and Air Conditioning Systems
NFPA 91	(2010) Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with additions and modifications specified herein.

Section 01 91 13 COMMISSIONING applies to the work and products specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products

specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Duct Reheat Coils; G

Active Chilled Beams; G

SD-10 Operation and Maintenance Data; G

Duct Reheat Coils; G, Data Package 2

Active Chilled Beams; G, Data Package 2

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 DUCT REHEAT COILS

Heating Hot Water Type. Manufacturers: Carrier, Trane, McQuay, Marlo, Temtrol, or Heatcraft.

Coils shall be constructed of 1/2 inch or 5/8 inch OD copper tubes with aluminum fins suitable for minimum working pressure to 200 psig and temperatures to 220 degrees F.

Coils having steel nipples for connection are not allowed.

Coils having steel nipples for connection are not allowed.

Coil headers shall be cast iron with tubes expanded into headers or heavy seamless copper with all tubes brazed to header.

Casing shall have G90 galvanized steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section.

Coil frame shall be suitable for drive slip or flange and gasket connection to ductwork.

2.2 ACTIVE CHILLED BEAMS

Manufacturers: Trox, Dadanco, or Flakt-Woods. Basis of design is Trox model DID600.

Active chilled beam design with primary air connections, removable/interchangeable induction nozzles, chilled water coils, integral air diffusers and removable perforated induction inlet grille. Units are

to be designed for 2-pipe, cooling only duty.

Inlet/discharge grille framework shall be constructed of aluminum or pressed steel components. Inlet grille shall be perforated steel or aluminum, of sufficient gauge to avoid sagging. Air plenum shall be constructed of minimum 22 gauge steel with manufacturer's standard painted finish.

Induction inlet grille on 2-way throw units shall be hinged along one side of grille to allow grille core to swing down 90 degrees for coil access from floor.

Units shall be designed with standard US (IP) dimensions and NPT pipe connections.

Units shall be nominal 24 inches wide and shall be compatible with lay-in ceiling system with standard t-bar ceiling grid. Unit face shall be drop-face or flat-face as scheduled.

Housing shall be formed/stamped aluminum or galvanized steel with manufacturer's standard baked white enamel finish. Housing shall be complete with flush mounted, removable perforated induction grille in center portion for access to cooling coil, supply air plenum with inlet duct collars as required, induction nozzles, and slotted supply diffusers in 1-way or 2-way configuration as scheduled.

Provide adjustable support tabs/brackets, minimum 4 per unit for hanger support from structure.

Water coils shall be constructed of 1/2 inch or 5/8 inch OD seamless copper tubes with minimum wall thickness of 0.016 inch with aluminum fins suitable for minimum working pressure to 300 psig at 75 degrees F temperature.

The minimum primary air inlet connection diameter for any chilled beam shall be 5 inches.

The local velocity of air discharged from any chilled beam shall not exceed 60 feet per minute when measured at a height 5-1/2 feet above the floor.

The local velocity of air discharged from any chilled beam shall not exceed 75 feet per minute when measured within 6 inches of any adjacent wall, or when measured halfway between rows of adjacent chilled beams.

Room sound levels due to discharge from units with performance and operating characteristics as scheduled shall not exceed noise criteria (NC) values in any spaces as indicated below.

Type of Room	Noise Criteria (NC)
Offices	25

2.3 NOISE, VIBRATION AND SEISMIC CONTROLS

Section 23 05 48.00 40 MECHANICAL SOUND VIBRATION AND SEISMIC CONTROL.

2.4 SOURCE QUALITY CONTROL

Special protection is not required for equipment that has a zinc coating conforming to ASTM A123/A123M ASTM A653/A653M. Otherwise, protect affected equipment items by manufacturers' corrosion-inhibiting coating or paint system that has proved capable of withstanding salt-spray test in accordance with ASTM B117. Test indoor and outdoor equipment for 125 hours; test outdoor equipment used in a marine atmosphere for 500 hours. For each specimen, perform a scratch test as defined in ASTM D1654.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment where indicated and as recommended by manufacturer's recommendations, NFPA 54, NFPA 90A, NFPA 90B, NFPA 91 and NFPA 211.

Install units as indicated on drawings, and according to manufacturer's installation instructions.

Install branch piping to each unit with minimum of 3 elbows to allow for expansion and contraction.

3.2 DUCT REHEAT COILS

Comb out fins when bent or crushed before enclosing coils in ductwork. Clean dust and debris from each coil to ensure its cleanliness.

Seal or gasket coil connection to ductwork to meet scheduled maximum allowable leakage rate.

Unless otherwise specified, connect piping to coils with multiple rows for counter-flow arrangement.

Install coils as indicated on drawings and/or as detailed.

Provide air vent and drain valve at each water coil as detailed.

Provide duct transitions per Section 23 31 13.00 40 METAL DUCTS.

Provide a coil service access door on the inlet side of each duct reheat coil.

3.3 ACTIVE CHILLED BEAMS

Mount units in acoustical tile ceilings as shown on mechanical drawings and on reflected ceiling plans.

Support units independently from ceiling grid with minimum of 4 corners per manufacturer's recommendations using threaded rod supported directly from building structure. Wires are not allowed.

-- End of Section --

SECTION 23 82 16.00 40

AIR COILS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Record of Existing Conditions; G

Fabrication Drawings; G

Connection Diagrams; G

Layout of All Controls; G

Internal Tubing and Wiring; G

Installation Drawings; G

Record Drawings; G

SD-03 Product Data

Chilled-Water Cooling; G

SD-05 Design Data

Design Analysis and Calculations; G

SD-06 Test Reports

Pressure Tests; G

Vacuum Tests; G

SD-07 Certificates

Certificates of Conformance; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.3 GENERAL REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

Submit manufacturer's catalog data for the following coil types indicating, when applicable, coil pressure and temperature ratings, coil casings, headers, tubing, circuiting, and drainable coils.

a. Chilled-water cooling

Submit fabrication drawings for coil units consisting of fabrication and assembly details to be performed in the factory. Include connection diagrams indicating the relations and connections of the following items:

a. Coil

b. Coil casings

c. Coil headers

d. Coil tubing

e. Coil circuiting

Indicate the general physical layout of all controls, and internal tubing and wiring details on the drawings. Submit design analysis and calculations for coils.

Submit record drawings for coil systems providing current factual information including deviations from, and amendments to, the drawings and concealed and visible changes in the work.

Submit record of existing conditions consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes acceptance of existing conditions.

1.4 QUALITY ASSURANCE

Provide coils that bear the ARI certification seal indicating compliance with AHRI 410. Submit certificates of conformance for following items showing conformance with the referenced standards contained in this section:

a. Coil

b. Coil casings

c. Coil headers

d. Coil tubing

e. Coil circuiting

PART 2 PRODUCTS

2.1 GENERAL

This Section covers coils in modular indoor central-station air handling units, semi custom factory-packaged air handling unit, custom air handling units and field-erected air handling units.

2.1.1 Coil Pressure and Temperature Ratings

Provide coils that are designed for the following fluid operating pressures and temperatures.

Service	Pressure (psi)	Temperature (Degrees F)
Chilled water	200	45
Heating Hot Water	200	220

Air-pressure test coils under water at the following minimum pressures:

Service	Pressure (psi)
Chilled water	250
Heating Hot Water	250

2.1.2 Coil Casings

Provide chilled water cooling coils casings with minimum 16-gauge 304 stainless steel. All chilled water coil casing blank-off plates are to be 304 stainless steel and all fasteners are to be all 304 stainless steel. Provide casing that is flanged on four sides for bolted assembly, except as otherwise specified.

Where coils are stacked, provide casing that is of double-bend construction. All chilled water cooling coils are to be furnished with welded 304 Stainless Steel drain pans.

Provide coil mounting within housing that is either fixed or slide-out type, except as otherwise specified. Provide slide-out type coils for ceiling-suspended package units, and for other package units whose capacity exceeds 15,000 cubic feet per minute.

2.1.3 Coil Headers

Provide coil headers of cast iron, brass, copper, or aluminum casting.

2.1.4 Coil Tubing

Provide coils that are constructed of copper tubing with aluminum or copper fins. Provide helical coil fins that are wound tight to the tubes and solder-coated. Provide plate fins that have spacer collars in metallic contact with the adjacent fin, and fins that are mechanically bonded to the tube. Ensure bare tube surface is not visible within the finned portion of the coil.

Provide solder-coated cooling coils of helical wound copper design.

Provide coil tubes in water and volatile refrigerant service that are parallel and that have sufficient intermediate full coil depth supports to prevent sagging of unsupported span due to working fluid pressures and temperatures and summer and winter coil-ambient conditions. Sagging is unacceptable if tube centerline is displaced by more than 3/16 inch from centerline of tube connection at outlet header when coils are more than two rows deep and when installed in accordance with the manufacturer's instructions. Provide adequate provisions for expansion and contraction to preclude sagging and distortion under thermal loads applied in indicated or specified service. Slope tubes to be free draining.

Provide maximum heating-coil face tube spacing of 3 inches on center for 1-inch outside-diameter (od) tubes, 2 inches for 3/4-inch od tubes, and 1-1/2 inches for 5/8-inch od tubes.

Provide coil face tube spacing for cooling coils and for helically wound heating coils immediately followed by water-cooling coils that do not exceed 1-1/2 inches on center.

Provide tubes that are straight, with turns made through headers or return U-bends, and connections and joints brazed, except as otherwise specified.

Ensure coil tube material is seamless deoxidized copper.

Provide raw coil tube stock wall with a minimum thickness of0.025 inch.

Where mechanical insert devices are used to increase liquid turbulence within tubes, increase the wall thickness of these tubes by0.010 inch over the minimum raw coil tube stock specified for the service.

Provide minimum tube od of 1/2 inch.

2.1.5 Coil Circuiting

Provide standard or full-circuited water coils that have as many full-length tubes in each circuit as the number of tubes in the depth of the coil face; provide double-circuit water coils that have twice as many as standard coils; and provide half-circuit water coils that have half as many as standard coils and to the next larger whole number where odd numbers are involved.

Provide counterflow type coils when more than two rows deep, except that in the case of double- or half-circuit coils, reasonable deviation from counterflow arrangement is permitted, provided the pressure drop and capacity requirements are met.

2.1.6 Drainable Coils

Provide drainable coils that are capable of being purged free of water with compressed air.

Provide self-draining coils with a drain point at the end of every tube and pitch to that point. Provide drain provisions that include: drained headers; U-bends with integral plugs; or nonferrous plugs in cast-iron headers. Provide tubes that drain substantially dry by gravity alone when drains and vents are open.

Where necessary, fill the coil with water to the end of the manufacturer's header connections and check drainage volume against the manufacturer's data.

2.2 COIL TYPES

2.2.1 Chilled-Water Cooling

Provide self-draining, counterflow type coils.

Select coils for tube velocity not less than 3.0 fps.

Maximum allowable fin spacing shall be 10 fins per inch. Coil depth shall not exceed 8 rows unless noted otherwise.

Coils shall be constructed of 0.024 inches tube wall, 0.625 inches OD seamless copper tubes with 0.0075 inches aluminum fins suitable for working pressures to 200 psig. Fins shall be mechanically bonded to tubes by tubing expansion. Coils shall be tested at 250 psig under water.

Coil fins shall be continuous plate fin type.

Coil headers shall be constructed of cast iron with tubes expanded into headers or heavy seamless copper with tubes brazed to header. Fit water coil headers with 0.25 inch ops spring-loaded plug drains and vent petcocks. Provide automatic air vents with ball type isolation valves for each coil piped to the drain pan.

Casings shall be minimum 16 ga 304 stainless steel having stainless steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section.

PART 3 EXECUTION

3.1 INSTALLATION

Install coils in accordance with the manufacturer's recommendations.

Submit installation drawings for coil systems. Indicate overall physical features, dimensions, ratings, service requirements, equipment weights and layout and arrangement details of equipment room on drawings.

Install coils as indicated on drawings and/or as detailed. Pitch coils for proper drainage according to manufacturer's installation instructions. Install shims as required.

Clean oil film from coil fins with hot water/detergent as recommended by

coil manufacturer.

Comb out fins when bent or crushed before enclosing coils in housing. Clean dust and debris from each coil to ensure its cleanliness.

Provide offsets in piping to facilitate coil removal. Unless otherwise specified, pipe coils for counter flow arrangement.

Provide piping flexible connections for floor-mounted coils.

Provide air vent and drain valve at each water coil.

Provide supply shut-off valve, return balancing valve, drain valve and air vent for each coil for air handling unit with multiple coils. Provide a Pete's Plug at the inlet and outlet of each coil.

Pipe condensate pan to the nearest drain with trap.

3.2 TESTS

For drainable types:

Field check coil pitch and leveling for drainability in the presence of the Contracting Officer.

Perform pressure tests and dehydrate coils. Perform vacuum tests, purge with inert gas, and seal coils.

Provide final test reports to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.3 OPERATION AND MAINTENANCE

Submit 6 copies of the operation and maintenance manuals 30 calendar days prior to testing the coil systems. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

-- End of Section --

SECTION 23 82 19.00 40

FAN COIL UNITS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S12.23	(1989; R 2011) Method for the Designation of Sound Power Emitted by Machinery and Equipment

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 440	(2008) Room Fan-Coils and Unit Ventilators

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2010; Errata 2011; INT 3 2012; INT 4 2012) Ventilation for Acceptable Indoor Air Quality

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; Cor 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011; Errata 2012) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 1995	(2011) Heating and Cooling Equipment

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Product Installation Lists

SD-02 Shop Drawings

Fabrication Drawings; G

Installation Drawings; G

SD-03 Product Data

Equipment and Performance Data; G

Coils; G

Casing; G

Enclosure; G

Motors; G

Fan; G

Drain Pans; G

Filters; G

Controls; G

Vibration Isolation; G

Insulation; G

Drain Pans; G

SD-04 Samples

Manufacturer's Standard Color Chart

SD-07 Certificates

Listing of Product Installations

Certificates of Conformance

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.3 GENERAL REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Section 01 91 13 COMMISSIONING applies to the work and products specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section.

Provide a blower-coil unit in place of a fan-coil unit where scheduled system requirements are greater than that which a typical fan-coil unit can provide.

Submit vibration isolation components.

Submit the listing of product installations for fan coil units showing a minimum of 5 installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Include purchaser, address of installation, service organization, and date of installation.

Submit fabrication drawings for fan coil units consisting of fabrication and assembly details to be performed in the factory.

Submit material, equipment, and product installation lists including the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Submit equipment and performance data for fan coil units consisting of use life, system functional flows, safety features, and mechanical automated details. Curves indicating tested and certified equipment response and performance characteristics shall also be submitted, including vibration isolation. Submit certificates of conformance for the following:

a. Coils

b. Casing

c. Enclosure

d. Motors

e. Fan

f. Drain Pans

g. Filters

h. Controls

Submit manufacturer's standard color chart indicating the manufacturer's standard color selections and finishes for fan coil units.

PART 2 PRODUCTS

2.1 GENERAL

Include an enclosure for cabinet models and casing for all concealed models.

Provide base unit complete with galvanized casing, water-coil assembly with auxiliary water or steam heating-coil, valve and piping package, drain pans, air filter, fan motor, and motor control. Sound-power-level, decibels reference, 10 to the minus 12 power watt, at the fan operating speed selected to meet the specified capacity, is not to exceed the

following values at the midfrequency of each octave band:

	OCTAVE BANDS				
	3RD	4TH	5TH	6TH	7TH
Frequency (hertz)	250	500	1,000	2,000	4,000
Power Level (decibels)	60	55	53	50	48

Obtain sound-power-level data or values for these units in accordance with the test procedures specified in ASA S12.23. Sound-power values apply to units provided with factory-fabricated cabinet enclosures and standard grilles. Values obtained for the standard cabinet models are acceptable for concealed models without separate tests provided there is no variation between models as to the coil configuration, blowers, motor speeds, or relative arrangement of parts. Fasten each unit securely to the building structure. Capacity of the units is as indicated. Ensure room fan-coil units are certified as complying with AHRI 440 and shall meet the requirements of UL 1995.

Unit data shall be certified in accordance with AHRI Standard 430 or 440.

Manufacturers: IEC, Williams, Carrier, Trane, McQuay or Price. Basis of design Trane Blower Coil Units.

2.2 ENCLOSURE

Construct enclosure of not lighter than 18-gage steel, properly reinforced and braced. Ensure front panel of enclosure is removable and provided with 1/2-inch thick insulation conforming to NFPA 90A, to prevent condensation. Ensure discharge louvers are four-way adjustable and designed to properly distribute air throughout the conditioned space. Ensure all ferrous-metal surfaces are galvanized or treated with a rust-inhibiting finish. Ensure all exposed-to-view enclosure corners and edges are rounded. Ensure discharge louvers are mounted in a top panel that is removable for coil cleaning. Ensure access doors are hinged and provided for all piping and control compartments. Ensure finish is in manufacturer's standard color as selected by the Contracting Officer.

2.3 CASING

Ensure casing is acoustically and thermally insulated internally with not less than 1/2-inch thick insulation conforming to NFPA 90A, fastened with waterproof and fire-resistant adhesive.

Units shall be furnished with 18 ga steel cabinet and access to all internal mechanical and electrical devices. Cabinets of exposed units shall have baked enamel finish in one of manufacturer's standard colors, selected by Architect. Cabinets of concealed units may be prime coated or galvanized steel. Ducted units shall be furnished with supply and return duct collars.

2.4 FAN

Ensure fan is galvanized steel or aluminum, centrifugal type with metal blades. Fan wheels shall be aluminum or galvanized steel construction,

centrifugal forward-curved and double-width type, statically and dynamically balanced. Ensure all surfaces are smooth, that assemblies are accessible for maintenance, and that disassembly and reassembly is done by mechanical fastening devices, not adhesives. Dynamically and statically balance fan to ISO 1940-1 at the factory, after assembly in unit. Fans may be direct-drive or V-belt drive as scheduled.

2.5 COILS

Ensure construct of the water coils is not less than 1/2-inch outside diameter (od) seamless copper tubing with copper or aluminum plate fins mechanically bonded or soldered to the tubes and provide with not less than 5/8-inch od female solder connectors, accessory piping package with terminal connections for control valves, and manual air vent on returns. Make provisions for coil removal.

Coils shall be constructed for minimum working pressure to 300 psig and temperatures to 200°F. Furnish coils with manual air vents. Coil performance data shall be in accordance with AHRI Standard 410.

Chilled water and heating hot water coils shall be provided as scheduled in the mechanical plans. Reference the fan coil schedule chart and referenced noted for required coil capacities.

2.6 DRAIN PANS

Size and locate drain pans to collect condensed water dripping from any item within the unit enclosure. Do not construct drain pans of lighter than 20-gage stainless steel thermally insulated to prevent condensation minimum 1/2" fire retardant closed cell foam. Coat thermal insulation with a waterproofing compound. Provide no less than 3/4-inch National Pipe Thread (NPT) or 5/8-inch od copper drain connection in the drain pan, with a slope not less than 1/8-inch per foot to drain. Drain pan shall be constructed in compliance with ASHRAE 62.1-2010 and insulation shall meet requirements of NFPA 90A.

All fan coil units are to be provided with a minimum 20 gauge galvanized steel secondary drain pan to be mounted below the fan coil unit that is a minimum 1-1/2" deep with folded or solder sealed corners. The pan is to be sized large enough to collect any leaking water from the fan coil unit. The secondary pan is to be supported so as to not interfere with the servicing and access of the fan coil unit above. Each secondary plan will also be provided with a pan mounted float switch per BAS control drawings and specifications.

2.7 FILTERS

Provide side access filter racks for each fan coil unit. Ensure filters are removable without tools. Furnish 2 sets of 2" thick minimum efficiency MERV-8, based on ASHRAE Test Standard 52.2, throwaway glass fiber filter for each unit.

On fan coil units with filters in the return grilles, retain the filter rack in the fan coil, but do not install filters within the fan coil units.

2.8 MOTORS

Provide motors that are premium efficiency direct connected or v-belt driven, two-bearing, permanent split-capacitor type with built-in overload

protection, conform to NEMA MG 1, and mounted on a resilient base. Design motors for 1,060 revolutions per minute maximum on 115-volt, single-phase, 60-hertz power unless otherwise noted in the fan coil schedules. Furnish motors with three built-in speeds, with four insulated leads (common, high, medium, and low) to terminate in a control-junction box.

Provide a solid-state variable speed controller capable of not less than 50 percent speed reduction in lieu of step speed control, when so specified.

Provide motors with thermal overload protection with automatic reset.

2.9 CONTROLS

Applicable requirements of Section 23 09 33.13 98 ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC applies.

Provide unit with factory-installed control valves furnished by the automatic temperature-control manufacturer.

Install the controls in a unit-mounted control panel. Provide remote-mounted controllers where indicated.

Ensure motor speed-control switch provides speed selection and off position, mounted for convenient use from an access door.

Non-fused disconnect switches shall be provided and factory mounted on all fan coil units.

2.10 INSULATION

Contain all thermal and acoustical insulation within a double walled enclosure or seal with a coating impervious to moisture. Units shall be acoustically and thermally insulated with minimum 1/2" glass fiber insulation. Drain pans shall be constructed of stainless steel insulated with minimum 1/2" fire retardant closed cell foam. Drain pan shall be constructed in compliance with ASHRAE 62.1-2010 and insulation shall meet requirements of NFPA 90A.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment as indicated and specified and in accordance with manufacturer's recommendations. Set dampers in a fixed position to provide the outside air quantity scheduled.

Submit installation drawings for fan coil systems in accordance with referenced standards in this section.

Mount units above concealed ceilings or as shown on drawings with ample clearances for controls access, coil pull and filter service.

Provide vibration isolation hangers for support of each unit.

Duct connections to fan coil units shall use flexible duct connections.

3.2 TESTS

Hydrostatically test coils at 250 pounds per square inch (psi) or under water at 250 psi air pressure. Ensure the coils are suitable for 200-psi working pressure.

3.3 OPERATION AND MAINTENANCE

Contractor shall submit 6 copies of the operation and maintenance manuals 30 calendar days prior to testing the fan coil units. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

-- End of Section --

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012) National Electrical Safety Code
IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

1.2 SUSTAINABLE DESIGN REQUIREMENTS

See section 01 33 29 LEED(TM) DOCUMENTATION for all material requirements.

1.3 RELATED REQUIREMENTS

This section applies to certain sections of Divisions 22 and 23, PLUMBING and HEATING VENTILATING AND AIR CONDITIONING. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections.

1.4 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.5 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 60 Hz as follows: 13.2 kV primary, three phase, three wire; 480 volts secondary three phase, three wire; and 208Y/120 volts secondary, three phase, four wire. Control system voltages (switcboard, generator, HVAC, etc.) shall be as indicated or specified in the other sections. Final connections to the power distribution system at the existing pad-mounted switchboard shall be made by the Contractor as shown on the drawings.

1.6 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.6.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.6.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

1.7 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Field Fabricated Nameplate List; G

1.8 QUALITY ASSURANCE

1.8.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of

similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.8.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.8.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.8.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.10 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in

approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.11 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.12 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates (interior nameplates may be permanent typed and printed adhesive tape type) for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core unless indicated otherwise on the drawings or in other specification sections. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

Field Fabricated Nameplate List: Submit a listing for approval that details all nameplates to be provided.

All power switching and power distribution devices (panelboards, transformers, circuit breakers, safety switches, variable speed drives, automatic transfer switches, UPS's, starters, contactors, etc.) nameplates shall include the following information and format:

Line 1: Load Served

Line 2: Circuit characteristics (voltage, phase-wire, amperage, KW/KVA)

Line 3: Supplying Source(s) name and circuit number.

All device plates shall be labeled with supplying source and circuit number. Where a device is UPS supplied or emergency power off (EPO) controlled provide a second label indicating "UPS-A" and "EPO" as applicable.

All busway plug-in units with receptacles shall include the following format.

Line 1: Supplying Source name and circuit number.

Line 2: Circuit characteristics (voltage, amperage, and phasing connections, A-B-C as applicable.)

1.13 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators,

and switchboard having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

1.14 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.15 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given prior to the equipment or system being accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.

PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements specified in the technical sections.

PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in the section specifying the associated electrical equipment.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

-- End of Section --

SECTION 26 05 13.00 98

MEDIUM-VOLTAGE CABLE
11/11

PART 1 GENERAL

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2000) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM B8	(2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-94-649	(2004) Standard for Concentric Neutral Cables Rated 5 Through 46 KV

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 48	(2009) Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 386	(2006; INT 1 2011) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE 400.2	(2004) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
IEEE 404	(2006) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE C62.11	(2005; Amd 1 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
NETA MAINT	(2011) Standard for Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2011) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

1.2 DEFINITIONS

Medium voltage power cables means all cables rated above 601 to 35,000 volts.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pulling Plan; G

SD-03 Product Data

15 kV Concentric Neutral Cable; G

Cable Tags; G

Fireproof Tape; G

Splices (including splice grounding and list of recommended tools for splicing operations); G

Surge Arresters; G

SD-06 Test Reports

Field Testing; G

KSC Medium Voltage Cable Test Form; G

Qualification Test Reports; G

Radiographic Tests; G

SD-07 Certificates

Factory-Conducted Tests on Each Shipping Length (Reel) of Cable; G

Splicer/Terminator Certifications; G

List of Splices/Terminations Installed by Splicer/Terminator; G

Manhole Photos; G

Conductor Resistance; G

Accelerated Water Absorption Test; G

Water Immersion Test; G

Ionization; G

High-Voltage; G

Partial Discharge Test; G

Qualification Test Reports; G

SD-08 Manufacturer's Instructions

Single Conductor 15 kV Shielded Cable; G

Terminations; G

Splices (including splice grounding); G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Verify personnel performing Medium Voltage (MV) splicing/terminations have 5 years minimum experience in cable splicing/terminations of the type used in this project. In addition, submit splicer/terminator certifications issued by the cable splice and termination manufacturer who has examined and tested a test splice/termination of each type required by this contract for each cable splicer/terminator. Ensure the certification identifies which splices/terminations it applies to. In addition require each individual, certified or not certified, with the required 5 years medium voltage splicing/terminating who is to perform cable splicing/terminating, to perform a minimum of one splice/termination of each type in the presence of the manufacturers' representative and the Government's representative. Contractor shall supply all materials, tools, and manufacturer's services required for the demonstration splices and tape type terminations. Submit each splice/termination performed by individuals without a manufacturer's certification to the manufacturer for testing and subsequent certification. Proof of certification will be verified by the NASA Contracting Officer's Technical Representative prior to installation of any splices/terminations. Certification is not required for load break elbows and dead break connectors.

Once a splice/termination has been started by a splicer/terminator, ensure the same splicer/terminator completes that particular splice/termination,

and that each splice/termination is started and completed in one continuous work period.

The Contractor shall maintain and submit a list of splices/terminations installed by splicer/terminator. The list shall include the following for each splice/termination completed:

- Name of splicer/terminator.
- Company name.
- Date splice/termination was performed.
- Location of splice/termination. For terminations at equipment indicate switch and position number as required to completely define the location.
- Feeder number.

Manhole Photos: Once the work inside a manhole is complete, the contractor shall take digital photos inside the manhole and shall label all the manhole walls in the photos (example: manhole E9 west wall to E10). The contractor shall compile the photos of all manholes and submit two CDs containing all manhole photos at the completion of the contract.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Shipping

Ship the cable on reels in such a manner that the cable is protected from mechanical injury. Hermetically seal every cable end of each length using heat-shrinkable molded cable end caps to exclude moisture and securely attached to the reel.

Ensure the minimum diameter of the reel drum is 14 times the overall diameter of the cable. For reels less than 60 inches in diameter, provide arbor holes sized for 2-1/2 inches spindles; for those greater than 60 inches in diameter, provide arbor holes sized for 3 inch spindles. Ensure reel sizes accommodate reel lengths specified in the purchase order, and that each reel contains only one length of cable cut to order.

Provide each reel with an arrow and appropriate wording, stenciled in plain view on each side, indicating proper rotation of reels. Plainly mark each reel on each side, and attach a tag to the cable end inside the lagging, stating the following information:

a. Purchaser's order number

b. Complete description of cable including manufacturer, cable size, voltage rating, percent insulation rating, insulating material, conductor size(s), year of manufacture

c. Actual shipping cable (reel) length

d. Reel number (e.g. 2 of 10)

e. Gross weight (i.e. with reel) and net weight (i.e. cable only)

Ship reels in a vertical position, sufficiently blocked in the bed of shipping vehicle to preclude movement.

PART 2 PRODUCTS

2.1 CONDUCTORS

2.1.1 Material

Provide annealed copper core (phase) conductor material in accordance with ASTM B8.

2.1.2 Stranding

Provide Class B stranded conductors.

2.2 CABLE IDENTIFICATION

Provide cables with printing on the outer jacket showing the cable type, name of the manufacturer, the year in which the cable was manufactured, sequential cable reel length markings and a unique number for identification purposes. Closely group the information on the tape at 6 foot maximum intervals to permit complete identification.

2.3 15 KV CONCENTRIC NEUTRAL CABLE

2.3.1 General; 15 kV Cable

Provide single conductor 15 kV shielded cable assemblies consisting of:

a. Conductor core described above, an extruded semiconductor shield over the conductors

b. 220 mils of ethylene-propylene-rubber (EPR) insulation

c. An extruded semiconductor insulation shield, a concentric neutral

d. A polyethylene (PE) jacket.

Ensure cable is rated for minimum 194 degrees F continuous conductor temperature and 266 degrees F emergency overload.

Provide single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable conforming to ICEA S-94-649 and AEIC CS8.

2.3.2 15 kV Cable Conductor Shielding

Provide conductors with a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). Ensure material has proven long-term chemical compatibility with both the conductor and overlying insulation materials, and that the stress control layer meets the electrical and physical requirements of ICEA S-94-649.

2.3.3 Insulation; 15 kV Cable

Provide ozone resistant insulation material, of extruded thermosetting ethylene-propylene based polymer, capable of withstanding the continuous and emergency overload temperature ratings of the conductor.

2.3.4 Non-metallic Insulation Shield; 15 kV Cable

Provide extruded insulation shield made of an extruded thermoset material compatible with the insulation and jacket. Ensure insulation shield is applied directly over and bonded to the insulation, and complies with AEIC CS8.

2.3.5 Concentric Neutral Shield; 15 kV Cable

Provide copper wires helically applied over the insulation shield, where the minimum total cross sectional area (of the shield wires) is 100% of the core conductor for 4/0 cable. Minimum size of an individual shield wire is No. 14 AWG.

2.3.6 Jacket; 15 kV Cable

Provide polyethylene jacketed cable (PE) extruded over the concentric neutral to a minimum thickness of 80 mils.

2.4 INSULATED MEDIUM VOLTAGE CONNECTORS

Provide insulated medium voltage connectors for new and modified existing dead-front construction pad mounted switchgear or switches and pad mounted transformers.

Provide connectors in kit form, which are the product of a single manufacturer, and compatible with both the cable and equipment bushing on which the connector is applied. Connectors shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material per IEEE 386. Provide a hot line voltage indicator on each connector installed as part of this project. Provide LED type hot line voltage indicators which are the product of a single manufacturer, and compatible with the connector on which the hot line voltage indicator is applied. Provide connectors with ratings as follows:

15kV 200 Ampere Load-break Connectors: BIL impulse withstand 1.2 x 50 microsecond wave: 95kV. Short time rating: 10,000 amperes rms, symmetrical for a time duration of 0.17 seconds and 3,500 amperes rms, symmetrical for a time duration of 3.0 seconds.

15kV 600 Ampere Dead-break Connectors: BIL impulse withstand 1.2 x 50 microsecond wave: 95kV. Short time rating: 40,000 amperes rms, symmetrical for a time duration of 2.0 seconds and 27,000 amperes rms, symmetrical for a time duration of 4.0 seconds. Where piggyback mount surge arresters are specified to be installed, provide 15kV 200 ampere bushing.

2.5 SPLICES

Provide splices in kit form, which are the product of a single manufacturer, compatible with the cable on which the splice is applied, and meeting the requirements in the paragraph entitled, "Splices and Terminations," of this section. Splices shall be suitable for use in the environment in which the splice is installed. Provide splices for use on 15kV cable as follows:

a. 15kV Cable Splices: Splices for 15kV EPR concentric neutral cable shall be heat-shrink type specifically designed for NASA cable and grounding provisions which include but is not limited to the

following: inner heat shrink stress control tube with external end sealant, additional heat shrink tube over inner tube and inner tube end sealant, heat shrink outer wraparound sleeve with heat sensitive indications on both the tube and tail/channel area to indicate proper torch heating, stress relief material, mastic, sealant, shielding mesh, and silicon grease.

2.6 CABLE TAGS

Provide cable tags as specified herein and detailed on the drawings. Provide cable tags on each new medium voltage cable installed as part of this project, and on each existing medium voltage cable to which a new medium voltage cable is spliced as part of this project. Provide a cable tag on each individual cable in each location where the cable is accessible (e.g. manholes, pull boxes, junction boxes, termination points). Cable tags shall be polyethylene. Handwritten legends are not acceptable.

2.6.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 4500 pounds per square inch, and are 0.035-inch thick, non-corrosive non-conductive. Ensure tags are resistive to acids, alkalis, organic solvents, salt water, and are distortion resistant to300 degrees F. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ensure ties have a minimum loop tensile strength of 175 pounds. Provide cable tags with black block letters, numbers, and symbols 1-inch high on a yellow background. Ensure letters, numbers, and symbols do not fall off or change positions regardless of the cable tags orientation.

2.7 FIREPROOF TAPE

Provide fireproof tape approximately 30 mils thick by 3 inches wide, consisting of a flexible, unsupported elastomer that expands in fire to provide a thick char buildup between the flame and the cable. Ensure the tape does not give off a smoke when subjected to flames or support combustion. Also, ensure tape does not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

2.8 FACTORY TESTING

Submit certified evidence that the cable manufacturer has made factory-conducted tests on each shipping length (reel) of cable. Submit certified copies of test data in accordance with applicable provisions of the referenced standard. Include in tests on each length of cable, conductor resistance; ionization; high voltage; partial discharge test. Contracting Officer or designee has the option of witnessing required factory testing at no additional cost. Provide a schedule of manufacturing and testing in advance to permit such witnessing, if requested.

Submit certified qualification test reports in accordance with AEIC CS8 made in accordance with the applicable referenced standards. Ensure certified copies of test data show conformance to the requirements of referenced standards and submit for approval prior to shipment of the cable.

Prior to manufacturing, provide data regarding degradation of proposed insulating material and cable performance due to water immersion test as

specified in this specification to the Contracting Officer or designee. Indicate in information AC breakdown stress in kV/mm or V/mil versus immersion time. Ensure a complete description and condition under which cable was tested accompanies the test information. Submit an accelerated water absorption test.

2.9 SURGE ARRESTERS

IEEE C62.11, rated 15kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Where surge arresters are specified, provide one per phase and ground per the manufacturer's published installation instructions.

PART 3 EXECUTION

3.1 DEMOLITION OR CABLE CUTTING

Notify the Contracting Officer 14 working days prior to an outage for demolition or cable cutting of medium voltage electrical system.

The Government has established a mandatory inspection point prior to Contractor performing any medium voltage cable cuts or demolition. Notify the Contracting Officer 48 hours in advance of this mandatory inspection point.

As part of the mandatory inspection point, positively identify and label the medium voltage cable to be worked utilizing an electronic cable identifier. Ensure the process of identifying and labeling the cable to be worked is witnessed by the Government. Cable cutting and demolition of any medium voltage cable can occur only after approval by the Contracting Officer.

3.2 INSTALLATION

Install medium-voltage cables in accordance with NFPA 70.

Refer to contract provisions for safety submittals and requirements associated with working in the vicinity of energized cables in manholes and at equipment. The use of arc-flash and shock prevention equipment and personal protective equipment is mandatory.

Notify the Contracting Officer 14 working days prior to an outage that requires testing for phasing and phase rotation of medium voltage electrical systems. The Institutional Services Contractor (ISC) will identify and tag the phasing of equipment and provide to the Contractor, in writing, the results of phasing and phase rotation tests. The Contractor is responsible for maintaining the phasing and phase rotation tests, and is responsible for maintaining the phasing, and matching the existing phase rotation and phasing when installing conductors in existing electrical systems.

Install the cables in the following locations:

Exterior:

- In underground duct banks
- In conduit above and below grade

- In manholes

Installed cable or conductors of a primary distribution system will be rejected by the Government when placed:

- Unsecured or openly racked along interior walls

- In the same raceway or conduit with AC/DC control circuits or AC power circuits operating at less than 600 volts

- In a manner allowing the cable to support its own weight

3.2.1 Protection During Splicing Operations

Provide blowers to force fresh air into manholes or confined areas where free movement or circulation of air is obstructed. Ensure waterproof protective coverings are available on the work site to provide protection against moisture while a splice is being made. Use pumps to keep manholes dry during splicing operations. Under no conditions, make a splice or termination with the interior of a cable exposed to moisture. Moisture-test conductor insulation paper before the splice is made. Use a manhole ring at least 6-inches above ground around the manhole entrance to keep surface water from entering the manhole. Plug unused ducts and stop water seepage through ducts in use before the splice is started.

3.2.2 Duct Cleaning

Thoroughly clean ducts before installation of power cables. Pull a standard flexible mandrel through each duct to loosen particles of earth, sand, or foreign material in the line.

3.2.2.1 PVC Duct

Ensure mandrel length is not less than 12 inches long and has a diameter 1/2 in less than the inside diameter of the duct. Pull a stiff bristled brush through each duct to remove the loosened particles. Ensure brush diameter is the same or slightly larger than the diameter of the duct.

3.2.3 Pulling Cables in Ducts and Manholes

3.2.3.1 Pulling Procedures

Provide and submit a pulling plan including calculations of pulling tension and side wall pressure anticipated, and the maximum allowable pulling tension for each pull. Do not perform any pull until Government reviews and approves the pulling plan.

Pull medium-voltage cables into ducts with equipment designed for this purpose, including power-driven winch, jamb skid, cable-feeding flexible tube guide, long radius quadrant block cable pulling sheaves, pulling eyes, and lubricants. Employ a sufficient number of trained personnel and equipment with two-way radio communication capability to ensure the careful and proper installation of the cable.

Set up cable reel at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Install a flexible tube guide through the opening in a manner that prevents the cable from rubbing on the edges of any structural member (manhole frame, chimney, duct, etc.).

Use two long-radius 30 inches minimum quadrant block cable pulling sheaves and necessary jamb skid support at the pulling end to ensure that sidewall pressures during pulling is not excessive. Use a dynamometer in the pulling line to ensure that the pulling force is not exceeded. Ensure the pulling force does not exceed the smaller of: allowable tension on pulling device, allowable tension on cable, or the tension which produces the allowable sidewall pressure. The allowable tension on the pulling device is 6500 pounds for pulling eyes and 1000 pounds for pulling grip (where allowed). Do not exceed the allowable tension on cable, using the allowable tension value computed from the following equation:

TM =0.036 X N X CM

Where: TM = maximum allowable pulling tension in pounds

N = number of conductors in the cable

CM = cross-sectional area of each conductor in circular mils

3.2.3.2 Allowable Sidewall Pressure

The allowable sidewall pressure is the smaller of 500 pounds per foot of bend radius or the cable manufacturer's recommended maximum value. Show in the pulling plan submittal the calculations for allowable tension and sidewall pressure as well as the anticipated tension and sidewall pressure for each pull in the project.

Unreel cable from the top of the reel, carefully controlling payout. Attach cable to be pulled through a swivel to the main pulling wire by means of a pulling eye installed by the factory or approved cable splicer. Use of a suitable cable grip is permitted only on cables less than 200 feet long and less than 2 inches in diameter.

Attach pulling eyes to the cable conductors of the 3-1/C circuit to prevent damage to the cable structure. Pull the entire 3-1/C circuit simultaneously.

3.2.3.3 Minimum Bending Radius

Minimum bending radius during cable pulling operations is 30 inches. For permanent cable bending/racking the minimum bending radius is 12 times cable diameter.

3.2.3.4 Coating of Cables

Liberally coat cables with a suitable cable-pulling lubricant as it enters the tube guide or duct. Do not use greaser and oil lubricants. Cover nonmetallic sheathed cables with wire-pulling compounds, when required, which have no deleterious effects on the cable. Use rollers, sheaves or tube guides, around which the cable is pulled, conforming to the 30 inches minimum bending radius of the cable during the pulling operations.

3.2.3.5 Pulling Speed

Pull cables into ducts at a speed not to exceed 50 feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle is not be permitted. Stop pulling operations immediately with any indication of binding or

obstruction and do not resume until such difficulty is corrected. Provide sufficient slack for free movement of cable due to expansion or contraction.

3.2.3.6 Cable Splice Support And Sealing

Firmly support cable splices made up in manholes on cable racks as indicated. Do not pull cable splices in ducts. Overlap cable ends at the ends of a section to provide sufficient undamaged cable for splicing. Overlap cables to be spliced in manholes to the centerline of the proposed joint by not less than 2 feet.

Immediately seal cut ends of cables cut in the field to prevent entrance of moisture with heat-shrinkable molded cable end caps.

3.2.4 Splices and Terminations

Field fabricate terminations from termination kits supplied by, and in accordance with, the termination manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified.

Make splices in manholes as shown on the drawings. Make cable terminations at equipment specifically indicated. Expedite splicing and terminating of cables to minimize exposure and cable deterioration.

Field fabricate cable splices from heat-shrinkable splicing kits supplied by, and in accordance with, the cable manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified. Locate cable splices in manholes midway between cable racks on walls of manholes and supported with cable arms at approximately the same elevation as the enclosing duct.

Use tools recommended by the splice manufacturer including calibrated cutting equipment to ensure consistent cut depths when preparing cable ends for the application of the splice kit. Submit a list of manufacturer's recommended tools for splicing operations. Connect the cable concentric neutral/shield wires across one side of the splice by split bundling the splice neutral wiring and connecting each bundle set to a continuous No. 4 AWG solid bare copper conductor via two compression conductors. Ensure the No. 4 AWG conductor extrudes from the cable splice jacket and connects to the manholes grounding system. Make all connections within the splice utilizing long barrel-type compression connectors and appropriate compression tools with proper size dies to ensure a satisfactory mechanical and electrical joint. Ensure bare connections of concentric neutral/shield wires are either contained within the splice kit or sealed via an additional outer covering, consisting of a heavy wall, heat-shrinkable tubing containing adhesive material (mastic) that melts as heat is applied and the outer tubing shrinks to form a moisture proof environmental seal. Provide outer tubing conforming to ANSI C119.1. Ensure splice meets the requirements of IEEE 404 for 15kV ratings and is rated by the manufacturer for use on 15kV class feeder cable systems. Take extra precautions to seal around the exit area of the bare copper jumpers with an additional mastic per the splice manufacturer's recommendations.

Terminate cables in approved cable terminations, rated Class 1 per IEEE 48. Dry terminations with medium voltage pennants, preformed, and hand wrapped stress cones can be used for terminating cables. Provide terminations with adequate means for making external connections to the cable

conductors of single-conductor cables (phase and concentric neutral), protecting the cable insulation against moisture, oil, or other contaminants. Take extra precautions in physically protecting and supporting cables, and maintaining the insulation level of the cable.

Include in installation built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables and at the terminals of single-conductor lead-covered cables rated 15 kV and above.

Install cable splices on cable racks so as the minimize the physical stress on the splice connections. Support splices at approximately the same elevation as the installed cable, except where space limitations or existing cable length limitations make this method impractical or impossible.

Support all universal demountable splices in such manner so as to minimize physical stress on the splice connections. Support each cable end termination using a pair of saddle type supports under the cable end termination and/or cable with a minimum 12 inches and a maximum 30 inches separation between the supports. Secure cable end termination and cable to the supports in such a manner as to prevent movement of termination or cable at the support. Install saddle type supports on galvanized steel framing channel anchored to the wall or securely fastened to the cable tray or installed by other approved methods.

Concentric neutral conductors of medium voltage cable systems shall be bonded to all manhole ground systems at splice locations and to both the equipment enclosure and its earth ground system at all terminations.

3.2.5 Fireproofing

Provide fireproofing (Arc Proofing) for individual cable conductor in manholes, handholes and vaults which carry current at 2200 volts or more.

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Extend the tape 1 inch into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure-sensitive glass cloth tape.

3.2.6 Cable Tag Installation

Install cable tags on each new cable installed as part of this project, in each manhole and at each termination. Install cable tags over the fireproofing and position the tags so that they are clearly visible without disturbing any other cabling or wiring.

3.3 FIELD TESTING

After the installation of power cables has been completed, including splices, joints, and terminations, and before the cable is energized, subject each medium voltage cable to field testing in accordance with the following requirements:

a. Provide test equipment, labor, and trained technical personnel as necessary to perform the electrical acceptance tests.

b. Obtain a KSC medium voltage cable test form from the Contracting Officer prior to commencing Field Testing. Record all tests on forms provided, and submit completed forms to the Contracting Officer.

c. Make arrangements to have tests witnessed and approved by the Contracting Officer.

d. Isolate each power-cable installation completely from extraneous electrical connections at cable splices/terminations and joints. Observe all safety precautions.

e. Ensure each power cable is first given an insulation resistance test using a meg-ohmmeter with a voltage output of at least 2,500-volts. Apply test for a long enough time to fully charge the cable (no less than one minute). Record readings as indicated on forms provided. The minimum reading is 5000 megohms at an ambient temperature of 68 degrees F. Correct readings taken at other than 68 degrees F ambient temperatures accordingly.

f. Ensure concentric neutral cable shields are bonded to the metal enclosure of all transformers, switches, and switchgear.

g. Conform testing to NETA ATS, and NETA MAINT.

Upon successful completion of the insulation resistance test, subject the cable to a Very Low Frequency (VLF) AC high potential test. Adhere general VLF testing measures, parameters, considerations, and results to the following:

a. Ensure test voltage duration is continuous duty for 30 minutes (non-interrupted)

b. Provide the test equipment to test the cable capacity in microfarads and record on the KSC Medium Voltage AC Hi-pot test form (VLF).

c. Provide the test equipment to generate the test voltages required for the 30 minute test duration and adhere to the following table:

VLF Test Voltage for Sinusoidal Waveform		
Cable Rating phase to phase	Acceptance (phase to ground test values)	Acceptance (phase to ground test values)
	(New cable)	(Existing cable spliced to new cable)
(rms voltage, KV)	(peak voltage, KV)	(peak voltage, KV)
15	28	22; (EPR TO EPR)
15	15	15; (EPR TO NON-EPR)

d. Ensure the sinusoidal test frequency is 0.1 Hertz.

e. Do not perform test on cable attached to equipment.

Ensure Splices/terminations are clean, dry, and tested per IEEE 48 and

IEEE 400.2.

Perform and submit radiographic tests on all splices/terminations at the discretion of the Contracting Officer to determine if voids exist. Rework unacceptable cable, splices or terminations at no additional expense to the Government.

-- End of Section --

SECTION 26 05 63.00 98

COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1584	(2002, Am 1 2004, Int 1-3 2008) Guide for Performing Arc-Flash Hazard Calculations
IEEE 242	(2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE 399	(1997) Brown Book IEEE Recommended Practice for Power Systems Analysis
IEEE C2	(2012) National Electrical Safety Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA Z535.4	(2011) American National Standard for Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code
NFPA 70E	(2012) Standard for Electrical Safety in the Workplace

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Fault Current, Load Flow, and Arc Flash Analysis Review Submittals; G

Protective Device Coordination Study Review Submittals; G

Proposed Test Plan; G

SD-03 Product Data

Fault Current, Load Flow, and Arc Flash Analysis; G

Protective Device Coordination Study; G

Equipment; G

System Coordinator; G

Protective Relays; G

Installation Procedures; G

SD-06 Test Reports

Field Testing; G

SD-07 Certificates

Certificates of Conformance for Devices and Equipment; G

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Submittals and Meetings

No later than 60 days after Contract Award, submit the following to the Contracting Officer for review and approval:

a. Fault Current, Load Flow, and Arc Flash Analysis Review Submittals

b. Protective Device Coordination Study Review Submittals

c. Proposed Test Plan

The Contractor and System Coordinator agree to attend a review meeting at a KSC location designated by the Contracting Officer and provide review submittals as follows:

a. 90 percent submittal and review meeting: Study is complete except for disposition of Government comments. Submit within 60 days after contract award.

b. 100 percent submittal: Incorporates approved Government comments. Setting sheets and test procedures from these documents are to be used to implement protective device settings. Submit within 20 days after the Review Meeting.

1.3.1.1 Proposed Test Plan

Submit a proposed test plan, consisting of complete field test procedure including tests to be performed, test equipment required, and tolerance limits, including complete testing and verification of the ground fault protection equipment, where used.

1.3.1.2 Review and Final Submittals Format

For review and final submittals, submit 1 single-sided and 1 double-sided bound copies and a PDF file formatted on Compact Disc (CD) and or electronic storage media. Also provide on a final submittal CD all power system analysis software data files necessary to restore and edit the model.

Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

a. Equipment data

Submit data consisting of manufacturer's time-current characteristic curves for individual protective devices, recommended settings of adjustable protective devices, and recommended ratings of non-adjustable protective devices.

Review protective device submittals of equipment to be provided and indicate any options or modifications required to achieve the requirements of this section. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. The Government is not responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

b. Protective Relays

Submit data including calibration and testing procedures and instructions pertaining to the frequency of calibration, inspection, adjustment, cleaning, and lubrication.

c. Installation Procedures

Submit written description of procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment.

1.3.2 Final Submittals

After completion of installation and testing submit the following to the Contracting Officer for review and approval:

a. Field Testing

Submit in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

1.3.3 Field Changes

If field changes are required due to discrepancies between the setting sheet documents and the available setting selections on the protective

device, submit within 10 days after installation the following to the Contracting Officer for review and approval:

a. Fault Current and Arc Flash Analysis

b. Protective Device Coordination Study

1.4 QUALITY ASSURANCE

Ensure all work performed is in conformance with the following standards:

IEEE C2

IEEE 1584

NEMA Z535.4

NETA ATS

NFPA 70

NFPA 70E

1.4.1 System Coordinator

Provide documentation verifying that system coordination, recommended ratings and settings of protective devices, and design analysis are prepared (performed/reviewed/approved) by a registered professional electrical power engineer with a minimum of 3 years of current experience in the coordination of electrical power systems.

1.4.2 System Installer

Ensure all final calibration, testing, adjustment, and placing into service of the protective devices is accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience in protective devices.

1.5 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this Section.

PART 2 PRODUCTS

2.1 GOVERNMENT PROVIDED INFORMATION

The Government will provide the short circuit values for the following connection points on the electrical system:

- Feeder 212 at the Orsino Substation and VFI-12.

- Feeder 204/205 at the Orsino Substation and VFI-31.

The Government will provide the existing protective device settings for the following devices on the electrical system:

- Feeder 212 at the Orsino Substation.

- Feeder 212 VFI-12.

- Feeder 204/205 at the Orsino Substation.

- Feeder 204/205 VFI-31.

2.2 ARC FLASH LABELS

Provide weatherproof detailed arc flash warning labels for all electrical equipment as required by NFPA 70 and NFPA 70E, including, medium voltage switches, transformers, switchboard main breakers, switchboard bus-tie breaker, switchboard feeder breakers, switchboard cable compartments, switchboards, panel boards, motor control centers, enclosed breakers, safety switches automatic transfer switches, motor starters, control panels, and other equipment modified or installed by the project that is likely to require examination, adjustment, servicing, or maintenance while energized.

2.2.1 Label Format

Label format is to be NFPA 70E detailed format type. Conform in detail with samples provided at the time of award. The government will provide the Contractor with the label template(s) currently in use at Kennedy Space Center. Format includes different colors and formatting per NEMA Z535.4 for different hazard levels and the following information:

a. Flash hazard boundary

b. Incident energy

c. Hazard Category and PPE

d. Shock Voltage

e. Minimum insulated glove rating

f. Limited approach boundary distance

g. Restricted approach boundary distance

h. Prohibited approach boundary distance

2.2.2 Label Content

Ensure arc flash label content is based on the operational scenario, fault location, and fault type (arcing or bolted) that results in the highest incident energy.

2.3 COORDINATED POWER SYSTEM PROTECTION

Prepare and submit analyses to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. Include a Fault Current, Load Flow, and Arc Flash Analysis; equipment evaluation report; and a Protective Device Coordination Study. Submit Certificates of Conformance verifying that the studies have been prepared (performed/reviewed/approved) by a registered professional engineer with demonstrated experience in power system coordination in the last 3 years. Provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

Prepare and submit short circuit studies, load flow studies, motor starting analysis for motors greater than 50 HP, coordination studies, and arc-flash hazard analysis in accordance with NETA ATS and as specified herein.

2.3.1 Scope of Analyses

The scope of power system analysis (short circuit study, arc flash analysis, and protective device coordination study) covered by this specificaiton begins at the 13.2 kV level and consists of the following:

a. Feeder 212 at the Orsino Substation; pre-coordination with the Government is required prior to making any changes on settings for this protective device.

b. Feeder 212 VFI-12, KSC Central Campus Replacement Headquaters Building Phase 1 relay protected position.

c. Feeder 204/205 at the Orsino Substation pre-coordination with the Government is required prior to making any changes on settings for this protective device.

d. Feeder 204/205 VFI-31, KSC Central Campus Replacement Headquaters Building Phase 1 relay protected position.

e. All KSC Central Campus Replacement Headquaters Building Phase 1 substation, power generation, and distribution system equipment involving protective devices with adjustable settings. Include the largest non-adjustable protective device in each circuit analysis.

f. Emergency and fire pump supply systems including all downstream distribution involving protective devices with adjustable settings. Include the largest non-adjustable protective device in each circuit analysis.

2.3.2 Determination of Facts

Perform field inspections to determine and document the time-current characteristics, features, and nameplate data for each existing protective device. Utilize the fault current availability indicated as a basis for fault current studies.

2.3.3 Single Line Diagram

Prepare a single line diagram to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Ensure each bus, device or transformation point has a unique identifier. If a fault-impedance diagram is provided, show impedance data. Show the location of switches, breakers, and circuit interrupting devices on the diagram together with available fault data, and the device interrupting rating.

2.3.4 Fault Current Analysis

2.3.4.1 Method

Perform the fault current analysis and load flow analysis in accordance

with methods described in IEEE 242, and IEEE 399. Single line drawings based on existing hardware will be provided to the Contractor for reference. Utilize specialized computer aided engineering software designed for fault current analysis, including the following capabilities:

a. Single-ended substation source operation

b. Double-ended substation source operation

c. Independent generator source operation

Perform analysis and provide separate study report generated for each operational scenario.

2.3.4.2 Data

Utilize actual hardware data in fault calculations. Ensure bus characteristics and transformer impedance are those proposed. Document all data in the report.

2.3.4.3 Fault Current Availability

Provide balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values at each voltage transformation point and at each power distribution bus. Show the maximum and minimum values of fault available at each location in tabular form on the diagram or in the report.

2.3.5 Coordination Study

Ensure the study demonstrates that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. Include a description of the coordination of the protective devices in this project. Provide a written narrative describing:

a. Which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings;

b. Situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap);

c. Coordination between upstream and downstream devices; and relay settings.

d. Provide recommendations to improve or enhance system reliability by reducing the incident energy level, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction).

Provide composite coordination plots on log-log graph paper.

a. Provide separate plots for phase and ground faults.

b. Include applicable cable and transformer damage curves on phase fault plots.

c. Limit the number of protective device curves on any plot to 5 .

2.3.6 Study report

Include the following in the report:

a. A cover sheet and table of contents. Provide separate sections with all applicable content, for all operating scenarios.

b. A narrative describing:

(1) The analyses performed;

(2) The basis and methods used;

(3) The desired method of coordinated protection of the power system.

c. Descriptive and technical data for existing devices and new protective devices proposed, including manufacturers published data, nameplate data, time-current curves, and definition of the fixed or adjustable features of the existing or new protective devices.

d. Document existing power system data including time-current characteristic curves and protective device ratings and settings.

e. Provide time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment, including recommended ratings and settings of all protective devices in tabulated form.

f. Utilize SKM or ETAP power analysis software to perform the analysis. Provide all calculations performed for the analyses, including computer analysis programs utilized, the name of the software package, developer, and version number. Include all information input to (define) nodes such as cable data, conduit type, circuit length, transformer impedance, bus impedance, generator impedances, etc. For all nodes include phase fault short circuit levels and X/R ratios, ground fault short circuit levels and X/R ratios, load flow levels, arc flash energy (for both bolted and arcing short circuit levels), and motor starting studying results. Indicate which study options have been chosen that the software utilizes to generate the Short Circuit Analysis and Arc Flash Hazard Analysis results; use preferred method below when available. Options included are, but not limited to the following:

(1) Standard used for arc-flash calculations: (IEEE 1584 - preferred method).

(2) 240 Volt Exceptions (report Cat 0 if XFMR less than 125kVA - preferred method).

(3) Maximum arcing time: (2 sec - preferred - fully dependent on task performed).

(4) Motor fault contributions: (5 cycles preferred - motors with 50 hp or greater are to be evaluated).

(5) Levels Mis-coordination checked (5 levels-preferred).

(6) Mis-coordination Ratio: (80 percent - preferred - ensure Cleared

Fault Threshold matches Mis-coordination Ratio).

(7) Flash Boundary Calculation Adjustments above 1kV, Trip Time less than =0.1s: (1.5 cal/square meter - preferred).

(8) Properly categorize all equipment types in Arc Flash Evaluation: (Ensure switchboard, panel boards have proper gap distance).

(9) Utility information from latest KSC Fault Study.

(10) Short Circuit Study Utilized: (Comprehensive-preferred).

(11) Fault types analyzed: (Three Phase, Single Line to Ground, Line to Line, Line to Line to Ground, All -preferred).

g. Single line diagram(s).

h. Protective device setting sheets, as separate pages, suitable for use by installing technicians, separate from other report analysis and data. Include recommended changes to existing protective device settings and settings for all new protective devices. Provide all information to field install the settings, including settings or features not used or turned off.

i. Tabulated Arc Flash data for all equipment requiring an arc flash warning label and all modified equipment also requiring an arc flash label.

j. Equipment Evaluation Report (EER) showing the AIC/SCCR ratings for all equipment evaluated and the required rating for the application where the equipment is installed. Ensure the EER identifies underrated and marginally rated equipment. Underrated equipment is defined as equipment with actual AIC/SCCR ratings that do not meet the required AIC/SCCR rating for the application/installation. Marginally rated equipment is defined as equipment within 90 percent to 100 percent of the required rated AIC/SCCR for the application/installation.

PART 3 EXECUTION

3.1 INSTALLATION

Install and test protective devices settings in accordance with the manufacturer's published instructions and in accordance with the protective device coordination study protective device setting sheets and test plan.

Affix detailed arc flash warning labels to all electrical equipment as required by NFPA 70 and NFPA 70E.

3.2 FIELD TESTING

3.2.1 General

Section 26 08 00 APPARATUS INSPECTION AND TESTING, applies to this section, with the additions and modifications specified herein. Submit Performance Test Reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of

controls. Submit Certificates of Conformance for Devices and Equipment to the Contracting Officer, certifying that all devices or equipment meet the requirements of the contract documents.

3.2.2 Safety

Provide and use safety devices such as arc flash personal protective equipment, electrically insulating rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. Replace any devices or equipment which are damaged due to improper test procedures or handling.

3.2.3 Molded-Case Circuit Breakers

Visually inspect circuit breakers. Verify current ratings and adjustable settings incorporated in accordance with the coordination study.

3.2.4 Power Circuit Breakers

3.2.4.1 General

Visually inspect the circuit breaker and implement settings in accordance with the coordination study.

3.2.4.2 Current Injection Tests

Test with approved settings installed in accordance with NETA ATS and the Test Plan; document results in the field test reports.

a. Determine long time pick-up value and delay by primary current injection.

b. Determine short time pick-up value and delay by primary current injection.

c. Determine instantaneous pick-up value by primary current injection.

d. Determine ground-fault pick-up value and delay by primary current injection.

e. Test trip unit functions by secondary current injection or in accordance with the manufacturer's requirements.

3.2.5 Protective Relays

3.2.5.1 General

Visually inspect protective relays. Implement relay settings in accordance with the coordination study.

3.2.5.2 Current Injection Tests

Test with approved settings installed in accordance with NETA ATS and the Test Plan; document results in the field test reports.

a. Determine long time pick-up value and delay by secondary current injection.

b. Determine short time pick-up value and delay by secondary current

injection.

c. Determine instantaneous pick-up value by secondary current injection.

d. Determine ground fault pick-up value and delay by secondary current injection.

-- End of Section --

SECTION 26 05 71.00 40

LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES
05/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.09	(1999; AMD 1 2005; Corr 1 2007; R 2007; Errata 2007; Amendment B 2011) Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.13	(2008; INT 1 2009) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.16	(2009) Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC 3200 V and below) Power Circuit Breakers
IEEE C37.17	(1997) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
IEEE C37.90	(2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE C63.2	(2009) Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specifications
IEEE C63.4	(2009) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

IPC D330	(1992) Design Guide Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 107	(1987; R 1993) Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus (inactive)
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 3	(2006) Molded Case Circuit Breakers and Their Application
NEMA FU 1	(2002; R 2007) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2011) Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2006; Reprint Feb 2011) Surge Protective Devices
UL 489	(2009; Reprint Jun 2011) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 50	(2007; Reprint Apr 2012) Enclosures for Electrical Equipment, Non-environmental Considerations
UL 96A	(2007; Reprint Jul 2012) Standard for Installation Requirements for Lightning Protection Systems

1.2 SUBMITTALS

Where equipment specified by this section is installed in switchboards, or

other similar equipment, coordinate and integrate drawing submittals with those of the other related specification sections.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Connection Diagrams; G and Fabrication Drawings for the following items in accordance with paragraph entitled "General Requirements" of this section.

All Shop Drawings shall be computer aided design (CAD) generated. With each submittal provide a CD with a complete copy of the drawings in PDF format.

Submit Shop Drawings for approval prior to equipment manufacturing.

Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made. Provide Digital media compact disc (CD) with all submittals including .DWG or .DXF CAD source files as well as PDF format files for all drawings.

Submit Installation drawings for the following items in accordance with the paragraph entitled "Installation" of this section.

Control Devices; G
Protective Relays; G
Electrical Power Monitoring Systems; G
Surge Protective Devices; G

SD-03 Product Data

Submit manufacturer's equipment and performance data for the following items including use life, system functional flows, safety features, and mechanical automated details.

Instrument Transformers; G
Enclosures; G
Circuit Breakers (including trip unit data and complete register list); G
Fuses; G
Control Devices; G
Protective Relays; G
Surge Protective Devices; G
Electrical Power Monitoring Systems; G
Indicating Lights; G

SD-06 Test Reports

Submit test reports for the following tests in accordance with the paragraph entitled "Field Testing" of this section.

Factory tests; G
Field testing; G

Submit test forms showing compliance with NETA ATS inspections and tests for approval prior to testing.

Submit completed test forms showing the results of all inspections and tests in accordance with NETA ATS inspections and tests after inspections and testing is complete.

SD-08 Manufacturer's Instructions

Submit manufacturer's instructions for the following items, including special provisions required to install equipment components and system packages. Provide detail on resistance impedances, hazards and safety precautions within the special notices.

Control Devices; G
Protective Relays; G
Circuit Breakers (including trip units); G
Electrical Power Monitoring Systems; G
Surge Protective Devices; G

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for the following equipment:

Circuit Breakers (including trip units); G
Protective Relays; G
Electrical Power Monitoring Systems; G
Surge Protective Devices; G

1.3 GENERAL REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING, Section 26 23 00 SWITCHBOARDS, and Section 26 32 15.00 10 DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES applies to work specified in this section.

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

Provide a power system study as specified in Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS. Set protective devices in accordance with the approved study submittal.

Submit Connection Diagrams showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, interconnection of the substation control and monitor system with KCCS, and internal tubing, wiring, and other devices.

Submit Fabrication Drawings for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

Provide products with continuous-current rating, interrupting rating, clearing time, and melting time, indicated herein and on the drawings. No change from the continuous-current rating, interrupting rating, clearing time, and melting time indicated herein and on the drawings shall be made

unless written permission has first been secured from the Contracting Officer.

PART 2 PRODUCTS

2.1 INSTRUMENT TRANSFORMERS

Comply with the interference requirements measured in accordance with IEEE C63.2, IEEE C63.4, and NEMA 107 for Instrument transformers.

2.1.1 Current Transformers

Provide current transformers that conform to IEEE C57.13 for installation in metal-enclosed switchboard. Use standard multi-ratio 5-A secondary transformer.

Provide wound, bushing, bar and window type transformers as required.

Provide transformers that have single or double secondary winding as required.

Provide transformers that are complete with secondary short-circuiting device.

For low voltage window-type current transformers, provide indoor dry type construction with secondary current ratings as indicated with B-1 burden, specified frequency, and minimum 10C100 accuracy.

2.1.2 Potential Transformers

For potential transformers, provide fixed mount potential transformers as indicated or required for metering and relaying applications. Unless otherwise indicated, use three (3) standard 120-volt, 60-hertz grounded secondary transformers for 3-phase applications.

Provide transformers that have single, tapped or double secondary as required.

Provide burden, frequency and accuracy as indicated on the drawings.

For low voltage switchboard bus tap power supply connections provide a fully enclosed circuit breaker or a pullout, dead-front type fuse block mounted in the metering compartment containing one fuse per phase.

Provide secondary fusing and pull-out type fuse block. Size fuses as recommended by the manufacturer.

2.2 ENCLOSURES

Provide enclosures for equipment in accordance with NEMA 250.

Contain equipment installed in clean, dry indoor locations in a NEMA Type 12 industrial use, sheet-steel enclosure, constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Contain equipment installed in damp, wet, or outdoor locations in a NEMA Type 4X 316 stainless steel watertight, corrosion-resistant sheet-steel enclosure, constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4X enclosures.

Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.

Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet conforming to ASTM A167 Type 300 series with ASM No. 4 general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with UL 50.

2.3 CIRCUIT BREAKERS

Provide circuit breakers that conform to UL 489, and NEMA AB 3.

2.3.1 Power Circuit Breakers

Provide air-break type power circuit breakers enclosed in ventilated housings for those rated below 600 volts with current (frame and trip), voltage, and interrupting ratings as indicated. Provide 100 percent rated drawout type circuit breakers.

Comply with IEEE C37.16 and IEEE C37.13 for power circuit breakers.

Mount draw-out breakers on a mobile frame with primary and secondary disconnecting devices to allow complete removal of the unit for inspection and maintenance. Provide a mechanism with an electrically and remotely operated racking mechanism that moves the breaker between the connected, test/ disconnect and withdrawn positions by means of a remote operator. Provide interlocks to prevent the complete withdrawal of the circuit breaker from its compartment when the stored-energy mechanism is in the fully charged position. Design circuit breakers to prevent the release of stored energy unless the mechanism is fully charged. Provide provisions to manually charge, open and trip electrically operated circuit breakers.

Equip power circuit breakers with static trip (solid-state) units with long-time, short-time, instantaneous and ground fault (LSIG) elements. Provide breakers that are electrically and mechanically trip-free in any position of the closing stroke. Provide silver-plated main contacts and sintered tungsten alloy arcing contacts. Accomplish tripping by a shunt-trip device. Provide electrical closing operation.

Trip units shall be digital solid-state type for low voltage power circuit breakers in accordance with IEEE C37.17; Square D Micrologic 6.0P (LSIG) or approved equal. Trip unit electronics module shall be interchangeable between breaker frame sizes without replacing current sensors or flux trip devices already installed. Units shall be powered from current sensors and a separate battery back-up source. Batteries shall only be used to power indicator lights and display after the unit trips. Trip units shall be adjustable. Trip settings shall not rely on rheostats, dip switches, jumpers or pins to maintain their present adjustments, and instantaneous trip settings shall be defeatable. Provide a sealable cover over the adjustments to prevent tampering. Units shall not rely solely on any volatile or nonvolatile electronic memory to maintain their settings.

Provide communication interface to allow the trip units to communicate using the communication system described in Section 26 23 00 SWITCHBOARDS paragraph entitled "Switchboard Monitoring and Control System." The digital solid state trip units shall be capable of clearly communicating all data to KCCS via Modbus TCP/IP communication protocol using a maximum

of one hardware conversion and no software conversions. Breaker status data shall include, but shall not be limited to, the following: breaker status, current, time of trip, operational history, cause of trip, current date and time, power (KW), energy (KWH), peak demand, self-diagnostic information and set points. Breaker remote control functions shall include, but shall not be limited to, the following: breaker open, close, and trip operations for electrically operated breakers, date/time energy clear, energy (KWH) clear and remote set date/time and trip reset.

Provide submittals of the KCCS communication drawings. Provide two licensed copies of all software and all hardware, including connection cables, necessary to modify and download programs to the digital solid state trip units.

Provide Citect programming to display the breaker status data described in this section on KCCS. Similar, Citect screens for existing trip units will be provided as a guide for the new screens. New screens shall match the "look and feel" of existing screens. If Square D Micrologic 6.0E/6.3E (LSIG) trip units are provided, no new Citect trip unit screens will be required. If other trip units are provided, the Contractor shall develop all new KCCS Citect interfaces as described in Section 26 23 00 SWITCHBOARDS paragraph entitled "Switchboards Monitoring and Control System."

Trip units shall be equipped with test jacks on circuit breaker face for service functional testing of each trip unit function using a full function test kit for secondary injection. Provide one full function test kit to the Contracting Officer as part of this project. Test kit shall be a product of the trip unit manufacturer.

Upon a circuit breaker trip operation, it shall not be possible to close the circuit breaker until a manual reset operation occurs locally at the breaker trip unit or a lockout relay activated by the circuit breaker trip unit.

Supply alarms, auxiliary switches, truck auxiliary switches, interlocks, and similar devices as required and indicated.

Provide breakers with a removable operating handle, provision for padlocking, and position indicator.

Provide all maintenance items for breakers including lifting device, racking equipment and manual spring charging equipment as required.

Submit certification of factory testing of Power Circuit Breakers in accordance with IEEE C37.09.

2.3.2 Molded-Case Circuit Breakers

Equip circuit breakers with static trip (solid-state) units with long-time, short-time, instantaneous and ground fault (LSIG) elements as indicated.

For circuit breakers on frames size of up to 250 amperes, provide thermal-magnetic tripping mechanism with fixed inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection, unless otherwise shown on the drawings. Locate the thermal-magnetic tripping mechanism elements in each pole of the breaker.

Trip units shall be digital solid-state type for low voltage power circuit breakers in accordance with IEEE C37.17; Square D Micrologic 6.2E/6.3E (LSIG) or approved equal. Trip unit electronics module shall be interchangeable between breaker frame sizes without replacing current sensors or flux trip devices already installed. Units shall be powered from current sensors and a separate battery back-up source. Batteries shall only be used to power indicator lights and display after the unit trips. Trip units shall be adjustable. Trip settings shall not rely on rheostats, dip switches, jumpers or pins to maintain their present adjustments, and instantaneous trip settings shall be defeatable. Provide a sealable cover over the adjustments to prevent tampering. Units shall not rely solely on any volatile or nonvolatile electronic memory to maintain their settings.

Provide communication interface to allow the trip units to communicate using the communication system described in Section 26 23 00 SWITCHBOARDS paragraph entitled "Switchboard Monitoring and Control System." The digital solid state trip units shall be capable of clearly communicating all data to KCCS via Modbus TCP/IP communication protocol using a maximum of one hardware conversion and no software conversions. Breaker status data shall include, but shall not be limited to, the following: breaker status, current, time of trip, operational history, cause of trip, current date and time, power (KW), energy (KWH), peak demand, self-diagnostic information and set points. Breaker remote control functions shall include, but shall not be limited to, the following: breaker open, close, and trip operations for electrically operated breakers, date/time energy clear, energy (KWH) clear and remote set date/time and trip reset.

Trip units shall be equipped with test jacks on circuit breaker face for service functional testing of each trip unit function using a full function test kit for secondary injection. Provide one full function test kit to the Contracting Officer as part of this project. Test kit shall be a product of the trip unit manufacturer.

Upon a circuit breaker trip operation, it shall not be possible to close the circuit breaker until a manual reset operation occurs locally at the breaker trip unit or a lockout relay activated by the circuit breaker trip unit.

Supply alarms, auxiliary switches, truck auxiliary switches, interlocks, and similar devices as required and indicated.

Provide breakers with a removable operating handle, and factory installed padlock attachment.

Where indicated on the drawings, the circuit breakers shall be fully rated (100% continuous current rated).

Size breaker as required for the continuous current rating of the circuit. Provide interrupting capacity indicated. Provide breaker class as required. Breakers shall be equipped with lugs suitable for 75 degrees C copper conductors indicated.

Provide sufficient interrupting capacity of the panel and lighting branch circuit breakers, to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Where not indicated, provide circuit breaker interrupting capacities with a minimum of 10,000 amperes and that conform to NEMA AB 3. Series ratings of breakers is not permitted.

Provide the common-trip type multi-pole circuit breakers having a single operating handle and a two-position on/off indication. Provide circuit breakers with temperature compensation for operation in an ambient temperature of 104 degrees F. Provide circuit breakers that have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective type tripping (time delay, magnetic, thermal, or ground fault).

Provide phenolic composition breaker body capable of having such accessories as handle-extension, handle-locking, and padlocking devices.

Provide circuit breakers used for meter circuit disconnects that meet the applicable requirements of NFPA 70 and that are of the motor-circuit protector type.

For circuit breakers used for service disconnection, provide an enclosed circuit-breaker type with external handle for manual operation. Provide sheet metal enclosures with a hinged cover suitable for surface mounting.

2.3.3 Enclosed Molded-Case Circuit Breakers

For enclosed circuit breakers, provide thermal-magnetic molded-case circuit breakers in surface-mounted, non-ventilated enclosures conforming to the appropriate articles of NEMA 250 and UL 489, with factory installed padlock attachments.

Provide enclosures for units per the paragraph entitled "Equipment and Enclosures." Provide copper ground bus and, where indicated, a solid neutral.

2.4 FUSES

Provide a complete set of fuses for all switches and switchboard. Provide fuses that have a voltage rating of not less than the circuit voltage.

Make no change in continuous-current rating, interrupting rating, and clearing or melting time of fuses unless written permission has first been secured.

Provide rejection type, high interrupting, current limiting, nonrenewable cartridge type fuses with time-delay dual elements, except where otherwise indicated. Conform to NEMA FU 1 for fuses.

Label fuses showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, clearly list fuse information on equipment drawings.

Provide dead-front pull-out type fuse holders when field-mounted in a cabinet or box. Do not use fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber.

2.5 CONTROL DEVICES

2.5.1 Magnetic Contactors

Provide magnetic contactors in accordance with NEMA ICS 1 and NEMA ICS 2 as required for the control of low-voltage, 60-hertz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the secondary

windings of low-voltage transformers.

Provide core-and-coil assembly that operates satisfactorily with coil voltage between 85 and 110 percent of its voltage rating.

Provide contactor that is designed with a normally open holding circuit auxiliary contact for control circuits, with a rating in accordance with NEMA ICS 1 and NEMA ICS 2.

Furnish solderless pressure wire terminal connectors, or make available for line-and-load connections to contactors in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide magnetic contactors with a rating in accordance with NEMA ICS 1and NEMA ICS 2.

2.5.2 Control-Circuit Transformers

Provide control-circuit transformers within the enclosure of switchboard, magnetic contactors, and motor controllers when the line voltage is in excess of 120 volts. Provide encapsulated dry type, single-phase, 60-hertz transformer, with a 120-volt (or 120/240-volt where indicated) isolated secondary winding.

Do not provide a transformer with a rated primary voltage less than the rated voltage of the controller, or a rated secondary current less than the continuous-duty current of the control circuit.

Provide voltage regulation of the transformer such that, with rated primary voltage and frequency, the secondary voltage is not less than 95 percent nor more than 105 percent of rated secondary voltage.

Provide source of supply for control-circuit transformers at the load side of the main disconnecting device. Protect secondary winding of the transformer and control-circuit wiring against overloads and short circuits, with circuit breakers where indicated and, if not indicated, with fuses selected in accordance with NEMA ICS 6. Ground secondary winding of the control-circuit transformer in accordance with NEMA ICS 6.

2.5.3 Magnetic Control Relays

Provide magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices, in response to variations in the conditions of electric control devices in accordance with NEMA ICS 1, and NEMA ICS 2.

Provide core-and-coil assembly that operates satisfactorily with coil voltages between 85 and 110 percent of their voltage rating.

Provide relays that are designed to accommodate normally open and normally closed contacts.

Provide 120-volt, 60-hertz, Class AIB magnetic control relays with a continuous contact rating of 10 amperes, and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

2.5.4 Pushbuttons and Switches

2.5.4.1 Pushbuttons

For pushbuttons for low-voltage ac full-voltage magnetic controllers, provide heavy-duty oiltight NEMA 250, Type 4, momentary-contact devices rated 600 volts, with pilot light, and with the number of buttons and the marking of identification plates as shown. Furnish pushbutton color code in accordance with NEMA ICS 6.

Provide pushbuttons that are designed with normally open, circuit-closing contacts; normally closed circuit-opening contacts; and two-circuit normally open and normally closed circuit-closing and -opening contacts. Provide pushbutton-contact ratings in accordance with NEMA ICS 1 and NEMA ICS 2 with contact designation A600.

Identify pushbuttons in remote control stations with identification plates affixed to front cover in a prominent location. Carry the identification of the system being controlled on the identification plate.

2.5.4.2 Selector Switches

Provide heavy-duty oiltight maintained-contact selector switches for low-voltage control circuits, with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Identify selector switches in remote control stations with engraved identification plates affixed to front cover in a prominent location. Carry the identification of the system being controlled on the identification plate.

2.5.4.3 Miscellaneous Switches

Provide float, limit, door, pressure, proximity, and other types of switches in accordance with IPC D330 and of the types and classes indicated.

2.5.4.4 Test Switches

Provide test switches as indicated on the drawings. Test switches shall be ABB Type FT-1 or equal with clear covers, and shall be mounted on the door of the instrument compartment or as indicated.

2.6 PROTECTIVE RELAYS

2.6.1 Multi-Function Voltage Relays

For undervoltage relays conform to IEEE C37.90.

Provide three-phase solid-state multi-function type voltage relays, Basler Electric or equal, with definite time characteristics and adjustable and calibrated pick-up settings for protection against negative sequence voltage (Device 47), undervoltage (Device 27), and overvoltage (Device 59). Provide thumb wheel setting switches for pick-up and timing adjustments and equip relays with electrically separate contact circuits for all protective functions that are suitable for operation on dc or ac control circuits.

Provide relays that are of draw-out construction with built-in testing

facilities and that are suitable for operation on 120-volt ac instrument circuits.

Provide a semi-flush mount case with matching cover to the hinged instrument panel.

2.6.2 Synchronization Check Relays

For synchronization check relays (Device 25) conform to IEEE C37.90.

Provide solid-state electronic relay, Basler Electric or equal, with the ability to user select synchronization check function for the following conditions:

Live Line - Dead Bus
Live Line - Live Bus
Dead Line - Dead Bus
Dead Line - Live Bus

Provide three-phase solid state relay designed to accept 120 Volts AC inputs. Dead line and live line settings shall be adjustable. Synchronization angle shall be adjustable from 1 to 99 degrees with an adjustable time delay of 1 to 99 seconds. Provide thumb wheel setting switches for pick-up and timing adjustments and equip relays with electrically separate contact circuits for all protective functions that are suitable for operation on dc or ac control circuits.

Provide relays that are of draw-out construction with built-in testing facilities, and that are suitable for operation on 120-volt ac instrument circuits.

Provide semi-flush mount case with matching cover to the hinged instrument panel.

2.6.3 Timing Relays

Provide timing relays with calibrated timing head, precision-wound potted coil, and a snap-action switch assembly. The calibrated timing head shall re-circulate air under controlled pressure through a variable orifice to provide a linearly adjustable timing. The precision-would potted coil shall be totally sealed without any external leads. The snap-action switch assembly shall be double-pole, double-throw with copper blades and silver-cadmium oxide contacts to insure positive wiping action.

2.6.4 Lockout Relays

Provide high speed lockout relays with manual rotary cam reset and latching relay clearing contact. Provide contact deck with contacts having a rating adequate for the duty performed, but shall not be less than 600 volts, 20 amperes continuous. Door mounted control switch shall have mechanical targets with spring return type of operation and pistol grip handle. All switches shall be equipped with engraved plastic escutcheons identifying its function.

2.7 ELECTRICAL POWER MONITORING SYSTEMS

For compatibility, metering equipment shall be NASA KSC Standard, Schneider Electric Square D CM4250 with ECC21 Ethernet communications card, IOC input/output card, and CMDLC backlit LCD display, and no other.

Metering equipment shall be UL recognized, CSA certified and also meet IEEE C37.90.

a. Meter Monitoring Functions: Provide meter designed for use on a 3-phase, 3- or 4-wire, systems with 3 current transformers and 2 or 3 voltage transformers as indicated. The meter shall provide direct reading metered or calculated values and shall auto range between units, kilo-units, and mega-units for all metered values.

b. Case: Display case shall be semi-flush mounted to a hinged panel door. Power supply and other metering components may be fixed mounted within an auxiliary compartment.

c. Meter Enclosure: Where indicated, provide an enclosure in accordance with the paragraph entitled "Equipment Enclosures" and include a back-panel for mounting power supply, terminal strip, and similar components and a hinged interior panel for mounting the display case. Provide a warning label on the hinged panel indicating energized line voltage components are behind the hinged panel.

d. Test Blocks: Provide four pole current and four pole potential test blocks, General Electric Type PK or Westinghouse Type FT in line after the power monitor for additional metering or testing.

e. Meter Fusing: Provide a fully enclosed pullout, dead-front type fuse block or a fusible disconnect switch, either containing one fuse per phase to protect the voltage input to the watt-hour meter. Size fuses as recommended by the meter manufacturer.

f. Provide short-circuiting type terminal strips for connecting meter to current transformer circuits.

2.8 FACTORY TESTING

Perform factory tests on control and low voltage protective devices in accordance with the manufacturer's recommendations.

Conduct short-circuit tests in accordance with Section 2 of NEMA ICS 1.

Factory witness testing, at Government's option, shall take place at vendor's facility for circuit breakers, trip units, and KCCS communication.

Provide documentation on successful completion of factory tests for the above equipment prior to final activation at KSC.

2.9 INDICATING LIGHTS

Provide transformer, push-to-test LED type, rated for 120 volts ac. Lights shall be capable of being relamped from the front.

2.10 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices which comply with UL 1449 and UL 96A in the locations indicated on the drawings. Provide surge protectors in a NEMA Type enclosure per NEMA ICS 6. Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS -
Each phase to neutral (L-N)

Neutral to ground (N-G)
Phase to ground (L-G)

Surge protective devices at the service entrance and major distribtuion equipment shall have a minimum surge current rating of 200,000 amperes per mode minimum as indicated and downstream protectors shall be rated 100,000 amperes per mode minimum as indicated. The maximum line to neutral (L-N) Suppressed Voltage Rating (SVR) shall be:

500V for 120V, single phase system
500V for 120/240V, single phase system
500V for 208Y/120V, three phase system
900V for 480Y/277V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating shall be:

150V for 120V, single phase system
300/150V for 120/240V, single phase system
300/150V for 208Y/120V, three phase system
600/320V for 480Y/277V, three phase system

EMI/RFI filtering shall be provided for each mode with the capability to attenuate high frequency noise. Minimum attenuation shall be 20db.

2.11 FINISH

Protect metallic materials against corrosion. Provide equipment with the standard finish by the manufacturer for indoor installations.

PART 3 EXECUTION

3.1 INSTALLATION

Install Control devices and protective devices that are not factory installed in equipment, in accordance with the manufacturer's recommendations and field adjusted and operation tested. Conform to NFPA 70, NEMA ICS 1 and NEMA ICS 2 requirements for installation of control and protective devices.

3.1.1 Surge Protective Devices

Provide coordinated surge protection for low voltage switchboard and downstream switchboards or panelboards as indicated.

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible.

3.2 FIELD TESTING

Demonstrate to operate as indicated control and protective devices not factory installed in equipment.

Ratio and verify tap settings of instrumentation, potential, and current transformers.

Perform all applicable inspections and electrical tests, including optional tests, in accordance with NETA ATS and Section 26 08 00 APPARATUS INSPECTION AND TESTING for all meter, over-current protective device, and relays including but not limited to the following:

a. Circuit Breakers, Air, Low-Voltage Power - Perform primary current injection tests.

b. Circuit Breakers, Air, Insulated Case/Molded Case - Do not perform primary current injection tests. Test trip unit and circuit breaker trip functions in accordance with the manufacturer's recommendations.

c. Protective Relays, Electromechanical and Solid-State (under voltage and synchronization relays)

d. Instrument Transformers

e. Metering Devices

f. Low Voltage Ground Fault Protection Systems

g. Surge Arresters, Low Voltage

Do not energize control and protective devices until recorded test data has been approved. Provide final test reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION 26 08 00

APPARATUS INSPECTION AND TESTING
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance test and inspections procedure; G

Acceptance tests and inspections; G

Integrated power system test procedure; G

Integrated power system test results; G

SD-07 Certificates

Qualifications of organization, and lead engineering technician; G

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

Contractor shall engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. No work required by this section of the specification shall be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization shall have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization shall have a calibration program, and test instruments

used shall be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments shall be performed by an engineering technician, certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.3.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Reports shall include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.3.3 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

1.3.4 Integrated Power System Test Procedure

Submit detailed test procedure for integrated power system test at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

1.3.5 Integrated Power System Test Results

Submit complete report documenting results of integrated power system test; identify deficiencies and recommend corrective action when appropriate. Type and neatly bind report to form a part of the final record.

1.4 RELATED REQUIREMENTS

This integrated power system test requirement of this section applies to certain sections of Divisions 22 and 23, PLUMBING and HEATING VENTILATING AND AIR CONDITIONING. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization shall perform acceptance tests and inspections. Test methods, procedures, and test values shall be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and

paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Equipment shall be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor shall supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer shall be notified at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

a. Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSES.

b. Section 26 05 13.00 98 MEDIUM VOLTAGE CABLE - Perform testing in accordance with requirements of that section.

c. Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Perform NETA ATS Optional tests except primary current injection testing of molded case breakers.

d. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING.

e. Section 26 32 15.00 10 DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES. Functional engine shutdown tests, vibration base-line test, and load bank test shall not be performed by the testing organization. These tests shall be performed by the start-up engineer. Perform NETA ATS Optional Tests.

f. Section 26 33 53.00 20 UNINTERRUPTIBLE POWER SUPPLY (UPS).

g. Section 26 23 00 SWITCHBOARD. Perform NETA ATS Optional Tests.

h. Section 26 23 01 EMERGENCY SWITCHBOARD. Perform NETA ATS Optional Tests.

i. Section 26 12 19.00 40 PAD-MOUNTED, LIQUID-FILLED, MEDIUM VOLTAGE TRANSFORMERS. Perform NETA ATS Optional Tests.

j. Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION

k. Section 26 36 23.00 20 AUTOMATIC TRANSFER SWITCHES. Perform NETA ATS Optional Tests.

3.2 INTEGRATED POWER SYSTEM TEST

Provide a detailed test procedure and execute multi-discipline testing that verifies all building systems will automatically transfer, restart, and function upon power system outages and power restoration without operator intervention. Test shall incorporate the following:

For each test below verify the following:

a. Electrical switchboard, ATS's, UPS's and other equipment operate automatically and maintain power to their connected loads within their design parameters.

b. Electrical power is restored to the facility and all systems automatically reset or re-start and operate normally.

Perform the following tests:

a. Fail the Feeder 204/205 utility source and verify:
   (1) The primary switchgear transfers the entire facility to the other utility source.

b. Restore the Feeder 204/205 utility source with the switchgear in closed transition mode and verify:
   (1) The primary switchgear retransfers by closed transition switching to normal double-ended configuration.

c. Switch the substation mode to MANUAL.
   (1) Manually single end the substation by closed transition switching to the 212 utility source.
   (2) Fail the 204/205 Source.
   (3) Switch the Substation to AUTOMATIC.

d. Restore the Feeder 204/205 utility source with the switchgear in open transition mode and verify:
   (1) The primary switchgear retransfers by open transition switching to normal double-ended configuration.

e. Fail the Feeder 212 utility source and verify:
   (1) The primary switchgear transfers the entire facility to the other utility source.

f. Restore the Feeder 212 utility source with the switchgear in closed transition mode and verify:
   (1) The primary switchgear retransfers by closed transition switching to normal double-ended configuration.

g. Switch the substation mode to MANUAL.
   (1) Manually single end the substation by closed transition switching to the 204/205 utility source.
   (2) Fail the 212 Source.
   (3) Switch the Substation to AUTOMATIC.

h. Restore the Feeder 212 utility source with the switchgear in open transition mode and verify:
   (1) The primary switchgear retransfers by open transition switching to normal double-ended configuration.

i. Using 13.2 kV power switching, energize both facility pad-mounted transformers from Feeder 212. With switchgear in AUTOMATIC GENERATOR OPERATION fail the 212 source and verify:
   (1) The entire facility transfer to and operates on generator operation.

j. Restore the Feeder 212 source and verify:
   (1) Primary switchgear re-transfers by open transition switching to normal configuration.
   (2) ATS units switch to normal source after time delay.

3.3 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.4 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization shall be present when equipment tested by the organization is initially energized and placed in service.

-- End of Section --

SECTION 26 09 23.00 40

LIGHTING CONTROL DEVICES
08/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

GREEN SEAL (GS)

GC-12	(1997) Occupancy Sensors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2011) Enclosures

UNDERWRITERS LABORATORIES (UL)

UL 773	(1995; Reprint Mar 2002) Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2006; Reprint Mar 2011) Standard for Nonindustrial Photoelectric Switches for Lighting Control
UL 924	(2006; Reprint Feb 2011) Standard for Emergency Lighting and Power Equipment

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Installation Drawings for occupancy sensitive motion sensitive control devices in accordance with the manufacturer's recommended instructions for installation.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings

Submit Lighting Control System Drawings; G - Include manufacturer's installation instructions.

SD-03 Product Data

Dimming ballast controls; G

Light Level Sensor; G

Dimmer Switch; G

Combination Lighting Contactor; G

Time Switch; G

Photocell Switch; G

Occupancy Sensors; G

Momentary Wall Switch; G

Room Controller; G

Emergency Controller; G

SD-06 Test Reports; G

Submit test reports for System Operation Tests in the presence of the Contracting Officer.

SD-08 Manufacturer's Instructions; G

Submit for all components and systems provided.

SD-10 Operation and Maintenance Data; G

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein. Include copies of final shop drawings, product data, and manufacturer's instructions showing complete detail of all lighting control equipment and associated hardware. Provide a PDF copy of the entire data package on a compact disc.

1.4 SYSTEM DESCRIPTION

1.4.1 Lighting Control Systems

Provide low voltage lighting control systems as indicated and specified. Provide low-voltage digital lighting controls, Wattstopper Digital Light Management (DLM) or approved equal. Lighting control equipment shall include: occupancy sensors, room controllers, emergency lighting controllers, wall switches, time switches, and lighting contactors.

Non-life safety interior fluorescent lighting shall be controlled by occupancy sensors connected downstream of any manual switching indicated.

Site lighting and exterior facility lighting shall be switched by lighting contactor equipment with combination photocell and time switch control

with manual hand-off-auto operational modes.

Exterior facility lighting at facility exit locations shall be wired to dedicated circuits and control equipment. Fixtures shall be switched by lighting contactor equipment with combination photocell and time switch control with manual hand-off-auto operational modes.

1.4.2 Lighting Control System Drawings

Lighting Control System Drawings for occupancy sensors, switching equipment, and other lighting control components shall include outline, arrangement, and detail drawings. Detail drawings shall include manufacturer's name and catalog number, electrical ratings, short-circuit current rating, control wiring diagrams, power wiring diagrams, and acceptable conductor type for terminals. Additionally for central emergency lighting control systems indicate total system transfer and re-transfer sequence of operation including normal supply voltage at which transfer to the alternate or normal supplies is initiated.

PART 2 PRODUCTS

2.1 DIMMER SWITCH

Approved by ballast manufacturer for control of ballasts provided and rated to control 430 mA rapid start, 800 mA high output or 265 mA lamps; contain relay to automatically remove power to circuit feeding dimming ballast when dimmer is off; incorporate circuitry to prevent lights from momentarily flashing when dimmer is turned on or off; dimming range from 100% down to 20% light output.

2.2 COMBINATION LIGHTING CONTACTOR

Provide NEMA ICS 2, mechanically held, electrically operated contactor. Rate contactor for 600 VAC and ampere rating as indicated, but no less than 30 amperes if not indicated. Provide combination type contactor in NEMA 12 enclosure conforming to NEMA ICS 6 with molded case circuit breaker disconnect switch, 120 VAC secondary control power transformer with primary and secondary fusing, and selector switch in accordance with section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Provide contactor with 120 V coil and silver alloy double-break contacts and coil clearing contacts for mechanically held contactor requiring no arcing contacts.

Provide contactor with hand-off-automatic selector switch, hermetically sealed. Use the automatic position when photoelectric or timer control is desired. Interface the selector switch with the lighting system magnetic contactor, time switch, and photocell to control system activity.

Provide each contactor with a spare, normally open auxiliary contact in addition to any other contacts indicated for applicable control circuit

2.3 TIME SWITCH

Provide astronomic electronic type, arranged to turn "ON" and "OFF" at predetermined time. Provide switch with a minimum of two Form-C dry contaces for each operation ON and OFF rated 120 volts. Provide automatically wound spring mechanism or capacitor, to maintain accurate time for a minimum of 7 hours following power failure. Connect switch contacts to lighting contactor equipment and provide time switch with a

manual on-off bypass switch. Surface mount the housing for the time switch, NEMA 12 enclosure conforming to NEMA ICS 6.

2.4 PHOTOCELL SWITCH

Provide photocell switch conforming to UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 120 volts ac, 60 Hz with single pole double-throw (spdt) contacts for mechanically held contactors rated 1000 watts designed to fail to the ON position. Provide switch which turns on at or below 3 footcandles and off at 4 to 10 footcandles. Provide time delay to prevent accidental switching from transient light sources. Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition. Provide switch:

a. In a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.

2.5 DIMMING BALLAST CONTROLS

The single slide dimming ballast control dimmer with on/off control, compatible with the ballast and control the ballast light output over the full dimming range, which are approved by the ballast manufacturer.

2.6 LIGHT LEVEL SENSOR

Provide UL listed light level sensor capable of detecting changes in ambient lighting levels, with a dimming range of 20 percent to 100 percent, minimum, and designed for use with dimming ballast and voltage system to which they are connected. Provide with sensor capable of controlling 40 electronic dimming ballast, minimum, with a sensor light level adjustable with a set level range from 10 to 100 footcandles, minimum. Provide a sensor with a bypass function to electrically override sensor control.

2.7 OCCUPANCY SENSORS

Provide UL listed occupancy sensor complying with GC-12. Design occupancy sensors and power packs to operate on the lighting circuit voltage indicated and at 20 amperes continuous duty. Provide sensors and power packs with circuitry that only allows load switching at or near zero current crossing of supply voltage, with mounting as indicated. Provide sensor with an LED occupant detection indicator, adjustable sensitivity, and adjustable delayed-off time range of 5 minutes to 15 minutes. Provide white wall mounted sensors, and white ceiling mounted sensors. Provide ceiling mounted sensors with 360 degree coverage adequate to monitor the entire area covered by switched fixtures unless otherwise indicated.

a. Provide crystal controlled ultrasonic sensor which does not cause detection interference between adjacent sensors.

b. Provide infrared sensors with a daylight filter, and a fresnel lens that is applicable to space to be controlled.

c. Ultrasonic/Infrared Combination Sensor

(1) Occupancy detection to turn lights on requires both ultrasonic and infrared sensor detection, such that the lights remain on if either the ultrasonic or infrared sensor detects movement.

Provide infrared sensor with a lens selected for indicated usage and daylight filter to prevent short wavelength infrared interference. Provide crystal controlled ultrasonic sensor frequency.

2.8 MOMENTARY WALL SWITCH

Provide low-voltage (RJ-45) digital momentary push button switches with single or two button configuration. Wall switches shall have two-way infrared transceiver for use with personal and configuration remote controls. Dimming switches shall include LEDs to indicate load levels. Switches shall have two RJ-45 ports to allow connection to any other digital room device.

2.9 ROOM CONTROLLER

Provide plenum-rated, dual-voltage (120/277V) room controller with one-, two-, or three-relay configuration as indicated by switching details. Controller shall have manual override, LED indication for each load, and zero cross circuitry. Dimming room controller shall include real-time current monitoring.

2.10 EMERGENCY CONTROLLER

Provide UL 924 listed device that monitors a switched circuit providing normal lighting to an area. Unit shall provide normal ON/OFF control of emergency lighting along with normal lighting. Upon loss of normal power, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Controller shall be dual-voltage (120/277V) with push-to-test button. Provide remote emergency test switch that is connected to auxiliary contact on controller.

2.11 EQUIPMENT IDENTIFICATION

2.11.1 Manufacturer's Nameplate

Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in an inconspicuous place; the nameplate of the distributing agent is not acceptable.

2.11.2 Labels

Provide labeled control devices, clearly marked for operation of specific lighting functions according to type.

Make markings related to control device type clear and locate to be readily visible to service personnel, but unseen from normal viewing angles when devices are in place.

PART 3 EXECUTION

3.1 INSTALLATION

Mount all lighting control equipment except photocell switches indoors. Install light sensitive occupancy sensors and light controls per manufacturer's installation instructions and installation drawings. Provide two handheld configuration tools at project completion for programming and maintenance purposes.

3.1.1 Time Control Switches

Install switches with not less than four 1/4 inch bolts. The use of sheet metal screws is not allowed. Request switch on and off time setting for each day of the week from the Contracting Officer.

3.1.2 Lighting Contactors

Coordinate terminal lugs with the wire size. Securely fasten equipment to the supporting structure or wall using not less than four 1/4 inch bolts. The use of sheet metal screws is not allowed.

3.1.3 Photocell Switch Aiming

Mount and aim switch according to manufacturer's recommendations. Set adjustable window slide for minimum footcandles photocell turn-on.

3.1.4 Occupancy Sensor

Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage shall provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings and to avoid nuisance activation and deactivation due to sudden temperature or airflow changes and usage. Set sensor "on" duration to 15 minutes.

3.1.5 Momentary Wall Switch

Install devices vertically on latch side of door within 6 inches of frame edge, unless otherwise indicated. Install devices at heights indicated. Multiple devices shall be ganged together with single coverplate.

3.1.6 Room Controller

Install in accessible area above ceiling as close as practical to wall switch location. Low voltage cabling shall be supported by j-hooks or other approved method. Low voltage cabling shall utilize unique color insulation to differentiate from network and security cabling.

3.1.7 Emergency Controller

Install in accessible area above ceiling as close as practical to room controller and emergency wall switch location. Low voltage cabling shall be supported by j-hooks or other approved method.

3.2 FIELD TESTING

Demonstrate that photoconductive control devices operate satisfactorily in the presence of the Contracting Officer.

Perform System Operation Tests in accordance with referenced standards in this section.

-- End of Section --

SECTION 26 12 19.00 40

PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM D 1535	(2008e1) Specifying Color by the Munsell System
ASTM D 877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D 92	(2005a; R 2010) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D 97	(2011) Pour Point of Petroleum Products

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2006; INT 1 2011) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE C2	(2012) National Electrical Safety Code
IEEE C37.47	(2000) Standard for High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches
IEEE C57.12.00	(2010) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.28	(2005; INT 3 2011) Standard for

	Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.34	(2009) Standard for Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 5 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2010) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.98	(1993; Errata 1998; R 1999) Guide for Transformer Impulse Tests
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-90/027F	(1993) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms
EPA 712-C-98-075	(1996) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-Mounted Transformer Drawings; G

SD-03 Product Data

Pad-Mounted Transformers; G

Submittal shall include manufacturer's information for each component, device, and accessory provided with the transformer.

SD-06 Test Reports

Acceptance Checks And Tests; G

SD-07 Certificates

Transformer Efficiencies; G

Submit certification from the manufacturer indicating conformance with the paragraph entitled "Specified Transformer Efficiencies."

SD-09 Manufacturer's Field Reports

Pad-mounted transformer Design Tests; G

Pad-mounted transformer Routine And Other Tests; G

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5; G

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

Transformer Test Schedule; G

Submit report of test results as specified by paragraph entitled "Field Quality Control."

1.5 QUALITY ASSURANCE

1.5.1 Pad-Mounted Transformer Drawings

Drawings shall indicate, but not be limited to the following:

a. An outline drawing, with front, top, and side views.

b. ANSI nameplate data.

c. Elementary diagrams and wiring diagrams with terminals identified of watthour meter and current transformers.

d. One-line diagram, including switch(es), current transformers, meters, and fuses.

e. Manufacturer's published time-current curves (on full size logarithmic paper) of the transformer high side fuses.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Material and Equipment Manufacturing Date

Do not use products manufactured more than 6 months prior to date of delivery to site, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the actual transformer(s) provided:

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, front, top, and side views

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Fuse curves for primary fuses

f. Information on watthour demand meter, CTs, and fuse block

g. Actual nameplate diagram

h. Date of purchase

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be pad-mounted transformers and related accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING.

2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS

IEEE C57.12.34, IEEE C57.12.28 and as specified herein.

2.2.1 Compartments

Separate the high- and low-voltage compartments with steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.1.1 High Voltage, Dead-Front

High-voltage compartment shall contain the incoming line, insulated high-voltage load-break connectors, bushing well inserts, six high-voltage bushing wells configured for loop feed application, load-break switch handle(s), access to oil-immersed fuses, dead-front surge arresters, tap changer handle, connector parking stands with insulated standoff bushings, protective caps, drain valve with sampler device, and ground pad.

a. Bushing well inserts: IEEE 386, 200 amperes, 15 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise. Provide feed-thru inserts as indicated.

b. Load-break switch: Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch shall be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handles in the high-voltage compartment. Operation of switches shall be as follows:

ARRANGEMENT NO.	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION LINE A SW. OPEN	LINE A SW. CLOSE	LINE B SW OPEN	LINE B SW CLOSE	XFMR. SW OPEN	XFMR. SW CLOSE
1	Line A connected to Line B and both lines connected to transformer		X		X		X
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line B only	X			X		X
4	Transformer open and loop closed		X		X	X	
5	Transformer open and loop open	X		X		X	

c. Provide bayonet type, oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. Bayonet fuse links shall sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing which closes when the fuse holder is removed and an external drip shield. Conspicuously display warning within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the open position and the tank pressure has been released.

1. Bayonet fuse assembly: 150 kV BIL.

2. Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.

d. Parking stands: Provide a parking stand near each bushing well. Provide insulated standoff bushings for parking of energized load-break connectors on parking stands.

e. Protective caps: IEEE 386, 200 amperes, 15 kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushing well inserts and insulated standoff bushings.

f. Drain valve with sampler device.

2.2.1.2 Low Voltage

Low-voltage compartment shall contain low-voltage bushings with NEMA spade terminals, bushing supports, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, ground pad, and accessories. Provide insulated low-voltage bushing supports connected to the ends of the spade terminals to minimize the torsional stress on the bushings due to cable weight/tension. Spade type cable terminals with NEMA 2-hole spacing and arrangement suitable for cable quantities indicated on the drawing based on a 2-hole lug per cable. Provide insulting boots to completely cover un-insulated transformer cable terminals, and cable lugs connections. Accessories shall include the following:

a. Fill plug.

b. Pressure relief device.

c. Liquid level gage.

d. Pressure-vacuum gage.

e. Dial type thermometer with maximum temperature indicator.

2.2.2 Compartment Construction

Separate the high- and low-voltage compartments with steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.3 Transformer

a. Less-flammable liquid-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

b. Transformer shall be rated as indicated on drawings, 95 kV BIL.

c. Transformer voltage ratings: 13.2kV - 480Y/277V.

d. Tap changer shall be externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Tap changers shall clearly indicate which tap setting is in use.

e. Minimum tested impedance for units provided shall not be less than 5.75 percent.

f. Audible sound levels shall not exceed 60 dB.

g. Transformer shall include lifting lugs and provisions for jacking under base. The transformer base construction shall be suitable for using rollers or skidding in any direction. Provide transformer top with an access handhole. Transformer shall have its kVA rating conspicuously displayed on its enclosure. The transformer shall have an insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

2.2.3.1 Specified Transformer Efficiencies

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. No-load losses (NLL) shall be referenced at 20 degrees C. Load losses (LL) shall be referenced at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less 99.08 percent or maximum calculated efficiency based on minimum impedence specified. The specified transformer efficiency value is based on requirements contained within 10 CFR 431, Subpart K.

2.2.4 Insulating Liquid

Less-flammable transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D 92 and a dielectric strength not less than 33 kV tested per ASTM D 877. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

a. The fluid shall be a biodegradable electrical insulating and cooling liquid classified by UL and approved by FM as "less flammable" fluids. The fluid shall meet the following fluid properties:

   1. Pour point: ASTM D 97, less than -15 degree C

   2. Aquatic biodegradation: EPA 712-C-98-075, 100%

   3. Trout toxicity: OECD Test 203, zero mortality of EPA 600/4-90/027F, pass

2.2.4.1 Liquid-Filled Transformer Nameplates

Provide distribution transformers with nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.2.5 Corrosion Protection

Bases and cabinets of transformers shall be corrosion resistant and shall be fabricated of stainless steel conforming to ASTM A167, Type 304 or 304L. Base shall include any part of pad-mounted transformer that is within 3 inches of concrete pad. Paint bases, cabinets, and tanks Munsell 7GY3.29/1.5 green. Paint coating system shall comply with IEEE C57.12.28. The Munsell color notation is specified in ASTM D 1535.

2.3 WARNING SIGNS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

2.4 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING.

2.5 CAST-IN-PLACE CONCRETE

Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day compressive strength unless specified otherwise. All concrete shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

Concrete shall be composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture. Fine aggregate shall be of hard, dense, durable, clean, and uncoated sand. The coarse aggregate shall be reasonably well graded from 3/16 inch to 1 inch. The fine and coarse aggregates shall be free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances. Water shall be fresh, clean, and free from salts, alkali, organic matter, and other impurities. Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day compressive strength unless specified otherwise. Slump shall not exceed 4 inches. Retempering of concrete will not be permitted. Exposed, unformed concrete surfaces shall be given a smooth, wood float finish. Concrete shall be cured for a period of not less than 7 days, and concrete made with high early strength portland cement shall be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer. Air entrain concrete exposed to weather using an air-entraining admixture conforming to ASTM C260/C260M. Air content shall be between 4 and 6 percent.

2.6 SOURCE QUALITY CONTROL

2.6.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

1. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

4. Dated calibration labels shall be visible on all test equipment.

5. Calibrating standard shall be of higher accuracy than that of the instrument tested.

6. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

   (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

   (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.6.2 Design Tests

IEEE C57.12.00, and IEEE C57.12.90. Section 5.1.2 in IEEE C57.12.80 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for each of the specified transformer(s). Perform design tests prior to the award of this contract.

a. Tests shall be certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests shall include the primary windings only of that transformer.

   1. IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

   2. State test voltage levels.

   3. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.34.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

2.6.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests shall be performed by the manufacturer on each of the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence shall be as follows:

a. Cold resistance measurements (provide reference temperature)

b. Phase relation

c. Ratio

d. No-load losses (NLL) and excitation current

e. Load losses (LL) and impedance voltage

f. Dielectric

1. Impulse

2. Applied voltage

3. Induced voltage

g. Leak

h. Dissolved gas analysis (DGA)

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Pad-Mounted Transformer Grounding

Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Meters and Current Transformers

ANSI C12.1.

3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.5 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

3.6 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount transformer on concrete slab as detailed on the drawings.

3.6.1 Cast-In-Place Concrete

Cast-in-place concrete work shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.6.2 Sealing

When the installation is complete, the Contractor shall seal all conduit

and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.7 FIELD QUALITY CONTROL

3.7.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, in accordance with NETA ATS, Section 26 08 00 APPARATUS INSPECTION AND TESTING, and additional requirements as indicated below. Perform and record results for all NETA ATS visual and mechanical inspections, standard tests, and optional tests unless otherwise indicated. The results of the acceptance checks and tests shall be neatly cataloged and bound, and shall be submitted to the Contracting Officer or their designee prior to Final Acceptance.

3.7.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

1. Verify that the tap-changer is set at specified ratio.

2. Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

3. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter and by verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

4. Verify correct equipment grounding. Ensure 15 kV cable shields are bonded to the tank ground pad.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

2. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3.7.1.2 Grounding System

a. Visual and mechanical inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

1. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to

test each ground or group of grounds. Equip the instrument with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2. Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.7.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times of checking and testing.

-- End of Section --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM AND GROUNDING
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
ASTM B3	(2001; R 2007) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2012) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2005) American National Standard for Electrical Metallic Tubing (EMT)
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FU 1	(2002; R 2007) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload

	Relays Rated 600 V
NEMA ICS 4	(2010) Terminal Blocks
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA KS 1	(2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA RN 1	(2005) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(1992; R 1997) Standard for Dry-Type Transformers for General Applications
NEMA TC 2	(2003) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2004) Standard for Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TP 1	(2002) Guide for Determining Energy Efficiency for Distribution Transformers
NEMA WD 1	(1999; R 2005; R 2010) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2012) Wiring Devices Dimensions Specifications
NEMA Z535.4	(2011) American National Standard for Product Safety Signs and Labels

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/TIA-607-B	(2011) Generic Telecommunications Bonding and Grounding (Earthing)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code
NFPA 70E	(2012) Standard for Electrical Safety in the Workplace
NFPA 780	(2011) Standard for the Installation of Lightning Protection Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.147	Control of Hazardous Energy (Lock Out/Tag Out)

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Jul 2007) Standard for Flexible Metal Conduit
UL 1063	(2006; Reprint Mar 2012) Machine-Tool Wires and Cables
UL 1561	(2011) Dry-Type General Purpose and Power Transformers
UL 1660	(2004; Reprint Apr 2008) Liquid-Tight Flexible Nonmetallic Conduit
UL 198M	(2003; Reprint Oct 2007) Standard for Mine-Duty Fuses
UL 20	(2010) General-Use Snap Switches
UL 360	(2009; Reprint Jun 2009) Liquid-Tight Flexible Steel Conduit
UL 4248	(2007) UL Standard for Safety Fuseholders
UL 44	(2010) Thermoset-Insulated Wires and Cables
UL 467	(2007) Grounding and Bonding Equipment
UL 486A-486B	(2003; Reprint Feb 2010) Wire Connectors
UL 486C	(2004; Reprint Feb 2010) Splicing Wire Connectors
UL 489	(2009; Reprint Jun 2011) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 498	(2012) Attachment Plugs and Receptacles
UL 5	(2011) Surface Metal Raceways and Fittings
UL 50	(2007; Reprint Apr 2012) Enclosures for Electrical Equipment, Non-environmental Considerations
UL 506	(2008; Reprint Mar 2010) Specialty Transformers
UL 508	(1999; Reprint Apr 2010) Industrial Control Equipment
UL 510	(2005; Reprint Apr 2008) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2004; Reprint Apr 2010) Metallic Outlet Boxes
UL 514B	(2004; Reprint Nov 2009) Conduit, Tubing

	and Cable Fittings
UL 514C	(1996; Reprint Novy 2011) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL 651	(2011; Reprint Mar 2012) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
UL 67	(2009; Reprint Sep 2010) Standard for Panelboards
UL 797	(2007) Electrical Metallic Tubing -- Steel
UL 817	(2001; Reprint Nov 2011) Standard for Cord Sets and Power-Supply Cords
UL 83	(2008) Thermoplastic-Insulated Wires and Cables
UL 854	(2004; Reprint Sep 2011) Standard for Service-Entrance Cables
UL 869A	(2006) Reference Standard for Service Equipment
UL 870	(2008) Standard for Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2006; Reprint May 2010) Ground-Fault Circuit-Interrupters
UL 1008 Supplement SB	(2011) Requirements for Inlet Assemblies for Transfer Switch Equipment
UL 1691	(2012) Single Pole Locking-Type Separable Connectors

1.2 DEFINITIONS AND RELATED REQUIREMENTS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

Lightning protection system material, installation, and testing requirements of Section 26 41 00.00 40 LIGHTNING PROTECTION SYSTEM applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panelboards; G

Transformers; G

Wireways; G

Motor controllers; G

Grounding System Installation Drawings; G

SD-03 Product Data

Conduit and fittings; G

Surface raceway; G

Outlet boxes and covers; G

Cabinets, junction boxes, and pull boxes; G

Portable generator/loadbank connection tap boxes; G

Wires and cables; G

Splices and termination components; G

Marking strips; G

Device plates; G

Fuses; G

Ground rods; G

Grounding and bonding conductors; G

Grounding and bonding connectors and fasteners; G

Receptacles; G

Switches; G

Transformers; G

Enclosed circuit breakers; G

Motor controllers; G

Manual motor starters; G

Electrical ground bars; G

Telecommunications Grounding Busbars; G

SD-06 Test Reports

Low voltage conductor tests; G

Circuit breaker tests; G

Panelboard tests; G

Grounding system tests; G

Transformer factory tests; G

Ground-fault receptacle tests; G

Motor controller tests; G

SD-09 Manufacturer's Field Reports

Transformer factory tests; G

SD-10 Operation and Maintenance Data1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer.

1.4.2.1 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.4.3 Grounding System Installation Drawings

a. Coordinate or incorporate with lightning protection system shop drawing, material, installation, and testing requirements of Section 26 41 00.00 40 LIGHTNING PROTECTION SYSTEM.

b. Submit installation shop drawing for the overall grounding system. Drawings shall include physical layout of the equipment, dimensions, mounting details, relationship to other parts of the work, and wiring diagram. Include all equipment and surge suppressor connection points.

c. Submit detail drawings for each major component to include manufacturer's descriptive and technical literature, catalog cuts, and installation instructions.

d. All Shop Drawings shall be computer aided design (CAD) generated. With each submittal, provide a CD with a complete copy of the drawings in PDF format.

e. Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made. Provide digital media compact disc (CD) with all submittals including .DWG or .DXF CAD source files as well as PDF format files for all drawings.

1.5 MANDATORY INSPECTION POINTS

Prior to concealing any ground connection above or below ground the following shall occur.

a. Provide 48 hour minimum notice for NASA inspections.

b. Submit to the NASA COTR all test results for grounding and bonding connections to be concealed.

c. Update as-built condition on the working copies of the installation drawing submittal.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials, equipment, and devices shall, as a minimum, meet requirements of UL, and shall be UL labeled where UL standards are established for those items, and requirements of NFPA 70.

2.2 CONDUIT AND FITTINGS

Shall conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6, hot-dipped galvanized finish only.

2.2.2 Polyvinyl Chloride (PVC) Conduit

NEMA TC 2 and UL 651. Provide Schedule 40 for concrete encasement and Schedule 80 for exposed and direct buried installations.

2.2.3 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

Provide galvanized steel type and use in dry interior locations only.

2.2.4 Plastic-Coated Rigid Steel

NEMA RN 1, Type 40(40 mils thick).

Provide coated conduit and fittings where installed underground and in corrosive areas. Provide coated conduit and fittings where indicated in exterior areas.

2.2.5 Flexible Metal Conduit

UL 1.

Provide galvanized steel type and use in dry interior locations only.

2.2.5.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

Provide protective jacket of PVC extruded over a flexible interlocked galvanized steel core conduit to protect wiring against moisture, oil, chemicals, and corrosive fumes.

2.2.6 Fittings for Metal Conduit, and Flexible Metal Conduit

UL 514B. Ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.

2.2.6.1 Fittings for Rigid Metal Conduit

Threaded-type. Split couplings unacceptable.

Provide fittings, (pulling-type) conduit bodies, bushings, locknuts and supports constructed of hot dipped galvanized malleable iron or steel.

Gaskets shall be the solid type. Conduit fittings with blank covers shall have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required. Covers shall have captive screws and be accessible after the work has been completed.

Bushings shall be insulated type. Provide grounding type bushings at both ends on conduit containing service entrance conductors with lug suitable for a copper grounding conductor up to (4/0). Provide capped bushings for spare underground conduits.

Provide gasketed liquid-tight hubs with hot-dipped galvanized finish when connecting rigid steel conduit to steel enclosures in wet or damp locations.

2.2.6.2 Fittings for EMT

Zink-coated steel compression type. Provide connectors with insulated throat.

2.2.7 Fittings for PVC Conduit

NEMA TC 3 and UL 514B.

Provide solvent welded type; cement shall be less than 1 year old.

2.2.8 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

Fittings for flexible nonmetallic conduit shall be hot dipped galvanized malleable iron. Provide external grounding lug for conduit sizes greater than (1-1/4 inch).

2.3 SURFACE RACEWAY

2.3.1 Surface Metal Raceway

UL 5, two-piece painted steel, totally enclosed, snap-cover type. Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Receptacles shall be as specified herein and shall be spaced minimum of one every 18 inches. Alternate receptacles shall be wired on different circuits.

2.4 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic. Box type shall be suitable for mounting service installed. Provide required rings, covers, and device plates for all boxes.

2.4.1 Floor Outlet Boxes

Boxes shall be adjustable and concrete tight. Each outlet shall consist of cast-metal body with threaded openings, for conduits, adjustable , brass flange ring, and cover plate with 1 inch threaded plug. Telecommunications outlets shall consist of flush, aluminum or stainless steel housing with a receptacle as specified and 1 inch bushed side opening. Receptacle outlets shall consist of flush aluminum or stainless steel housing with duplex-type receptacle as specified herein. Provide gaskets where necessary to ensure watertight installation. Provide plugs with installation instructions to the Contracting Officer for 5 percent of outlet boxes for the capping of outlets upon removal of service fittings.

2.4.2 Outlet Boxes for Telecommunications System

Provide standard type 4 inches square by 2 1/8 inches deep. Outlet boxes for wall-mounted telecommunications outlets shall be 4 by 2 1/8 by 2 1/8 inches deep. Depth of boxes shall be large enough to allow manufacturers' recommended conductor bend radii. Outlet boxes for fiber optic telecommunication outlets shall include a minimum 3/8 inch deep single or two gang plaster ring as shown and installed using a minimum 1 inch conduit system. Outlet boxes for handicapped telecommunications station shall be 4 by 2 1/8 by 2 1/8 inches deep.

2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 100 cubic inches, UL 50 and NEMA 250.

Pull and junction boxes in dry locations shall be hot-dipped galvanized steel without knockouts and with screw fastened covers.

Cabinets or boxes installed in interior dry locations shall be rated NEMA 1 except for boxes in mechanical equipment rooms which shall be rated NEMA 12.

Cabinets or boxes installed in outdoor, wet or damp locations shall be rated NEMA 4X and fabricated from Type 316 stainless steel.

Boxes with terminal strips or components installed shall include hinged covers, latch, pad-lock provisions, and interior mounting panel.

2.6 PORTABLE GENERATOR/LOADBANK CONNECTION TAP BOXES

UL 1008 Supplement SB. Outdoor, surface wall-mounted cabinet designed to allow quick and convenient connection of a portable generator or load bank to the facility's permanently-wired electrical system.

a. Ratings and Configuration:

(1) Voltage: 480 volts, 3 phase, 3 wire plus ground.

(2) Ampacity: As indicated on drawings.

(3) Short circuit withstand (mechanical bracing): 65,000 amps rms symmetrical.

(4) Mechanical compression lugs for permanent wiring connections, long barrel, NEMA two-hole type.

(5) Color-coded cam-lock connectors for portable wiring connections.

b. Construction:

(1) Enclosure: NEMA 3R stainless steel.

(2) Dimensions: 38"W x 38"H x 18"D (nominal).

(3) Include welded ears or similar provisions for wall mounting.

(4) Front door: hinged, gasketed with three-point pad-lockable latch.

(5) Bottom cable entry door: hinged, gasketed for access to cam-lock connectors.

(6) Interlock bottom door to prevent opening when front door is open.

(7) "In-use" design to maintain NEMA 3R integrity when bottom door is open and portable cables are connected.

(8) Paint after fabrication: powder coated, ANSI Gray color.

(9) Bus: silver-plated copper supported on insulators.

(10) Include safety barrier to cover permanent wiring lugs.

(11) Clearly mark and label all connections for phases and ground.

c. Provisions for Portable Wiring Connections:

Provide a field of 400 amp male cam-lock receptacles per phase and ground arranged for the connection of a portable generator or load bank using Type W portable power cables with 400 amp cam-lock connectors. The total quantity of cam-lock receptacles per phase and ground shall be as required to match the ampacity of the tap box.

(1) Single pole male cam-lock receptacles: UL 498 and UL 1691.

(2) Suitable for use in outddor environments.

(3) Cam-lock receptacles rated for 600 volts and up to 400 amps continous.

(4) Color-coding: Phase A - Brown, Phase B - Orange, Phase C - Yellow, Neutral - White, Ground - Green.

2.7 WIRES AND CABLES

Wires and cables shall be copper and shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

2.7.1 Conductors

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and capacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.7.1.1 Minimum Conductor Sizes

Minimum size for branch circuits shall be No. 12 AWG; for Class 1 remote-control and signal circuits, No. 14 AWG; for Class 2 low-energy, remote-control and signal circuits, No. 16 AWG; and for Class 3 low-energy, remote-control, alarm and signal circuits, No. 22 AWG.

2.7.2 Color Coding

Provide for service, feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors. "Phase, neutral and ground conductors up to and including 4/0 AWG color coding shall be factory applied, color impregnated insulation. For conductors larger than 4/0 AWG color coding shall be by plastic tape." Color coding of ungrounded conductors and neutrals in different voltage systems shall be as follows:

a. 208Y/120 volts, three-phase, four wire

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

(4) Neutral - white

b. 480Y/277 volts, three-phase, four wire

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

(4) Neutral - gray

c. 480 volts, three phase, three wire

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

2.7.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, non-service entrance power and lighting wires installed above grade shall be 600-volt, Type THWN/THHN conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.7.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

Equipment grounding conductors installed in PVC conduit shall be bare copper wire.

2.7.5 Service Entrance and Underground Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

For service entrance cables and cables installed underground outside between pad-mounted, liquid-filled medium-voltage transformers and low voltage switchgear, use Type RHW-2/USE-2 with EPR insulation.

2.7.6 Cable Tray Cable

UL listed; type TC.

2.7.7 Cord Sets and Power-Supply Cords

UL 817

2.8 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

Make all splices in AWG No. 8 and larger with copper indentor crimp-type connectors and compression tools. Joints shall be factory insulated or wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

Make terminations to NEMA type cable pads using copper 2-hole standard or

long barrel (as required) indentor crimp-type lugs.

Manufacturer's required tooling and dies shall be used on indentor crimp-type lugs.

Vinyl electrical tape shall be 8.5-mil thickness suitable for high and low temperature use.

Rubber splicing tape shall be 30-mil Ethylene Propylene Rubber (EPR) rated (90 degrees C) 194 degrees F.

Insulate and waterproof splices in conductors installed underground by one of the following methods which are suitable for continuous submersion in water:

a. Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which shall be applied in accordance with the manufacturer's written instructions.

b. Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation shall not require heat or flame, or any additional materials such as covering or adhesive. It shall be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.9 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. For metal outlet boxes, plates on unfinished walls shall be of zinc-coated sheet steel or cast metal having round or beveled edges. For nonmetallic boxes and fittings, other suitable plates may be provided. Plates on finished walls shall be satin finish stainless steel, minimum 0.03 inch thick. Screws shall be machine-type with countersunk heads in color to match finish of plate. Sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for "wet locations with plug-in use".

2.10 SWITCHES

2.10.1 Toggle Switches

NEMA WD 1, UL 20, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Handles shall be gray or as approved by the Architects. Wiring terminals shall be screw-type, side-wired. Contacts shall be silver-cadmium and contact arm shall be one-piece copper alloy. Switches shall be rated quiet-type ac only, 120/277 volts, with current rating, switching arrangement, and number of poles indicated.

2.10.2 Switch with Red Pilot Handle

NEMA WD 1. Provide pilot lights that are integrally constructed as a part of the switch's handle. The pilot light shall be red and shall illuminate whenever the switch is closed or "on". The pilot lighted switch shall be rated 20 amps and 120 volts or 277 volts as indicated. Provide the circuit's neutral conductor to each switch with a pilot light.

2.10.3 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Fused switches shall utilize Class R fuseholders and fuses, unless indicated otherwise. Switches serving as motor-disconnect means shall be horsepower rated.

Provide equipment ground bus bar for equipment grounding conductors and isolated neutral assembly for neutral conductors.

Provide switches in enclosures per NEMA ICS 6 as follows:

a. Dry Locations except Mechanical Equipment Rooms - NEMA 1.

b. Mechanical Equipment Rooms - NEMA 12.

c. Damp, Outdoor, or Wet Locations - NEMA 4X Type 316 stainless steel.

2.11 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Time-current characteristics curves of fuses serving motors or connected in series with circuit breakers or other circuit protective devices shall be coordinated for proper operation. Submit coordination data for approval. Fuses shall have voltage rating not less than circuit voltage.

2.11.1 Fuseholders

Provide in accordance with UL 4248.

2.11.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 198M, Class RK-1 or RK-5 time-delay type as appropriate. Associated fuseholders shall be Class R only.

2.11.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Class CC)

UL 198M,Class CC for zero to 30 amperes.

2.12 RECEPTACLES

UL 498, hard use, heavy-duty,specification grade, grounding-type. Ratings and configurations shall be as indicated. Bodies shall be of gray or as indicated or approved by the Contracting Officer. Face and body shall be thermoplastic supported on a metal mounting strap. Dimensional requirements shall be per NEMA WD 6. Provide screw-type, side-wired wiring terminals or the solderless pressure type having suitable conductor-release arrangement. Connect grounding pole to mounting strap. The receptacle shall contain triple-wipe power contacts and double or triple-wipe ground contacts.

2.12.1 Switched Duplex Receptacles

Provide separate terminals for each ungrounded pole. Top receptacle shall be switched when installed.

2.12.2 Weatherproof Receptacles

Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations with plug-in use."

2.12.3 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices. Provide screw-type, side-wired wiring terminals.

2.12.4 Special Purpose Receptacles

Provide in ratings and configurations as indicated. Furnish one matching plug with each receptacle.

2.13 PANELBOARDS

UL 67 and UL 50 having a short-circuit current rating as indicated. Panelboards for use as service disconnecting means shall additionally conform to UL 869A. Panelboards shall be bolt-on circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise. Main breaker shall be top or bottom mounted as indicated with provisions for connecting the sizes and quantities on incoming cables indicated. Where "space only" is indicated, make provisions for future installation of breakers. Directories shall indicate load served by each circuit in panelboard. Directories shall also indicate ratings and source of service to panelboard (e.g., Panel PA, 208Y/120 VAC - 100 Amps, served from Panel MDP, Circuit 9). Type directories and mount in holder behind transparent protective covering. Panelboards shall be listed and labeled for their intended use. Panelboard shall have nameplates in accordance with paragraph "Field Fabricated Nameplates."

2.13.1 Enclosure

Enclosures shall meet the requirements of UL 50. All cabinets shall be fabricated from sheet steel of not less than No. 10 gauge if flush-mounted or mounted outdoors, and not less than No. 12 gauge if surface-mounted indoors, with full seam-welded box ends. Indoor surface mounted or flush-mounted cabinets shall be hot-dipped galvanized after fabrication; cabinets shall be painted in accordance with paragraph "Painting." Cabinets mounted outdoors shall be NEMA 4X Type 316 stainless steel. Front edges of cabinets shall be form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front. All cabinets shall be so fabricated that no part of any surface on the finished cabinet shall deviate from a true plane by more than 1/8 inch. Holes shall be provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface. Provide enclosure dead-fronts with latchable hinged doors,

door-in-door construction. Flush doors shall be mounted on hinges that expose only the hinge roll to view when the door is closed. Each door shall be fitted with a combined catch and lock, except that doors over 24 inches long shall be provided with a three-point latch having a knob with a T-handle, and a cylinder lock. Two keys shall be provided with each lock, and all locks shall be keyed alike. Finished-head cap screws shall be provided for mounting the panelboard fronts on the cabinets.

2.13.2 Panelboard Buses

All panelboard buses shall be copper. Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide top or bottom main-lug-only or main breaker as indicated with provisions for connecting the sizes and quantities of incoming cables indicated. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.13.3 Circuit Breakers

Provide molded-case circuit breakers in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.13.4 Surge Protective Devices (for Panelboards)

Provide integral factory installed surge suppression equipment in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.13.5 ENCLOSED CIRCUIT BREAKERS

Provide enclosed molded-case circuit breakers in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.14 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors, also called motor circuit protectors (MCPs); shall conform to UL 508 and UL 489 and shall be provided as shown. MSCPs shall consist of an adjustable instantaneous trip circuit breaker used only in conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. MSCPs shall be rated in accordance with the requirements of NFPA 70.

2.15 TRANSFORMERS

NEMA ST 20, general purpose, dry-type, self-cooled, ventilated. Provide indoor transformers in NEMA 1 enclosure. Provide outdoor transformers in NEMA 3R stainless steel enclosure; provided with weather-shield unless unit is totally enclosed. Transformer shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for

transformer ratings indicated.

2.15.1 Specified Transformer Efficiency

Transformers shall be energy efficient type. Minimum efficiency, based on factory test results, shall not be less than NEMA Class 1 efficiency as defined by NEMA TP 1.

2.15.2 Transformers with Non-Linear Loads

Transformer insulation shall be a UL recognized 220 degrees C system. Neither the primary nor the secondary temperature shall exceed 220 degrees C at any point in the coils while carrying their full rating of non-sinusoidal load. Transformers are to be UL listed and labeled for K-4 in accordance with UL 1561. Transformers evaluated by the UL K-Factor evaluation shall be listed for 115 degrees C average temperature rise only. Transformers with K-Factor ratings with temperature rise of 150 degrees C rise shall not be acceptable. K-Factor rated transformers shall have a minimum reactance of 2 percent to prevent excessive neutral current when supplying loads with large amounts of third harmonic.

2.15.3 Transformer Impedance

Transformer impedance shall not result in fault current exceeding the interrupting rating of devices connected to the secondary windings assuming an unlimited primary fault current source. This requirement shall supersede energy efficiency requirements above when in conflict.

2.16 MOTOR CONTROLLERS

UL 508, NEMA ICS 1, and NEMA ICS 2, except fire pump controllers shall be as specified in Section 21 13 00.00 98 FIRE SUPPRESSION SPRINKLER SYSTEMS. Controllers shall have thermal overload protection in each phase and shall have one spare normally open and one spare normally closed auxiliary contact. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, under-voltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay. Magnetic-type motor controllers shall have under-voltage protection when used with momentary-contact pushbutton stations or switches and shall have under-voltage release when used with maintained-contact pushbutton stations or switches. When used with pressure, float, or similar automatic-type or maintained-contact switch, controller shall have hand/off/automatic selector switch. Connections to selector switch shall be such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices, shall be connected in motor control circuit in "hand" and "automatic" positions. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device shall be made in accordance with indicated or manufacturer's approved wiring diagram. Selector switch shall have means for locking in any position. For each motor not in sight of controller or where controller disconnecting means is not in sight of motor location and driven machinery location, controller disconnecting means shall be capable of being locked in open position. As an alternative, provide a manually operated, lockable, non-fused switch which disconnects motor from supply source within sight of motor. Overload protective devices shall provide adequate protection to motor windings; be thermal inverse-time-limit type; and

include manual reset-type pushbutton on outside of motor controller case. Cover of combination motor controller and manual switch or circuit breaker shall be interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position. Minimum short circuit withstand rating of combination motor controller shall be rms symmetrical amperes equal to or more than the short circuit rating of panel providing power to the motor.

2.16.1 Control Wiring

All control wire shall be stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and shall pass the VW-1 flame tests included in those standards. Hinge wire shall have Class K stranding. Current transformer secondary leads shall be not smaller than No. 10 AWG. The minimum size of control wire shall be No. 14 AWG. Power wiring for 480-volt circuits and below shall be of the same type as control wiring and the minimum size shall be No. 12 AWG. Special attention shall be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.16.2 Control Circuit Terminal Blocks

NEMA ICS 4. Control circuit terminal blocks for control wiring shall be molded or fabricated type with barriers, rated not less than 600 volts. The terminals shall be removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 10 in size and shall have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement shall be subject to the approval of the Contracting Officer and not less than four (4) spare terminals or 10 percent, whichever is greater, shall be provided on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. The Contractor shall submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.16.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks shall meet the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity shall be provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. The terminals shall be of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, screws shall have hexagonal heads. Conducting parts between connected terminals shall have adequate contact surface and cross-section to operate without overheating.

Each connected terminal shall have the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.16.3 Control Circuits

Control circuits shall have maximum voltage of 120 volts derived from control transformer in same enclosure. Transformers shall conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits, shall have primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side. Provide fuses in each ungrounded primary feeder. One secondary lead shall be fused; other shall be grounded.

2.16.4 Enclosures for Motor Controllers

Provide switches in enclosures per NEMA ICS 6 as follows:

a. Dry Locations except Mechanical Equipment Rooms - NEMA 1.

b. Mechanical Equipment Rooms - NEMA 12.

c. Damp, Outdoor, or Wet Locations - NEMA 4X Type 316 stainless steel.

2.16.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers shall have compelling relays and shall be multiple-button, station-type with pilot lights for each speed.

2.16.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations shall be heavy duty, oil-tight design.

2.16.7 Pilot and Indicating Lights

Provide LED cluster lamps.

2.17 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

Single, Double or Three pole designed for flush or surface mounting with overload protection and pilot lights as shown.

2.17.1 Pilot Lights

Provide yoke-mounted, seven element LED cluster light module. Color shall be green red amber in accordance with NEMA ICS 2.

2.18 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment shall be in accordance with requirements of Division 23, " Heating, Ventilating, and Air Conditioning."

2.19 GROUNDING AND BONDING EQUIPMENT

2.19.1 Ground Rods

UL 467. Ground rods shall be solid copper, with minimum diameter of 3/4 inch and minimum length of 20 feet.

2.19.2 Ground Bars

Copper ground bars shall be provided in equipment rooms as indicated.

2.19.3 Electrical Ground Bars

Provide 1/4 inch by 4 inches copper bar, electro-tin plated, length as indicated, pre-drilled as indicated with 9/16 inch diameter holes to accept lugs with industry standard NEMA two-hole spacing (1-3/4 inches). Equip ground bar with four (4) 4/0 AWG bare copper pigtails; each 36 inches in length and attached at a corner of the ground bar by exothermic weld as indicated. Bolt ground bar to wall using 2 inches insulator-type standoff brackets.

2.19.4 Telecommunications Grounding Busbars

Provide corrosion-resistant grounding busbar suitable for indoor installation in accordance with ANSI/TIA-607-B. Busbars shall be plated for reduced contact resistance. Provide a telecommunications main grounding busbar (TMGB) in the telecommunications entrance facility and a (TGB) in all other telecommunications rooms and equipment rooms. The telecommunications main grounding busbar (TMGB) and the telecommunications grounding busbar (TGB) shall be sized as indicated, and if not indicated, in accordance with the immediate application requirements and with consideration of future growth. Provide telecommunications grounding busbars as follows:

a. TMGB: 1/4 inch by 4 inches copper bar, electro-tin plated, length as indicated. Bolt ground bar to wall using 2 inches insulator-type standoff brackets. Pre-drilled holes as indicated to meet TIA J-STD-607: 5/16 inch diameter. holes at 5/8 inch spacing and 7/16 inch diameter holes at 1 inch spacing.

b. TGB: 1/4 inch by 2 inches copper bar, electro-tin plated, length as indicated. Bolt ground bar to wall using 2 inches insulator-type standoff brackets. Pre-drilled holes as indicated to meet ANSI/TIA-607-B: 5/16 inches diameter holes at 5/8 inch spacing and 7/16 inch diameter holes at 1 inch spacing.

2.19.5 Counterpoise

Grounding and bonding conductors for counterpoise, duct bank systems, substations, main panels and distribution points, and ground rod connections must be annealed bare copper conforming to ASTM B3, stranded, with 98 percent conductivity. Wire size must be in accordance with the grounding requirements of NFPA 70. Minimum size shall be 4/0 unless otherwise indicated.

2.19.6 Connectors and Fasteners

Grounding and bonding connectors and fasteners above ground or within ground test wells must be copper or bronze, designed for the specific

application, and conform to the requirements of UL 467.

Provide irreversible connections where required by NFPA 70 or where indicated. Inaccessible ground connections installed underground shall be made by exothermic weld process. Within the welding procedure, include the proper mold and powder charge and conform to the manufacturer's recommendations.

Bonding straps and jumpers must be copper and size must be in accordance with the grounding requirements of NFPA 70. Minimum size shall be No. 4 unless otherwise indicated.

2.20 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.21 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Provide red laminated plastic label with white center core where indicated. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.22 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. The marking shall be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.23 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00, FIRESTOPPING.

2.24 WIREWAYS

UL 870. Material shall be steel epoxy painted galvanized 16 gauge for heights and depths up to 6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length required for the application with hinged- cover NEMA type enclosure per NEMA ICS 6 as follows:

a. Dry Locations except Mechanical Equipment Rooms - NEMA 1

b. Mechanical Equipment Rooms - NEMA 12.

c. Damp, Outdoor, or Wet Locations - NEMA 4X Type 316 stainless steel.

2.25 SURGE PROTECTIVE DEVICES

Provide surge suppression equipment in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.26 FACTORY APPLIED FINISH

Outdoor electrical equipment shall be NEMA 4X fabricated from Type 316 stainless steel unless otherwise indicated or specified. Indoor e lectrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements as specified herein. Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or equivalent treatment prior to painting. Exterior surfaces shall be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Exterior surfaces shall be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish. Equipment located indoors shall be ANSI Light Gray. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces, shall conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit shall be continuous with no splices from service entrance equipment to outdoor power system connection.

3.1.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures shall be labeled and identified as such.

3.1.2.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, each enclosure, new and existing, shall be labeled as one of several enclosures containing service entrance disconnect devices. Label, at minimum, shall indicate number of service disconnect devices housed by enclosure and shall indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure, shall be provided only as permitted by NFPA 70.

3.1.3 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Shared neutral, or multi-wire branch circuits, are not permitted unless specifically indicated on the drawings. Minimum conduit size shall be 3/4 inch. Vertical distribution in multiple story buildings shall be made with metal conduit in fire-rated shafts. Metal conduit shall extend through shafts for minimum distance of 6 inches. Conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors shall be firestopped in accordance with Section 07 84 00, FIRESTOPPING.

3.1.3.1 Pull Wire

Install pull wires in empty conduits. Pull wire shall be plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.1.4 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Do not install crushed, corroded or deformed conduit. Avoid trapped conduit runs where possible. Take care to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clear any clogged conduit of obstructions. Replace clogged conduit that cannot be cleared of obstructions with new.

3.1.4.1 Rigid Steel Conduit

Make field-made bends and offsets with approved hickey or conduit bending machine. Conduit elbows larger than 2-1/2 inches shall be long radius.

3.1.4.2 Electrical Metallic Tubing (EMT)

EMT shall be grounded in accordance with NFPA 70, using pressure grounding connectors especially designed for EMT.

3.1.4.3 Flexible Metallic Conduit

Use flexible metallic conduit to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

Bonding wires shall be used in flexible conduit as specified in NFPA 70, for all circuits. Flexible conduit shall not be considered a ground

conductor.

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit.

Liquidtight flexible metallic conduit shall be used in wet and oily locations and to complete the connections to motor-driven equipment.

3.1.4.4 Rigid Nonmetallic Conduit

Rigid PVC conduit shall be direct buried.

A bare copper grounding conductor shall be in conduit with conductors and be solidly connected to ground at each end. Grounding wires shall be sized in accordance with NFPA 70.

3.1.4.5 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use outdoors, in wet locations, or in damp locations.

f. Do not use in fire pump rooms.

3.1.4.6 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40 and PVC Schedule 80

(1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, and other such areas.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in fire pump rooms.

(4) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

(5) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

3.1.4.7 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS.

3.1.4.8 Service Entrance Conduit, Underground

PVC, Type-EPC 80, or plastic-coated galvanized rigid steel. Underground portion shall be encased in minimum of 3 inches of concrete and shall be

installed minimum 18 inches below slab or grade.

3.1.4.9 Underground Conduit Other Than Service Entrance

PVC, Type EPC-40 or 80.

3.1.4.10 Conduit Installed Under Floor Slabs

Conduit run under floor slab shall be located a minimum of 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.

3.1.4.11 Conduit Through Floor Slabs

Where conduits rise through floor slabs, curved portion of bends shall not be visible above finished slab.

3.1.4.12 Conduit Installed in Concrete Floor Slabs

PVC, Type EPC-40, unless indicated otherwise. Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Do not stack conduits. Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends shall not be visible above finish slab. Increase slab thickness as necessary to provide minimum one inch cover over conduit. Where embedded conduits cross building and/or expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings shall allow horizontal and vertical movement of raceway. Conduit larger than one inch trade size shall be parallel with or at right angles to main reinforcement; when at right angles to reinforcement, conduit shall be close to one of supports of slab. Where nonmetallic conduit is used, raceway shall be converted to plastic coated rigid steel or plastic coated steel IMC before rising above floor, unless specifically indicated.

3.1.4.13 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.4.14 Conduit Support

Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, beam clamps, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete ceiling shall be vibration resistant and shock-resistant. Holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support

system. Conduit and box systems shall be supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Installation shall be coordinated with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Support exposed risers in wire shafts of multistory buildings by U-clamp hangers at each floor level and at 10 foot maximum intervals. Where conduit crosses building expansion joints, provide suitable expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.4.15 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits.

3.1.4.16 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.4.17 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be 1/2 inch diameter. Provide liquidtight flexible conduit in wet and damp locations and in fire pump rooms for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.1.5 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in damp or wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 7 feet above floors and walkways, or when installed in hazardous areas and when specifically indicated. Boxes in other locations shall be sheet steel. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures

when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, do not cut reinforcing steel.

3.1.5.1 Boxes

Boxes for use with raceway systems shall be minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Telecommunications outlets shall be a minimum of 4 inches square by 2 1/8 inches deep. Mount outlet boxes flush in finished walls.

3.1.5.2 Pull Boxes

Construct of at least minimum size required by NFPA 70. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.5.3 Extension Rings

Extension rings are not permitted for new construction.

3.1.6 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches 48 inches above finished floor. Mount receptacles 18 inches above finished floor, unless otherwise indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets to center of device or outlet. Measure mounting heights of receptacle outlet boxes in the hazardous area to the bottom of the outlet box.

3.1.7 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors 4/0 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors larger than 4/0 AWG diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves.

3.1.7.1 Marking Strips

White or other light-colored plastic marking strips, fastened by screws to each terminal block, shall be provided for wire designations. The wire numbers shall be made with permanent ink. The marking strips shall be

reversible to permit marking both sides, or two marking strips shall be furnished with each block. Marking strips shall accommodate the two sets of wire numbers. Each device to which a connection is made shall be assigned a device designation in accordance with NEMA ICS 1 and each device terminal to which a connection is made shall be marked with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits shall be provided for the Government's wire designations. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.8 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with indentor crimp-typeconnectors and compression tools. Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to conductor insulation.

Except where specifically indicated on the drawings, splices are not permitted between transformer secondary windings and transformer secondary overcurrent protection device.

3.1.9 Covers and Device Plates

Install with edges in continuous contact with boxes or with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.10 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.11 Grounding and Bonding

Provide In accordance with NFPA 70, NFPA 780, and as indicated on the drawings. Ground exposed, non-current-carrying metallic parts of electrical equipment, access flooring support system, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems. Make ground connection at main service equipment as indicated. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection.. Make ground connection to driven ground rods on exterior of building. Interconnect all grounding media in or on the structure to provide a common ground potential. This shall include lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. In addition to the requirements specified herein, provide telecommunications

grounding in accordance with ANSI/TIA-607-B. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

Ground grids and duct bank ground systems must consist of a series of ground rods installed with interconnecting grounding conductors between ground rods. Space ground rods as noted. Do not bury ground grid less than 24 inches below the finish grade. Grounding conductors must be exothermically fusion welded together at crossover points and to ground rods.

Provide grounding electrode and connections for each lightning protection system down conductor in accordance with the requirements of Section 26 41 00.00 40 LIGHTNING PROTECTION SYSTEM.

3.1.11.1 Ground Rods

Provide cone pointed ground rods installed full depth plus 6-inches minimum, installed to provide an earth ground of the appropriate value for the particular equipment being grounded. Ground rods shall be installed using a water jetting procedure. The resistance to ground shall be measured using the fall-of-potential method described in IEEE 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.11.2 Grounding and Bonding Connections

Make grounding connections which are buried or otherwise normally inaccessible, excepting specifically those connections for which access for periodic testing is required, by exothermic weld.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

c. Bond metallic enclosures, raceway systems, and all electrical equipment to equipment and earth grounds. Install all metallic conduit, raceway, and enclosure systems to function as an equipment ground system supplemental to equipment grounding conductors. Install bonding jumpers across all expansion fittings or joints.

d. Conduits entering boxes and enclosures must be bonded to the box with locknuts and grounding-type bushings connected to the equipment and earth ground systems. Provide adequate bushing ground lug size to accept bonding conductors sized in accordance with NFPA 70.

e. Flexible and PVC conduit must have an integral copper grounding conductor. PVC grounding conductor shall be bare.

f. Where indicated at ground test wells, make all connections to the ground rod using bolted mechanical connectors. Locate the ground rod near the corner of the hand-hole with enough space to allow attachment of a clamp-on ground test meter to the rod and conductors within the hole.

3.1.11.3 Ground Bus

A copper ground bus shall be provided where indicated on the drawings. Noncurrent-carrying metal parts of transformer neutrals, UPS neutrals, and other electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment. For equipment rooms in computer and data processing, ground buses shall be provided where indicated and connected to the building grounding system. Connections shall be bolted type in lieu of thermoweld, so they can be changed as required by additions and/or alterations.

3.1.11.4 Resistance

Maximum resistance-to-ground of grounding system shall not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions. The resistance to ground shall be measured using the fall-of -potential method described in IEEE 81 with multiple, adequate electrode spacings and repeated measurements as necessary to verify an accurate value.

3.1.11.5 Telecommunications System

Provide telecommunications grounding in accordance with the following:

a. Telecommunications Grounding Busbars: Provide a telecommunications main grounding busbar (TMGB) in the telecommunications entrance facility. The TMGB shall be as close to the electrical service entrance grounding connection as practicable. Provide a telecommunications grounding busbar (TGB) in all other telecommunications rooms and telecommunications equipment rooms. The TGB shall be as close to the telecommunications room panelboard as practicable, when equipped. Where a panelboard for telecommunications equipment is not installed in the telecommunications room, the TGB shall be located near the backbone cabling and associated terminations. In addition, the TGB shall be placed to provide for the shortest and straightest routing of the grounding conductors. Where a panelboard for telecommunications equipment is located within the same room or space as a TMGB, that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure shall be bonded to the TMGB. Where a panelboard for telecommunications equipment is located within the same room or space as a TGB, that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure shall be bonded to the TGB. Telecommunications grounding busbars shall be installed to maintain clearances as required by NFPA 70 and shall be insulated from its support. A minimum of 2 inches separation from the wall is recommended to allow access to the rear of the busbar and the mounting height shall be adjusted to accommodate overhead or underfloor cable

routing.

b. Telecommunications Bonding Conductors: Provide main telecommunications service equipment ground consisting of separate bonding conductor for telecommunications, between the TMGB and readily accessible grounding connection of the electrical service. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds3 feet in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum. Provide a telecommunications bonding backbone (TBB) that originates at the TMGB extends throughout the building using the telecommunications backbone pathways, and connects to the TGBs in all telecommunications rooms and equipment rooms. The TBB conductors shall be installed and protected from physical and mechanical damage. The TBB conductors should be installed without splices and routed in the shortest possible straight-line path. The bonding conductor between a TBB and a TGB shall be continuous. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in telecommunications spaces. Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. Whenever two or more TBBs are used within a multistory building, the TBBs shall be bonded together with a grounding equalizer (GE) at the top floor and at a minimum of every third floor in between. The TBB and GE shall not be connected to the pathway ground, except at the TMGB or the TGB.

c. Telecommunications Grounding Connections: Telecommunications grounding connections to the TMGB or TGB shall utilize listed compression two-hole lugs, exothermic welding, suitable and equivalent one hole non-twisting lugs, or other irreversible compression type connections. All metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the TMGB or TGB shall be bonded to the TMGB or TGB respectively. Provide a bond from TGB, TMGB and busbars in the electrical rooms to local structural steel with a minimum No. 6 AWG conductor. When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the TGB may be bonded to these horizontal members in lieu of the vertical column members. All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose. Coordinate provisions of bonding pigtails for all busbars with structural to ensure bond is made, unconditionally.

3.1.11.6 Manhole and Duct Bank Grounding

Provide counterpoise and ground rods for new duct bank systems as indicated on the drawings. Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

Provide bare grounding conductors. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 4 AWG.

Connect all incoming 2/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 4 AWG conductor.

3.1.12 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications but shall be provided under the section specifying the associated equipment.

3.1.13 Government-Furnished Equipment

Contractor shall make connections to Government-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

3.1.14 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS. Where field painting of enclosures for panelboards, or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 14 calendar working days' notice prior to each test.

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

Perform all applicable inspections and electrical tests, including

optional tests unless indicated otherwise, in accordance with NETA ATS for all equipment provided including but not limited to:

a. Transformer factory tests

b. Circuit breaker tests (except do not perform primary current injection trip tests on molded case circuit breakers).

c. Grounding system tests

d. Low voltage conductor tests

e. Panelboard tests

f. Motor controller tests

3.5.1 Conductors

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panelboards, and other disconnecting devices shall be used to isolate the circuits under test.

Perform Insulation-Resistance Test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values shall not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes 8 AWG and smaller insulation resistance testing is not required.

Perform Continuity Test to insure correct cable connection (i.e., correct phase conductor, grounded conductor, and grounding conductor wiring) end-to-end. Any damage to existing or new electrical equipment resulting from Contractor mis-wiring will be repaired and re-verified at the Contractor's expense. All repairs shall be approved by the Contracting Officer prior to acceptance of the repair.

3.5.2 Panelboards

Panelboards shall be given continuity and insulation tests after the installation has been completed and before the panelboard is energized.

Conduct insulation tests on 480-volt panelboards using a 1,000-volt insulation-resistance test set. Record readings every minute until three equal and consecutive readings have been obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Conduct insulation tests on panelboards rated 300 volts or less using a 500-volt minimum insulation-resistance test set. Record readings after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be

not less than 25 megohms.

Record test data and include the location and identification of panelboards and megohm readings versus time.

Conduct Phase-Rotation Tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved by the Contracting Officer.

3.5.3 Receptacle Tests

3.5.3.1 Ground-Fault Receptacle Tests

Test ground-fault receptacles with a tester that trips the receptacle. Verify receptacle is reset after tester is removed.

3.5.3.2 Convenience Receptacle Tests

Verify correct polarity and voltage at each receptacle.

3.5.4 Grounding System Tests

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

Perform the following tests in the presence of the Contracting Officer.

3.5.4.1 Bond Resistance Test

Test any bond made inaccessible by other construction or work prior to being made inaccessible. Resistance of any bond connection must not exceed 0.5 milliohm. Rework bonds that exceed this resistance at no additional cost to the Government.

Provide bonding resistance tests, test equipment, and test reports for all bonds and connections in accordance with the requirements of Section 26 41 00.00 40 LIGHTNING PROTECTION SYSTEM.

3.5.4.2 Ground Resistance Tests

Test grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise must not exceed 50 milliohms.

Ground resistance and counterpoise tests must be made during dry weather, and no sooner than 48 hours after rainfall. Conduct tests using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE 81.

Indicating instrument must be self-contained and include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Calibrate direct-reading ohmmeter for ranges of 0 to 20 ohms and 0 to 200 ohms.

The resistance to ground shall be measured using the fall-of -potential method described in IEEE 81 with multiple, adequate electrode spacings and repeated measurements as necessary to verify an accurate value. Place auxiliary grounding electrodes in accordance with instrument manufacturer's recommendations but not less than 50 feet apart, in accordance with IEEE 81.

-- End of Section --

SECTION 26 23 00

SWITCHBOARDS
07/06

PART 1 GENERAL

This specification section applies to utility service switchboard "MSB-A" and "MSB-B" configured in a dual-source, double-ended configuration.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D1535	(2012) Specifying Color by the Munsell System
ASTM D709	(2001; R 2007) Laminated Thermosetting Materials

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-104-696	(2001) Standard for Indoor-Outdoor Optical Fiber Cable

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 4	(1995; Amendment A 2001) Standard Techniques for High Voltage Testing
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

IEEE C2	(2012) National Electrical Safety Code
IEEE C37.90.1	(2002; Errata 2003; Errata 2004) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
NETA MAINT	(2011) Standard for Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA PB 2.1	(2007) General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 V or Less
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products
NEMA PB 2	(2011) Deadfront Distribution Switchboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1666	(2007; Reprint Jun 2012) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
UL 467	(2007) Grounding and Bonding Equipment
UL 891	(2005) Switchboards

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568-C.3	(2008; Add 1 2011) Optical Fiber Cabling Components Standard

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.3.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submit these items together with NASA Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES submittals which is referenced in this section.

SD-02 Shop Drawings

Switchboard Drawings; G

Submit in accordance with the paragraph entitled "Switchboard Drawings". Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

All Shop Drawings shall be computer aided design (CAD) generated. Provide Digital media compact disc (CD) with all submittals including .DWG or .DXF files for all drawings in the "As-Built Submittal". Also on this CD provide a complete copy of the drawings in PDF format.

Submit Shop Drawings for approval prior to equipment manufacturing.

Submit fabrication drawings for fabrication and assembly details to be performed in the factory.

Submit KCCS Project Integration Data; G and System Software:

Provide prior to the second and third KCCS integration review meetings.

Submit Installation Drawings covering the switchboard assemblies in accordance with the paragraph entitled "Installation" of this section. Include in these drawings complete details of equipment layout and design.

Submit Switchboard Foundation Data; G covering switchboard assemblies; G and shall include dimensioned plans of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made. Provide digital media compact disc (CD) with all submittals including .DWG or .DXF CAD source files as well as PDF format files for all drawings.

SD-03 Product Data

Submit manufacturer's technical data in accordance with the paragraph entitled "Switchboard Product Data" for the following items:

Switchboard; G

Switchboard Assemblies including enclosures, paint coatings, and buses; G

All switchboard components; G including breakers, trip units, control components, and protective relays; G.

Instruments and instrument transformers; G

Control-power transformers; G

Control-Power Circuit Transfer Contactor; G

Space Heaters; G

Programmable Logic Controller (PLC); G

Operator touch-screen; G

Communications components; G

Switchboard Monitoring and Control Systems; G

Electrical Power Monitoring System; G

Recommended Spare parts and supply list; G

SD-06 Test Reports

Acceptance checks and tests; G

Submit test forms showing compliance with NETA ATS inspections and

tests for approval prior to testing.

Submit completed test forms showing the results of all inspections and tests in accordance with NETA ATS inspections and tests after inspections and testing is complete.

Include the following Production Test reports on switchboard assemblies with the Factory Test reports:

- Dielectric Tests

- Relay and Metering circuit performance tests; G

- Mechanical Operation Tests; G

- Complete Functional Testing of the entire system; G

- Grounding of Instrument Transformer Casing Test

- Electrical Operation and Control Wiring Tests including Circuit Continuity; G

- Polarity Verification

Submit field test reports on switchboard assemblies in accordance with paragraph entitled "Field Testing," of this section; G

Submit field test reports on switchboard assemblies in accordance with paragraph entitled "Relay Settings and Tests," of this section; G

Submit field test reports on switchboard assemblies in accordance with paragraphs entitled "Field Testing for Communications," of this section; G

Do not energize switchboard assemblies until recorded test data has been approved by the Contracting Officer.

SD-07 Certificates

Controls Specialist Qualifications; G Include the qualifications of the controls engineer that will perform PLC controls installation, KCCS system integration, and overall system validation.

Certificate of Compliance; G showing Switchboard Monitoring and Communication System hardware successfully communicate with existing Citect Software.

Submit Certificate of Compliance showing successful completion of the certification testing as required by the paragraph entitled " Certification Testing" of this section; G

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G

Provide a minimum of six (6) bound, and six (6) CD ROMs in PDF format, Operation and Maintenance Manuals in accordance with the

paragraph entitled "Assembled Operation and Maintenance Manuals".

1.5 QUALITY ASSURANCE

1.5.1 Switchboard Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the switchboard including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

c. Manufacturer's standard application, installation, operation and maintenance manuals for switchboard and all switchboard components provided.

d. Manufacturer's standard programming manuals for all components requiring customized software.

1.5.2 Switchboard Drawings

Drawings shall include, but are not limited to the following:

a. One-line diagram including breakers.

b. Outline drawings including front elevation, section views, footprint, paint coatings, and overall dimensions.

c. Bus configuration including dimensions and ampere ratings of bus bars.

d. Markings and NEMA nameplate data.

e. Circuit breaker type, interrupting rating, and trip devices, including available settings.

f. Switchboard components including all control switches, auxiliary relays, instrument transformers, power meters, protective relays, and space heaters

g. Control power diagrams including UPS source connections, control power transformers, and control-power transfer contactors, and all connected loads. Provide load calculations justifying ratings of all components provided.

h. Three-Line Diagrams detailing all protective device, protective relay, metering, and instrumentation transformer connections.

i. Schematics and Wiring Interconnection Diagrams including all Programmable Logic Controller, touch screen, communication device, breaker, switch, metering, control power, metering, and relay connections.

j. Sequence of Operation: This document shall cover all switchboard operational modes including Automatic Mode and Manual Mode.

k. Switchboard Monitoring and Control Systems: Include hardware with touch screen monitor, software, and interconnection drawings which include details of the power sources and communications pathways for devices accessed by KCCS.

l. Integral switchboard operation procedures detailing all switching modes including, but not limited to loss of one source, loss of both sources, closed transition loss of PLC, loss of touch screen.

m. Sequence of Operation for all switchboard operational modes including Automatic Mode, and Manual Mode.

n. All software programs and software data files.

o. Function block program and device address listing.

p. All operator screens.

q. List of programming and monitoring software and hardware.

r. All application software screens.

1.5.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4.1 Material and Equipment Manufacturing Date

Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Assembled Operation and Maintenance Manuals

Manuals shall be assembled and bound securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in

the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall fully detail the switchboard "As-Built" condition and be as follows:

a. Technical data and instruction manuals required by the paragraph entitled, "SD-03, Product Data."

b. Drawings required by the paragraph entitled, "SD-02, Shop Drawings." Drawings shall be "as-built" indicating all changes made during the installation.

c. Spare parts and supply list.

d. All software programs on CD ROM

e. Detailed start-up report including a list of customer trained individuals.

f. Provide two (2) original licensed copies of all software manuals with the final Operation and Maintenance Manuals package.

1.7 DEFINITIONS

The Kennedy Complex Control System (KCCS) is a combination of hardware and software components that are used to monitor and control Power, HVAC, Water and Waste and Pneumatic Utilities across the Kennedy Space Center.

Citect is an Industrial Controls, Supervisory Control and Data Acquisition (SCADA) software application that is used to monitor and control the I/O devices connected to the KCCS network. The Citect application provides the Human Machine Interface (HMI) to display, trend, alarm and control and/or monitor the I/O points connected to or through the I/O devices. Information is transferred to and from the Citect server over a dedicated Ethernet controls network using Modbus TCP/IP as the transportation protocol.

1.8 ENGINEERING SERVICES

Power system analysis, arc-flash studies, and protective relay settings for all equipment specified in this section shall be in accordance with Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS.

The Contractor shall provide a Controls Specialist to oversee the integration and validation of the substation PLC controls and the integration of the PLC, trip units, and metering into the KCCS system. Submit the Controls Specialist qualifications of the controls engineer for approval.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SWITCHBOARD "MSB-A AND MSB-B"

NEMA PB 2 and UL 891.

2.2.1 Ratings

The voltage rating of the switchboard shall be 480 volts, 3 phase, 3-wire. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall be as indicated. The switchboard shall be UL listed and labeled for service entrance use.

2.2.2 Construction

The switchboards shall be dead-front switchboards conforming to NEMA PB 2 and labeled under UL 891. The switchboards shall be completely enclosed self-supporting metal structures with the required number of vertical panel sections, buses, power circuit breakers, and molded-case circuit breakers as shown on the drawings. Switchboards shall be fully rated for a short-circuit current indicated.

Switchboard shall consist of vertical sections bolted together to form a rigid assembly and shall be front and rear aligned. All circuit breakers shall be front accessible. Switchboards shall have front accessible load connections. Front access to main breakers, tie breakers, and control sections shall be by hinged door. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections.

2.2.2.1 Switchboard Assemblies

Provide general arrangement of the number of compartments and each compartment's components as shown.

Switchboard breaker compartments must include the following equipment:

- Drawout metal-enclosed low-voltage power circuit breaker - all main-tie-main breakers each in a dedicated section

- Fixed molded case circuit breakers distribution sections - all feeders. Provide auxiliary contacts on all feeder breakers for monitoring by the switchboard monitoring and control system.

- Provisions for terminating incoming service cables indicated to the metal-enclosed bus with NEMA 2-hole type lugs.

- Space heaters in all draw-out breaker and cable termination sections.

Provide drawout power circuit breakers with three-position operation and truck position switches:

- Connected Position - Contacts are fully engaged. Breaker must be tripped before it can be racked into or out of this position.

- Test/Disconnect Position - Position must allow for complete testing and operation of the breaker without energizing the primary circuit.

- Withdrawn (Removed) Position - Places the breaker completely out of the compartment, ready for removal.

- Breaker truck switches shall be wired in series or parallel with each mechanism operated contact used in control sequences such that control sequences consider breaker position. For control sequences closed or tripped breakers must be in the connected position and breakers not in the connected position are treated as open or disconnected.

Drawout compartments must contain the mechanisms for racking the breaker on and off the bus both manually and using remotely operated equipment. Provide a barrier that covers energized bus when the breaker is in the withdrawn position.

Fully equip switchboard spare breaker compartments for future use to receive the removable element with complete bus connections, disconnecting devices, rails, and cell interlocks.

Provide filler compartments incidental to the switchboard assembly as empty compartments with hinged cover plates.

Control power compartments for the switchboard assembly must include the following:

- Provision for terminating incoming UPS power source. Provide overcurrent protection for each circuit breaker and other loads.

- Each switchboard side, A-side and B-side, shall include a control power transformer with primary and secondary protection. The output of the (2) transformers shall be switched to a common control power bus using a Device 83 transfer contactor; preferred source shall be the source currently in use. This control power bus shall supply back-up input power to the UPS Device 83 transfer contactor, power circuit breaker spring charging motors, and to the switchboard space heaters.

- The UPS control power source shall supply power to the power meters, trip units, PLC, PLC touch screen, breaker trip and close coils, indicating and status lights, protective relays, unmanaged Ethernet switch and media converters. This power shall be switched to a common UPS control power bus using a Device 83 transfer contactor; the preferred source of this contactor shall be the UPS power source.

Auxiliary compartments for the utility switchboard, must include the following:

- Potential transformers; use three potential transformers for inputs to voltage relay, metering, and synchronization check relays. Provide (4) sets as follows: A-side utility main breaker cable line, A-side switchboard load bus, B-side switchboard load, bus, and B-side utility main breaker line side.

- Three line-side source current transformers; 2500: 5 multi-ratio. Provide two (2) sets as follows: A- and B-side utility main breakers.

- Multi-function voltage relay. Provide at the line side to each of (2) utility source locations.

- Bus Fault lockout relay for each main breaker.

- Synchronization check relays. Provide for the following three (3)

utility source synchronization checks: A-side utility transformer to A-side switchboard bus, B-side utility transformer to B-side switchboard bus, and A-side switchboard bus to B-side switchboard bus.

- Square D CM4250 network connected to the unmanaged Ethernet switch. Provide two (2) meters, one for each utility service.

- Test switches for protective relays and metering.

- Programmable Logic Controller (PLC) and touch-screen interface. PLC shall be connected to the unmanaged Ethernet switch. PLC shall be mounted such that the modules are facing out, away from the back panel of the switchboard.

- Miscellaneous switches, relays, time relays, and indicating lights.

- Transient voltage surge suppression with overcurrent protection and disconnecting means for each incoming set of service cables.

The following safety functions must be directly wired to device contacts indicated, and shall be hardwired to the circuit breaker control circuits such that they cannot be bypassed by the switchboard's PLC. Also replicate functions indicated in the PLC logic.

- A-Side Bus Fault Lockout Relay (86A) Logic:

  (1) A-Side utility main breaker (MAIN A) trip.

  (2) Utility tie breaker (TIE) trip with A-side utility main (UTIL A) open or withdrawn.

- A-Side Utility Main Breaker Block Close:

  (1) A-Side bus fault lockout relay (86A).

  (2) A-Side utlity main breaker (MAIN A) source/bus synchronization relay (no utility source available or unsynchronized utility/bus energized voltages).

  (3) A-Side utility main breaker (MAIN A) is disconnected.

- A-Side utility Main Breaker Trip:

  (1) A-Side bus fault lockout relay (86A).

- Utility Tie Breaker (TIE) Block Close:

  (1) A-Side bus fault lockout relay (86A).

  (2) Utility tie breaker (TIE) is disconnected.

  (3) A-Side/tie synchronization relay (unsynchronized A-bus/B-bus energized voltages only).

  (4) B-Side bus fault lockout relay (86B).

- A-Side Utility Tie Breaker Trip:

  (1) A-side bus fault lockout relay (86A).

(2) B-Side bus fault lockout relay (86B).

(3) A-Side Main (MAIN A), B-Side Main (MAIN B) closed, and Tie breaker closed for 10 seconds by means of an adjustable timing relay (0 to 60 seconds) independent of the PLC monitoring and control system.

- B-side Bus Fault Lockout Relay (86B) Logic:

  (1) B-Side utility main breaker (MAIN B) trip.

  (2) Utility tie breaker (TIE) trip with B-Side utility main.

  (3) MAIN B open or withdrawn.

- B-Side Utility Main Breaker Block Close:

  (1) B-Side bus fault lockout relay (86B).

  (2) B-Side utility main breaker (UTIL B) utility source/bus synchronization relay (no utility source available or unsynchronized utility/bus energized voltages).

  (3) B-Side Main breaker (MAIN B) is disconnected.

- B-Side Utility Main Breaker Trip:

  (1) B-Side bus fault lockout relay (86B).

2.2.2.2 Switchboard Foundations

Submit switchboard Foundation Data for switchboard assemblies. Include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

2.2.2.3 Switchboard Components

Switchboard components including but not limited to circuit breakers, trip units, protective relays, metering, surge protective devices, instrument transformers, control transformers, indicating lights, and control components in accordance with NASA Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.2.2.4 Enclosure

The switchboard enclosure shall be indoor NEMA 1 or outdoor NEMA 3R stainless steel (ASTM A167 Type 304 or 304L) per NEMA ICS 6 as indicated built with selected smooth panels not less than 14 gauge. Exposed panels on the front and ends shall have bent angle or channel edges with all corner seams welded and ground smooth. The front outside surfaces shall not be drilled or welded for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front. The front panels shall be made in sections flanged on four sides and attached to the framework by screws and arranged for ready removal for inspection or maintenance.

Enclosure shall be bolted together. Provide hinged doors on all front access main breaker, tie breaker, and control sections. Provide removable bolt-on covers elsewhere. Ventilating openings shall be provided as required and shall be of the grille or louver type. All ventilating openings shall be provided with corrosion-resistant, inspect-proof screens on the inside.

Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of ASTM A167 type 304 or 304L stainless steel for outdoor units and galvanized steel for indoor units. Base shall include any part of enclosure that is within 3 inches of concrete pad. Galvanized steel shall be ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

Paint enclosure, including bases, ASTM D1535 light gray No. 61 or No. 49. Paint coating system shall comply with IEEE C57.12.28 for galvanized steel and IEEE C57.12.29 for stainless steel. Treat all interior and exterior steel parts to inhibit corrosion.

2.2.2.5 Compartment Details

Completely wire compartments with cable terminals, cable clamps, control bus, control power switch, and terminal blocks. Generate and submit Schematics and Wiring Diagrams for each compartment. Make terminal blocks readily accessible for the external connections of metal-enclosed switchboard

Run low-voltage wiring for controls and accessories to terminal blocks having numbered points, as indicated, to identify circuits. Run low-voltage wiring in conduit or wiring raceways to isolate the wiring from high-voltage circuits. Clearly identify all wiring connections.

Clearly identify and designate, by cubicle, all switchboard components, including but not limited to fuse blocks, push buttons, selector switches, indicating lights, and terminal blocks (i.e., 1A, 1B, 2A, 2B, this being cubicle 1 device A, cubicle 1 device B, etc.) Identify device designation with a label, with a minimum 1/4 inch high lettering. Wiring between sections/cubicles must identify the end devices by section/cubicle number and device designation.

Provide terminal blocks with engraved plastic terminal strips with screw type terminals having letter designations and numbered terminal points. Terminal blocks in each section/cubicle used for the same wiring as the adjacent sections/cubicles must have the same letter designation preceded by the section/cubicle number. Terminal blocks associated with current transformers must be short circuiting type. Terminal blocks with sliding links are not allowed. Terminal blocks for multi-ratio current transformers must be wired with all taps and ground, one terminal block per current transformer. Wiring must be SIS Class insulation, sized No. 12 AWG at 120/240 panel with 20 amp breakers, No. 14 AWG for control, No. 12 AWG for potential leads, and No. 10 AWG for current leads. Terminate all current conductors with compression ring terminal lugs and control and potential conductors with compression forked (with tabs) terminal lugs. Do not use male/female spade connectors. Final conductor leads for terminations on the switchboard heaters must be a minimum of 150 degrees high temperature wiring.

Locate at each end, wire marking for controls, metering, relaying, and

accessory conductors. Wire markers must be white plastic tubing heat stamped with black block type letters. On all wire markers, indicate the device or equipment, including specific terminal numbers to which the other end of the wire is attached, and the terminal number to which the wire is directly attached (near end/far end marking).

Identify each compartment of the switchboard assembly by an identification plate engraved with circuit and function designations. Plate must be a minimum of 1 inch high and long.

Removable elements of the same type and rating in the switchboard assembly must be physically and electrically interchangeable in corresponding compartments. Provide front-hinged panel suitable for mounting instruments, relays, control switches, and indicating lamps.

2.2.2.6 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide copper ground bus secured to each vertical section along the entire length of the switchboard. The neutral connection and main bonding jumper shall be rated 100 percent of the main bus continuous current rating as indicated.

2.2.2.7 Mimic Bus

Provide mimic bus using 3/32 inch red plastic laminate. Mimic bus must show breakers and bus. Fasten to switchboard using stainless steel screws.

2.2.2.8 Main and Distribution Sections

The main, distribution, bus-tie, and auxiliary sections shall consist of individually mounted drawout power circuit breakers for Main-Tie-Main breaker each in a dedicated section, and molded-case circuit breakers as indicated.

Provide integral factory installed surge suppression equipment with overcurrent protection in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.2.3 Protective Device

2.2.3.1 Power Circuit Breakers

All switchboard MSB, main, and tie breakers must be electrically operated drawout type power circuit breakers and conform to Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

The trip units on all breakers shall communicate MODBUS through the respective CM4250 ECC RS 485 connection the reportable information for power and energy.

All breakers must be equipped with auxiliary position contact for monitoring the switchboard "Monitoring and Control" system.

All breakers must be equipped with factory installed lockout provisions.

2.2.3.2 Molded-Case Circuit Breaker

Provide molded-case circuit breakers in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

The trip units on all breakers shall communicate MODBUS through the respective CM4250 ECC RS 485 connection the reportable information for power and energy.

All breakers must be equipped with auxiliary position contact for monitoring the switchboard "Monitoring and Control" system.

All breakers must be equipped with factory installed lockout provisions.

2.2.4 Instruments and Instrument Transformers

Indicating instruments, protective relays, current and potential transformers, instrument transfer switches, and control-power transformers must conform to the applicable requirements of Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.2.5 Control-Power Circuits

2.2.5.1 Control-Power Circuit Transfer Contactor

Design contactor for automatic transfer of control-power for 120/240-volt, single-phase, 60-Hz service with current rating. Make contactor the open type, two-pole, double-throw with solid neutral connections and must automatically transfer its load circuits to the alternate power supply upon loss of power in the normal supply. Device must be electrically operated and mechanically held and obtain its operating current from the source to which the load is transferred. Provide contactors for automatic transfer of control power suitable for installation in metal-enclosed switchgear. Provide two extra normally open and two extra normally closed contacts. One set of contacts must be wired to the PLC for status indication.

There shall be two control-power circuit transfer contactors: one shall switch between source A and source B; the second one shall switch between UPS output and the first contactor output.

2.2.6 Control-Power Circuit Overcurrent Protection

Provide AC circuit breakers mounted within the switchboard to feed compartment heater, lights, convenience outlets, and other devices.

2.2.7 Service and Maintenance Devices

Include the following service and maintenance devices as a part of the switchboard:

- A manual handle for operating the air and power circuit breaker isolating mechanism

- Removable manual maintenance closing devices for air and power circuit breakers

- Facilities for operating air and power circuit breakers in the test or removed position

- Facilities for racking and withdrawing power circuit breakers for inspection or maintenance. Provide both a manual racking handle and a racking system capable of being remotely operated to protect the operator from potential arc-flash energy.

- Hoist system and breaker lifting devices at each switchboard assembly to remove circuit breakers from their compartment.

- Test plugs and cable for meters and relays

- A NEMA 5-20R GFCI receptacle at each switchboard end for service tools

2.2.8 Protective Relays and Devices

Protective relays and devices must test and comply with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES and IEEE C37.90.1.

2.2.9 Indicator Lights

Indicator lights must comply with Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Provide the following lights at each switchboard assembly, both A-Side and B-Side; make indicator light colors as follows and label according to the following functions:

Function	Color
Breaker Open	Green
Breaker Closed	Red
Control Power Available	Red
Automatic Mode	Blue
Manual Mode	White
Bus Lockout	Amber

2.3 SWITCHBOARD MONITORING AND CONTROL SYSTEMS

Provide complete switchboard monitoring and control systems as described in this section. These systems are defined to include, but are not limited to, a programmable logic controller (PLC) that monitors and controls remote devices, touch screen display human machine interface (HMI), electrical power monitoring system, device communications interface hardware, intercommunication wiring, software, startup and training services, and ongoing technical support. This system shall comply with the applicable portions of IEEE 802.3. The Manufacturer and Controls Specialist shall demonstrate that the communication systems provided under this project will communicate efficiently with the KCCS Citect software. Efficiently implies that the data will be transmitted and received such that the response time to the KCCS workstation will be less than 4 seconds. This demonstration shall include multiple trip units, meters, a PLC and a laptop loaded with the KCCS Citect project software. Provide two licensed copies of all software and all hardware necessary to modify and download the program to the touch screen.

Provide the Citect operator screens to monitor and control the new data points on any new or modified switchboard that communicates to KCCS. The Government will perform the final integration of the new screens, Genies, and Super Genies into the existing KCCS Citect file server. The Citect project modifications shall include but not be limited to creating variable, alarm and trend tags, modifying/developing Genies and Super Genies and modifying/developing operator screens.

A Government sample KCC Citect project containing a library of Citect symbols, Genies and Super Genies will be provided to the Contractor to use for development of the new operator screens. The sample project includes the Citect interfaces for the CM 4250 power meters, the Modicon Quantum PLC and the Square D Micrologic trip units. If the SMCS communication architecture described in the design documents are followed, new development for existing components will not be required. New operator screens depicting the new switchboard are still required but they can be developed using the existing KCCS Citect library.

Three KCCS integration design reviews will be scheduled by the Contractor to ensure that all of the parties involved in developing any new Citect interfaces (screens, Genies, Super Genies, alarms data exchange methods) are properly coordinated. The first meeting will be a kickoff meeting where the Government will provide a sample KCCS Citect project to assist in the development of new interfaces. Provide KCCS Project Integration Data for the second and third review meetings. At the second meeting, the Contractor will provide a sample of all the new types of Citect interfaces that are being developed. At the third meeting, the Contractor will provide a fully working sample of the entire project. The first meeting shall be scheduled within 75 days of the contract award.

Circuit breakers shall be electrically operated with capability to be manually operated locally via touch screen, locally via control switches, and remotely via KCCS.

All automatic transfer control functions shall be accomplished via the PLC. Circuit breakers shall remain in the last state if PLC is taken off-line.

All timing and control for automatic transfer shall be performed via the PLC. Auxiliary relays shall only be used where circuit breaker control circuit exceeds the rating of the PLC output contacts. Auxiliary relays shall only be used to directly connect one circuit breaker control circuit. Use of auxiliary relays to provide relay logic or timing functions is not permitted. Relays shall be industrial grade, octal based, single tier with screw terminals, pilot light, retainer clip, vibration resistant 10 amp rated output contacts.

The switchboard transfer control shall be designed to auto transfer load on loss of power on either or both of the two utility sources and provide automatic re-transfer on source return after an adjustable time period. The re-transfer operation for a utility source to utility source retransfer shall be selectable either open or closed transition. The following functions shall be activated the touch screen display or KCCS remote operator:

Automatic/Manual Mode.
Open/Closed Utility to Utility Transition.

The touch screen display controls shall allow the user to enable/disable the automatic transfer function and initiate the appropriate changes to the PLC logic to allow the selection of the desired unit substation modes of operation. Modes of operation are 'Automatic' or 'Manual' with utility/utility re-transfer options for either 'Open' or 'Closed' transition. The touch screen display controls shall also allow the user to change the time delays for the transfer scheme. These changes shall not require the use of additional equipment such as a laptop computer or

additional PLC programming software. Touch screen display controls for operating circuit breakers shall require two step commands, the first to initiate the command and the second to confirm command.

2.3.1 Programmable Logic Controller (PLC)

Provide a PLC and touch screen for the switchboard. For compatibility, PLC shall be NASA KSC Standard, Schneider Electric Modicon Quantum Series, and no other. Provide touch screen, Magelis Touch Screen XBTGT6330 or approved equal, display with the following characteristics and features:

a. Industrial grade
b. Impact and scratch resistant
c. Color screen with greater than or equal to (228 mm) 9 inch screen size
d. Screen lockout for cleaning
e. Field replaceable display that is capable of being replaced while in service
f. Provide one spare display for each display installed
g. Integrated drivers for direct serial connection to PLC
h. Simultaneous communications with multiple PLCs
i. Dual serial communication ports
j. Windows based configuration software
k. Support for third party graphics
l. Dynamic object based graphics
m. Bitmap graphics
n. Software manuals
o. Users manuals
p. Interface cables

2.3.1.1 Discrete Input Points

Provide the following discrete input points including 10% spare for future use to the PLC:

a. Protective relay activation and status for all relays within the switchboard and others external from the switchboard as required for control sequences.
b. Breaker status, open/close and truck position (where applicable), for all circuit breakers (utility-tie-feeder) within the switchboard and others external from the switchboard as required for control sequences.
c. Lockout relay status
d. Automatic/Manual transfer mode status
e. UPS control power status
f. AC control power status
g. Internal status registers of the PLC (communication via Ethernet connection TCP/IP or connection with Modicon quantum PLC)
h. All emergency switchboard "EMSB" breaker positions
i. All emergency generator functions specified in Specification Section 26 32 15.00 10 DIESEL GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES"
j. Generator/ ATS interface cabinet generator selection both Fixed and Portable

2.3.1.2 Discrete Outpoint Points

Provide the circuit breaker discrete open and close output points including 10 percent spare for future use to the switchboard's PLC as required:

Breaker trip/close commands for all utility main and bus tie switchboard breakers
Bus lockout relay status
Automatic mode status
Manual mode status
AC control power status
UPS control power status
Normal configuration
Exerciser control output to each automatic transfer switch
Power source status to building automation system (BAS): On normal power
Power source status to building automation system (BAS): On generator power
Power source status to Chilled Water PLC: On normal power
Power source status to Chilled Water PLC: On generator power

2.3.2 Power Circuit Breaker Trip Units

Power circuit breaker trip units shall conform to Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.3.3 Electrical Power Monitoring System

Provide the following metering equipment:

a. Main: Where indicated, provide metering equipment to monitor energy usage on the circuit indicated. For compatibility, metering equipment shall be NASA KSC Standard, Schneider Electric Square D CM4250 with ECC21 Ethernet communications card, IOC input/output card, and CMDLC backlit LCD display, and no other. Provide meter appurtenances, including cables, as required for complete and proper operation. Metering equipment shall conform to Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Install metering equipment in accordance with the metering equipment manufacturers published installation instructions. Mount metering equipment in strict accordance with the orientation recommendations of the metering equipment manufacturer. Mount LCD display on the front panel of the compartment containing the circuit being monitored.

2.3.4 Communications

Provide for the exchange of data via Ethernet communications with the following:

a. KCCS
b. Circuit breaker trip unit interface
c. Utility Switchboard Electrical Power Monitoring System (Modbus TCP)
d. Emergency Switchboard "EMSB" Electrical Power Monitoring System (Modbus TCP)
e. Fire Pump Service Electrical Power Monitoring System (Modbus TCP).
f. UPS system.
f. Other facility systems indicated.

Provide industrial unmanaged Ethernet switch N-TRON 309FX-ST or equal. Provide industrial media adapters as required. Ethernet communications contained completely within switchboard shall employ 4-pair #23 AWG CAT6 Type CM indoor/outdoor rated fully water blocked and sunlight resistant cable. Ethernet communications extending outside of switchboard shall employ 62.5/125 um multimode (OM1) indoor/outdoor all dielectric riser (OFNR) rated backbone fiber optic cable (FOC) conforming to ICEA S-104-696, TIA-568-C.3, UL 1666, and NFPA 70.

2.3.5 Sequence of Operation

Sequence of operation for the transfer scheme of the Main-Tie-Main (M-T-M) circuit breakers and generator source breakers shall be as follows:

2.3.5.1 General

All operating modes shall be selectable from the touch screen or remotely via KCCS. Delay time shall be stored in registers and adjustable from a table detailing the delay function and current time delay setting.

Transfer scheme shall have two operating modes: Automatic and Manual with selectable open transition and closed transition switching for utility to utility re-transfer. Circuit breakers shall remain in the last state when mode is changed except when going to the automatic mode. Only controls under the current mode shall have any control capability over the circuit breakers. Block close features shall not be defeated in any mode. If a bus fault occurs then the mode shall automatically default to manual.

The switchboard transfer control shall be designed to auto transfer load on loss of power to any available source and provide automatic re-transfer on source return after an adjustable time period. The switchboard shall automatically switch on power source state changes to achieve the following source priority supplying all loads: priority 1 - dual utility source, priority 2 - single utility source. The re-transfer operation shall be selectable either Open Transition or Closed Transition from the touch screen or KCCS remote operator.

Normal Configuration - All main(s) breakers are electrically operated via PLC control:

- The A-Side utility source is energized and A-Main breaker (MAIN A) is closed.
- Utility bus tie breaker, TIE, is open.
- The A-Side load breakers are closed.
- The B-Side utility source is energized and B-Main breaker (MAIN B) is closed.
- The B-Side load breakers are closed.
- PLC programs are in "Automatic" and "Closed Transition" modes.
- The PLC is communicating, operable, and normal.

2.3.5.2 Automatic Operation

The "Automatic" transfer mode is designed as the normal configuration for the utility scheme and gives the PLC at each unit switchboard complete and autonomous control of the switchboard. The PLC program shall be controlled by KCCS to allow KCCS to take control of the switchboard remotely through an Ethernet connection to the PLC by enabling or disabling the 'Automatic' transfer mode. An indicator light seen on the front of the switchboard shall illuminate while in the 'Automatic' transfer mode.

Automatic Sequence of Operation shall be as follows or equivalent. Single-end transfer to A-side from double-ended operation and return to double-ended operation control is indicated; B-side transfer operations are to match those indicated for the A-side. All breaker trip and close signals shall be momentary and released when desired position is achieved or specified time-out is indicated.

A-Side source transfer control upon loss of utility source.

If the A-Side utility source (supplying pad mounted transformer) multi-function voltage relays picks-up and the B-side bus is energized, and the B-Side utility main breaker (MAIN B) is closed, then after a 2 second delay (adjustable):

(1) If closed and connected, the A-side utility main circuit breaker (MAIN A) shall open.

If the A-Side bus is de-energized with the utility main breaker (MAIN A) open or disconnected, the B-Side bus is energized, and B-Side utility main breaker (MAIN B) is closed, then after a 2 second delay (adjustable):

(1) If open and connected, the utility tie breaker (TIE) shall close.

A-Side normal utility source return re-transfer control:

If the utility voltage returns to the A-Side (MAIN A) main for a stabilization period adjustable from 1 to 120 seconds initially set at 60 seconds, the A-Side utility main breaker (MAIN A) is open and connected, the B-Side utility main (MAIN B) is closed and connected, and the B-side bus is energized, then:

If open transition mode is selected, then:

(1) If closed and connected, the utility tie (TIE) is opened.

(2) If the utility tie (TIE) is open or disconnected, the utility main (MAIN A) is closed after 1 second (adjustable delay).

If closed transition mode is selected, and utility-utility source voltage synchronization is verified, then:

(1) The A-side utility main breaker (UTIL A) is closed.

(2) Upon the utility main (UTIL A) verified closed, the utility tie (TIE) is immediately opened if closed and connected.

If the A-side utility main (MAIN A) is not closed within 5 seconds of being commanded the PLC shall then:

(1) Turn off the close command to A-Side main (MAIN A)

(2) Verify the A-Side utility main breaker (MAIN A) is open.

(3) If open and connected, close the TIE.

(4) Change the switchboard mode to MANUAL/

c. A discrete indication of "Automatic" mode shall be sent to KCCS via a set of contacts.

2.3.5.3 Manual Operation

The "Manual" transfer mode is designed to give either a local operator by

using the touch screen or the KCCS operator (at a remote location) complete control of the switchboard. The operator takes control of the switchboard by enabling or disabling the 'Automatic' transfer mode. An indicator light visually seen on the front of the switchboard shall illuminate while in the 'Manual' transfer mode. When the KCCS operator remotely engages the 'Manual' transfer mode, the circuit breakers will remain in their current positions and the following shall apply:

a. Breaker 'Open' functions shall operate directly from KCCS commands and touch screen display.

b. Breaker 'Close' functions shall operate by KCCS and touch screen after verification of the sync-check relay and respective breaker trip lockout device. Hardwired block close interlocks shall not be defeated.

c. Open Transition mode shall prevent the paralleling of the utility main and utility tie breakers.

d. Closed Transition mode (selectable from the touch screen) enables closed transition switching if the sources are synchronized per the settings on the synchronization relay.

e. Utility main and tie breaker controls shall be electrically interlocked so that at the most two of the three breakers (M-T-M) can be closed for an extended amount of time. If two out of the three breakers are closed and if the third breaker is called to close, the source feeders shall be verified through the sync-check relays that each source feeder is synchronized before the third breaker is closed. Upon breaker closure the previously selected utility main or tie breaker shall be immediately tripped to minimize parallel operation.

f. A discrete indication of "Manual" mode shall be sent to KCCS via a set of contacts.

2.4 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.5 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each switchboard and device. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.6 COORDINATED POWER SYSTEM PROTECTION

Provide a power system study as specified in Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS. Set switchboard protective devices in accordance with the approved study

submittal.

PART 3 EXECUTION

3.1 CERTIFICATION TESTING

Perform Certification Testing showing Switchboard Monitoring and Communication System. Compliance Certification Testing must include a Government witness qualification demonstration of at least, but not limited to the following equipment if the proposed hardware has not been previously approved (current approved hardware is from Square D):

Circuit breakers

Trip units

PLC

Meters

Submit certificate of compliance showing completion of certification testing.

3.2 FACTORY TESTING

Factory witness testing (source inspection), at Government's option, must occur at the switchboard manufacturer. The switchboard manufacturer must checkout the switchboard assembly as a connected system. The switchboard manufacturer must demonstrate that the communications system provided under this project communicates efficiently with the Citect software in accordance with the requirements in the paragraph entitled "switchboard Monitoring and Control Systems" of this section.

Tests on switchboard assemblies must include polarity verification, grounding of instrument transformer casing test, mechanical operation tests, electrical operation and control wiring tests including circuit continuity, relay and metering circuit performance tests, and dielectric tests. Conduct tests in accordance with IEEE 4 and UL 467.

Manufacturer must provide written test results for all tests performed. Submit test reports to the Contracting Officer prior to shipping equipment.

3.3 INSTALLATION

Installation must conform to IEEE C2 and NFPA 70.

Electrically and mechanically connect the complete assembly at the site from coordinated subassemblies shipped in complete sections from the manufacturer. Carefully align, level, and secure complete installation in conformance with the manufacturer's recommendations.

Carefully join separated switchboard assemblies to present a neat appearance, with main and ground bus joints tightened to the manufacturers recommended torque values. Handle assemblies with appropriate lifting devices.

Submit Installation Drawings for the switchboard assemblies. Include in drawings complete details of equipment layout and design. Include a plan drawing showing all electrical underground installation (duct banks,

conduits, and grounding) that meets the design requirements indicated on the drawings but is coordinated to actual equipment provisions provided.

3.4 FIELD TESTING

The switchboard manufacturer must provide the test equipment, labor and technical expertise for testing and checkout of the switchboard assembly as a connected system after it is installed. Provide manufacturer's written test results for all tests performed. Submit test reports including Certificate of Compliance to the Contracting Officer prior to energizing equipment. Replace any material, equipment or devices found to be defective at no cost to the Government.

Comply with NETA ATS and NETA MAINT for electrical acceptance tests of transformers, switchboard, breakers, relaying, metering and all related material, including secondary current injection tests and manufacturers recommendations. Submit a testing procedure 30 calendar days prior to field testing. Include in the testing procedure a complete functional testing of the entire system which evaluates the functionality and performance of all control and automatic sequencing and operation of the switchboard.

Additional testing to those described in NETA ATS and NETA MAINT are as follows:

a. Demonstrate switchboard automatic transfer schemes in all configurations and all modes, timing functions and interlocks for breakers operate as specified.

b. Remove all controls and DC power from PLC/PC and verify when power is restored, programming automatically recovers with no anomalies. This test must ensure fully functional programming is restored and ready to operate on restoration of power to PLC/PC. Perform this test three separate times.

c. Demonstrate control voltage automatic transfer relay and components until on properly.

d. Functionally verify SMCS system through the Ethernet connection fully operational and all I/O functions are as specified.

e. Demonstrate switchboard local/remote switch, if installed, and associated breaker manual control switches operate as specified.

Perform switchboard testing in accordance with Section 019113 COMISSIONING separate from all testing specified in this section.

Final acceptance is dependent upon the satisfactory performance of the equipment under test. Provide final test data to the Contracting Officer.

3.5 RELAY SETTINGS AND TESTS

Properly coordinate all circuit-interrupting devices before the switchboard assemblies are energized. Thoroughly inspect and adjust protective relays at the site in the presence of and at the discretion of the Contracting Officer.

3.6 FIELD TESTING FOR COMMUNICATIONS

3.6.1 Field Quality Control

Furnish the services of a manufacturer's representative and Controls Specialist to assist in starting-up and programming the system. The manufacturer's representative must be factory-trained and have a thorough knowledge of the software, hardware, and system programming. Provide the following services:

a. Perform full functionality tests on the communications network from all IEDs to the Ethernet gateway.

b. Setting all the addresses of all devices in the equipment.

c. Verifying and troubleshooting the integrity of the data line.

d. Assisting the Government in correcting any data line problems.

e. Configure the SMCS software to match the field devices.

3.6.2 Field Testing

Verify complete system operation including all hardware, software and communication devices. Verify networking performance with all interfacing systems by other manufacturers.

Perform all applicable inspections and electrical tests, including optional tests, in accordance with NETA ATS for all switchboard equipment including but not limited to:

a. switchboard Assemblies
b. Circuit Breakers, Air Low-Voltage Power
c. Protective Relays
d. Instrument Transformers
e. Metering Devices
f. Grounding Systems
g. Ground-Fault Protection Systems, Low Voltage
h. Surge Arresters, Low Voltage

3.6.3 Manufacturers Certification

A qualified factory-trained manufacturer's representative must certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.6.4 Training

Furnish the services of manufacturer representatives to train the owner's personnel in operation and programming of the system. The manufacturer representatives must be factory-trained and must have a thorough knowledge of the switchboard, PLC and touch-screen software, hardware and system programming. Include in the training session on the PLC and all controls:

a. Switchboard on-site training

(1) Full operation demonstrations of all functions.

(2) Breaker electrical and mechanical operations.

(3) Explanations and instructions for all protective devices.

b. Classroom on-site training for programming the touch screen.

3.6.5 After Start-Up Support

The manufacturer must provide a 24-hour 800 telephone number manned with Engineers/Technicians expert in SMCS devices, software and communication system troubleshooting or capable of providing technical information. Provide this support at no cost to the Government for a period of five years.

3.7 ENERGIZING SWITCHBOARD ASSEMBLIES

Do not energize switchboard assembly until it is completely installed, tested, approved by the Contracting Officer, and ready for operation. Site testing must be conducted and approved by the Contracting Officer.

Using ammeter, voltmeter, and wattmeter or phase-angle meter, the values and polarities of voltage and current, measure and compare with those expected in the various relay circuits. Inspect and note all contact positions of directional elements and the voltage relays.

After inspection and satisfactory tests have been completed on all active relay circuits under a no-load condition, perform an operational test with diverted load currents or simulated ground faults on each relay.

Prepare a comprehensive report with records of connections, electrical constants, settings, test values, operating performance, and failures or weaknesses found on test.

Tests and procedures for testing must be in accordance with the paragraph entitled "Field Testing" in this section and the manufacturer's recommendations. Upon completion of all testing and approval of the Contracting Officer, the switchboard must be energized, as approved by the Contracting Officer.

3.8 GROUNDING

3.8.1 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.9 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.9.1 Switchboard

ANSI/NEMA PB 2.1.

3.9.2 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.9.3 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.9.4 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.10 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.10.1 Interior Location

Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 4 inches thick. The top of the concrete slab shall be approximately 4 inches above finished floor. Edges above floor shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.11 FIELD QUALITY CONTROL

3.11.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS and Section 26 08 00 APPARATUS INSPECTION AND TESTING, with the additions and modifications specified herein.

3.11.1.1 Switchboard Assemblies

a. Perform applicable inspections and electrical tests for switchboard and molded case circuit breaker equipment including but not limited to:

   1. Compare equipment nameplate data with specifications and approved shop drawings.

   2. Inspect physical, electrical, and mechanical condition.

   3. Verify appropriate anchorage, required area clearances, and correct alignment.

   4. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

   5. Verify that circuit breaker sizes and types correspond to approved shop drawings.

   6. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter and by verifying tightness of

accessible bolted electrical connections by calibrated torque-wrench method.

7. Clean switchboard.

8. Inspect insulators for evidence of physical damage or contaminated surfaces.

9. Exercise all active components.

b. Electrical Tests

1. Perform insulation-resistance tests on each bus section.

2. Verify operation of switchboard heaters.

3.11.1.2 Circuit Breakers

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect circuit breaker for correct mounting.

3. Operate circuit breaker to ensure smooth operation.

4. Inspect case for cracks or other defects.

5. Inspect all bolted electrical connections for high resistance using low resistance ohmmeter and verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method.

b. Electrical Tests

1. Perform breaker adjustments for final settings in accordance with Government provided settings.

3.11.1.3 Grounding System

a. Perform inspections and electrical tests in accordance to include the following:

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1. Measure bond resistance between the switchboard ground bus and the supplying source ground bus and between the switchboard ground bus and the earth ground.

3.11.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function.

Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

SECTION 26 23 01

EMERGENCY SWITCHBOARDS
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D1535	(2012) Specifying Color by the Munsell System
ASTM D709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012) National Electrical Safety Code
IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA PB 2.1	(2007) General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 V or Less
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products
NEMA PB 2	(2011) Deadfront Distribution Switchboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Grounding and Bonding Equipment
UL 891	(2005) Switchboards

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.3.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchboard Drawings; G

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

All Shop Drawings shall be computer aided design (CAD) generated. Provide Digital media compact disc (CD) with all submittals including .DWG or .DXF files for all drawings. Also on this CD provide a complete copy of the drawings in PDF format.

Submit Shop Drawings for approval prior to equipment manufacturing.

Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made.

SD-03 Product Data

Switchboard; G

SD-06 Test Reports

Acceptance checks and tests; G

Submit test forms showing compliance with NETA ATS inspections and tests for approval prior to testing.

Submit completed test forms showing the results of all inspections and tests in accordance with NETA ATS inspections and tests after inspections and testing is complete.

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G

1.5 QUALITY ASSURANCE

1.5.1 Switchboard Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the switchboard including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

c. Manufacturer's standard switchboard application, installation, operation and maintenance manuals.

1.5.2 Switchboard Drawings

Drawings shall include, but are not limited to the following:

a. One-line diagram including breakers

b. Outline drawings including front elevation, section views, footprint, and overall dimensions

c. Bus configuration including dimensions and ampere ratings of bus bars

d. Markings and NEMA nameplate data

e. Circuit breaker type, interrupting rating, and trip devices, including available settings

1.5.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4.1 Material and Equipment Manufacturing Date

Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.2 Assembled Operation and Maintenance Manuals

Manuals shall be assembled and bound securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data."

b. Catalog data required by the paragraph entitled, "SD-03, Product Data."

c. Drawings required by the paragraph entitled, "SD-02, Shop Drawings." Drawings shall be "as-built" indicating all changes made during the installation.

d. Spare parts and supply list.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SWITCHBOARD

NEMA PB 2 and UL 891.

2.2.1 Ratings

The voltage rating of the switchboard shall be 480 volts, 3 phase, 3-wire. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall be as indicated. The switchboard shall be UL listed and labeled for its intended use.

2.2.2 Construction

The switchboards shall be dead-front switchboards conforming to NEMA PB 2 and labeled under UL 891. The switchboards shall be completely enclosed self-supporting metal structures with the required number of vertical panel sections, buses, and molded-case circuit breakers as shown on the drawings. Switchboards shall be fully rated for a short-circuit current indicated.

Switchboard shall consist of vertical sections bolted together to form a rigid assembly and shall be front and rear aligned. All circuit breakers shall be front accessible. Switchboards shall have front accessible load connections. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections.

2.2.2.1 Enclosure

The switchboard enclosure shall be indoor NEMA 1 or outdoor NEMA 3R

stainless steel (ASTM A167 Type 304 or 304L) per NEMA ICS 6 as indicated built with selected smooth panels not less than 14 gauge. Exposed panels on the front and ends shall have bent angle or channel edges with all corner seams welded and ground smooth. The front outside surfaces shall not be drilled or welded for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front. The front panels shall be made in sections flanged on four sides and attached to the framework by screws and arranged for ready removal for inspection or maintenance.

The switchboard shall be provided with barriers between emergency and standby sections. The switchboard shall include instrument transformers, and metering as indicated, and space heaters.

Enclosure shall be bolted together with removable bolt-on covers, and sloping roof downward toward the rear. Front doors shall be provided with stainless steel padlockable vault handles with a three point catch. Ventilating openings shall be provided as required and shall be of the grille or louver type. All ventilating openings shall be provided with corrosion-resistant, inspect-proof screens on the inside.

Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of ASTM A167 type 304 or 304L stainless steel for outdoor units and galvanized steel for indoor units. Base shall include any part of enclosure that is within 3 inches of concrete pad. Galvanized steel shall be ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

Paint enclosure, including bases, ASTM D1535 light gray No. 61 or No. 49. Paint coating system shall comply with IEEE C57.12.28 for galvanized steel and IEEE C57.12.29 for stainless steel. Treat all interior and exterior steel parts to inhibit corrosion.

2.2.2.2 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide copper ground bus secured to each vertical section along the entire length of the switchboard. The neutral bus shall be rated 100 percent of the main bus continuous current rating as indicated.

2.2.2.3 Main and Distribution Sections

The main and distribution sections shall consist of individually mounted, molded-case circuit breakers as indicated. Provide all circuit breakers with lockout/tag-out attachment.

Provide integral factory installed surge suppression equipment in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.2.3 Protective Device

2.2.3.1 Molded-Case Circuit Breaker

Provide molded-case circuit breakers in accordance with Section

26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

The trip units on all molded-case circuit breakers shall communicate MODBUS through the respective CM 4250 ECC RS 485 connection the reportable information for power and energy.

All breakers must be equipped with auxiliary position contact for monitoring the switchboard "Monitoring and Control" system.

All breakers must be equipped with factory installed lockout provisions.

2.2.4 Electrical Power Monitoring System

Provide the following metering equipment:

a. Main: Where indicated, provide metering equipment to monitor energy usage on the circuit indicated. For compatibility, metering equipment shall be NASA KSC Standard, Schneider Electric Square D CM4250 with ECC21 Ethernet communications card, IOC input/output card, and CMDLC backlit LCD display, and no other. Provide meter appurtenances, including cables, as required for complete and proper operation. Metering equipment shall conform to Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Install metering equipment in accordance with the metering equipment manufacturers published installation instructions. Mount metering equipment in strict accordance with the orientation recommendations of the metering equipment manufacturer. Mount LCD display on the front panel of the compartment containing the circuit being monitored.

b. Provide 1200:5 current transformers and three-phase potential transformers in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.3 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.4 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each switchboard and device. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.5 COORDINATED POWER SYSTEM PROTECTION

Provide a power system study as specified in Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS. Set switchboard protective devices in accordance with the approved study submittal.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

3.2.1 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Switchboard

ANSI/NEMA PB 2.1.

3.3.2 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.3.3 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.3.4 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.4.1 Exterior Location

Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 by 6 inch No. 6 mesh placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. The top of the concrete slab shall be approximately 4 inches above the finished grade. Edges above grade shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4.2 Interior Location

Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 4 inches thick. The top of the concrete slab shall be approximately 4 inches above finished floor. Edges above floor shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS and Section 26 08 00 APPARATUS INSPECTION AND TESTING, with the additions and modifications specified herein.

3.5.1.1 Switchboard Assemblies

a. Perform applicable inspections and electrical tests for switchboard and molded case circuit breaker equipment including but not limited to:

   1. Compare equipment nameplate data with specifications and approved shop drawings.

   2. Inspect physical, electrical, and mechanical condition.

   3. Verify appropriate anchorage, required area clearances, and correct alignment.

   4. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

   5. Verify that circuit breaker sizes and types correspond to approved shop drawings.

   6. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter and by verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

   7. Clean switchboard.

   8. Inspect insulators for evidence of physical damage or contaminated surfaces.

   9. Exercise all active components.

b. Electrical Tests

   1. Perform insulation-resistance tests on each bus section.

   2. Verify operation of switchboard heaters.

3.5.1.2 Circuit Breakers

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect circuit breaker for correct mounting.

3. Operate circuit breaker to ensure smooth operation.

4. Inspect case for cracks or other defects.

5. Inspect all bolted electrical connections for high resistance using low resistance ohmmeter and verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method.

b. Electrical Tests

1. Perform breaker adjustments for final settings in accordance with Government provided settings.

3.5.1.3 Metering and Circuit Breaker Monitoring

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings for meters, instrument transformers and Static Trip Units (provide with the circuit breakers).

2. Inspect meters, instrument transformers and Static Trip Units (provided with the circuit breakers) for correct mounting.

3. Inspect case for cracks or other defects.

b. Electrical Tests

1. Perform checks for metering and circuit breakers monitoring and verify they are in compliance with the specifications.

3.5.1.4 Grounding System

a. Perform inspections and electrical tests in accordance to include the following:

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1. Measure bond resistance between the switchboard ground bus and the supplying source ground bus and between the switchboard ground bus and the earth ground.

3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in

good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

SECTION 26 29 23

VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 519	(1992; R 1993; Errata 2004) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 3.1	(2009) Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA ICS 7	(2006) Adjustable-Speed Drives

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(2009; Reprint Jun 2011) Molded-Case

	Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 508C	(2002; Reprint Nov 2010) Power Conversion Equipment

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING, and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements

1.3.1.1 Electromechanical and Electrical Components

Electrical and electromechanical components of the Variable Frequency Drive (VFD) shall not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.

1.3.2 Electrical Requirements

1.3.2.1 Power Line Surge Protection

IEEE C62.41.1 and IEEE C62.41.2, IEEE 519 Control panel shall have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge arrestor shall be mounted near the incoming power source and properly wired to all three phases and ground. Fuses shall not be used for surge protection.

1.3.2.2 Sensor and Control Wiring Surge Protection

I/O functions as specified shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Schematic diagrams; G

Interconnecting diagrams; G

Installation drawings; G

Submit drawings for government approval prior to equipment construction or integration. Modifications to original drawings made during installation shall be immediately recorded for inclusion into the as-built drawings.

SD-03 Product Data

Variable frequency drives; G

Wires and cables; G

Equipment schedule

Include data indicating compatibility with motors being driven.

SD-06 Test Reports

VFD Test; G

Performance Verification Tests; G

Endurance Test

SD-08 Manufacturer's Instructions

Installation instructions

SD-09 Manufacturer's Field Reports

VFD Factory Test Plan; G

Factory test results

SD-10 Operation and Maintenance Data

Variable frequency drives, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Provide service and maintenance information including preventive maintenance, assembly, and disassembly procedures. Include electrical drawings from electrical general sections. Submit additional information necessary to provide complete operation, repair, and maintenance information, detailed to the smallest replaceable unit. Include copies of as-built submittals. Provide routine preventative maintenance instructions, and equipment required. Provide instructions on how to modify program settings, and modify the control program. Provide instructions on drive adjustment, trouble-shooting, and configuration. Provide instructions on process tuning and system calibration.

1.5 QUALITY ASSURANCE

1.5.1 Schematic Diagrams

Show circuits and device elements for each replaceable module. Schematic diagrams of printed circuit boards are permitted to group functional

assemblies as devices, provided that sufficient information is provided for government maintenance personnel to verify proper operation of the functional assemblies.

1.5.2 Interconnecting Diagrams

Show interconnections between equipment assemblies, and external interfaces, including power and signal conductors. Include for enclosures and external devices.

1.5.3 Installation Drawings

Show floor plan of each site, with V.F.D.'s and motors indicated. Indicate ventilation requirements, adequate clearances, and cable routes.

1.5.4 Equipment Schedule

Provide schedule of equipment supplied. Schedule shall provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule shall include the total quantity of each item of equipment supplied. For complete assemblies, such as VFD's, provide the serial numbers of each assembly, and a sub-schedule of components within the assembly. Provide recommended spare parts listing for each assembly or component.

1.5.5 Installation instructions

Provide installation instructions issued by the manufacturer of the equipment, including notes and recommendations, prior to shipment to the site. Provide operation instructions prior to acceptance testing.

1.5.6 Factory Test Results

Document test results and submit to government within 7 working days after completion of test.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 WARRANTY

The complete system shall be warranted by the manufacturer for a period of one year, or the contracted period of any extended warrantee agreed upon by the contractor and the Government, after successful completion of the acceptance test. Any component failing to perform its function as specified and documented shall be repaired or replaced by the contractor at no additional cost to the Government. Items repaired or replaced shall be warranted for an additional period of at least one year from the date that it becomes functional again, as specified in the FAR CLAUSE 52.246-21.

1.8 MAINTENANCE

1.8.1 Spare Parts

Manufacturers provide spare parts in accordance with recommended spare parts list.

1.8.2 Maintenance Support

During the warranty period, the Contractor shall provide on-site, on-call maintenance services by Contractor's personnel on the following basis: The service shall be on a per-call basis with 36 hour response. Contractor shall support the maintenance of all hardware and software of the system. Various personnel of different expertise shall be sent on-site depending on the nature of the maintenance service required. Costs shall include travel, local transportation, living expenses, and labor rates of the service personnel while responding to the service request. The provisions of this Section are not in lieu of, nor relieve the Contractor of, warranty responsibilities covered in this specification. Should the result of the service request be the uncovering of a system defect covered under the warranty provisions, all costs for the call, including the labor necessary to identify the defect, shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES (VFD)

Provide frequency drive to control the speed of induction motor(s). The VFD shall include the following minimum functions, features and ratings.

a. Input circuit breaker per UL 489 with a minimum of 65,000 amps symmetrical interrupting capacity and door interlocked external operator.

b. A converter stage per UL 508C shall change fixed voltage, fixed frequency, ac line power to a fixed dc voltage. The converter shall utilize a full wave bridge design incorporating diode rectifiers. Silicon Controlled Rectifiers (SCR) are not acceptable. The converter shall be insensitive to three phase rotation of the ac line and shall not cause displacement power factor of less than .95 lagging under any speed and load condition.

c. An inverter stage shall change fixed dc voltage to variable frequency, variable voltage, ac for application to a standard NEMA design B squirrel cage motor. The inverter shall be switched in a manner to produce a sine coded pulse width modulated (PWM) output waveform.

d. The VFD shall be capable of supplying 120 percent of rated full load current for one minute at maximum ambient temperature.

e. The VFD shall be designed to operate from a 480 volt, plus or minus 10 percent, three phase, 60 Hz supply, and control motors with a corresponding voltage rating.

f. Acceleration and deceleration time shall be independently adjustable from one second to 60 seconds.

g. Adjustable full-time current limiting shall limit the current to a preset value which shall not exceed 120 percent of the controller rated current. The current limiting action shall maintain the V/Hz ratio constant so that variable torque can be maintained. Short time starting override shall allow starting current to reach 175 percent of controller rated current to maximum starting torque.

h. The controllers shall be capable of producing an output frequency over the range of 3 Hz to 60 Hz (20 to one speed range), without low speed cogging. Over frequency protection shall be included such that a failure in the controller electronic circuitry shall not cause frequency to exceed 110 percent of the maximum controller output frequency selected.

i. Minimum and maximum output frequency shall be adjustable over the following ranges: 1) Minimum frequency 3 Hz to 50 percent of maximum selected frequency; 2) Maximum frequency 40 Hz to 60 Hz.

j. The controller efficiency at any speed shall not be less than 96 percent.

k. The controllers shall be capable of being restarted into a motor coasting in the forward direction without tripping.

l. Interlock control circuits with driven motor's disconnect switch where such motor disconnect switches are provided. Disconnecting on-line motor shall shut down controller. Controller shall restart upon reconnection of motor.

m. Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controllers to any of the following conditions shall not result in component failure or the need for fuse replacement:

1. Short circuit at controller output

2. Ground fault at controller output

3. Open circuit at controller output

4. Input undervoltage

5. Input overvoltage

6. Loss of input phase

7. AC line switching transients

8. Instantaneous overload

9. Sustained overload exceeding 115 percent of controller rated current

10. Over temperature

11. Phase reversal

n. Solid state motor overload protection shall be included such that current exceeding an adjustable threshold shall activate a 60 second timing circuit. Should current remain above the threshold continuously for the timing period, the controller will automatically shut down.

o. A slip compensation circuit shall be included which will sense changing motor load conditions and adjust output frequency to provide speed regulation of NEMA B motors to within plus or minus 0.5 percent

of maximum speed without the necessity of a tachometer generator.

p. The VFD shall be factory set for manual restart after the first protective circuit trip for malfunction (overcurrent,undervoltage, overvoltage or overtemperature) or an interruption of power. The VFD shall be capable of being set for automatic restart after a selected time delay. If the drive faults again within a specified time period (adjustable 0-60 seconds), a manual restart will be required.

q. The VFD shall include external fault reset capability. All the necessary logic to accept an external fault reset contact shall be included.

r. Provide critical speed lockout circuitry to prevent operating at frequencies with critical harmonics that cause resonant vibrations. The VFD shall have a minimum of three user selectable bandwidths.

s. Provide the following operator control and monitoring devices mounted on the front panel of the VFD:

   1. Manual speed potentiometer.

   2. Hand-Off-Auto (HOA) switch.

   3. Power on light.

   4. Drive run power light.

   5. Fault light.

   6. Bypass light.

   7. Local display.

   8. Main breaker ON/OFF disconnect handle.

   9. Drive OFF - BYPASS switch.

t. Provide properly sized NEMA rated by-pass and isolation contactors to enable operation of motor in the event of VFD failure. Mechanical and electrical interlocks shall be installed between the by-pass and isolation contactors. Provide a selector switch and transfer delay timer.

u. Provide the following monitoring device connetions on an interface terminal strip within the VFD enclosure:

   1. Output speed (4-20 milli-amp DC) or (0-10 Volts DC) as required by equipment.

   2. Drive in AUTO (dry contact)

   3. Drive in MANUAL (dry contact)

   4. Drive in Bypass (dry contact)

   5. Drive Fault (dry contact).

   6. AC input power status (dry contact

2.2 ENCLOSURES

Provide equipment enclosures conforming to NEMA 250, NEMA ICS 7, NEMA ICS 6.

2.3 WIRES AND CABLES

All wires and cables shall conform to NEMA 250, NEMA ICS 7, NFPA 70.

2.4 NAMEPLATES

Nameplates external to NEMA enclosures shall conform with the requirements of Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS. Nameplates internal to enclosures shall be manufacturer's standard, with the exception that they must be permanent.

2.5 SOURCE QUALITY CONTROL

2.5.1 VFD Factory Test Plan

To ensure quality, each VFD shall be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test plans and test reports.

PART 3 EXECUTION

3.1 INSTALLATION

Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings. A field representative of the drive manufacturer shall supervise the installation of all equipment, and wiring.

3.2 FIELD QUALITY CONTROL

Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Contractor shall conduct performance verification tests in the presence of Government representative, observing and documenting complete compliance of the system to the specifications. Contractor shall submit a signed copy of the test results, certifying proper system operation before scheduling tests.

3.2.1 VFD Test

Perform all applicable inspections and electrical tests, including optional tests, in accordance with the manufacturer's requirements, NETA ATS, and Section 26 08 00 APPARATUS INSPECTION AND TESTING.

A proposed test plan shall be submitted to the contracting officer at least 28 calendar days prior to the proposed testing for approval. The tests shall conform to NEMA ICS 1, NEMA ICS 7, NETA ATS and all manufacturer's safety regulations. The Government reserves the right to witness all tests and review any documentation. The contractor shall inform the Government at least 14 working days prior to the dates of testing. Contractor shall provide video tapes, if available, of all training provided to the Government for subsequent use in training new personnel. All training aids, texts, and expendable support material for

a self-sufficient presentation shall be provided, the amount of which to be determined by the contracting officer.

3.2.2 Performance Verification Tests

"Performance Verification Test" plan shall provide the step by step procedure required to establish formal verification of the performance of the VFD. Compliance with the specification requirements shall be verified by inspections, review of critical data, demonstrations, and tests. The Government reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements. The contractor shall inform the Government 14 calendar days prior to the date the test is to be conducted.

3.2.3 Endurance Test

Immediately upon completion of the performance verification test, the endurance test shall commence. The system shall be operated at varying rates for not less than 192 consecutive hours, at an average effectiveness level of .9998, to demonstrate proper functioning of the complete PCS. Continue the test on a day-to-day basis until performance standard is met. During the endurance test, the contractor shall not be allowed in the building. The system shall respond as designed.

3.3 DEMONSTRATION

3.3.1 Training

Coordinate training requirements with the Contracting Officer.

3.3.1.1 Instructions to Government Personnel

Provide the services of competent instructors who will give full instruction to designated personnel in operation, maintenance, calibration, configuration, and programming of the complete control system. Orient the training specifically to the system installed. Instructors shall be thoroughly familiar with the subject matter they are to teach. The Government personnel designated to attend the training will have a high school education or equivalent. The number of training days of instruction furnished shall be as specified. A training day is defined as eight hours of instruction, including two 15-minute breaks and excluding lunch time; Monday through Friday. Provide a training manual for each student at each training phase which describes in detail the material included in each training program. Provide one additional copy for archiving. Provide equipment and materials required for classroom training. Provide a list of additional related courses, and offers, noting any courses recommended. List each training course individually by name, including duration, approximate cost per person, and location of course. Unused copies of training manuals shall be turned over to the Government at the end of last training session.

3.3.1.2 Operating Personnel Training Program

Provide three 4 hour training session at the site at a time and place mutually agreeable between the Contractor and the Government. Provide session to train 6 operation personnel in the functional operations of the system and the procedures that personnel will follow in system operation. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. Alarm formats

e. Failure recovery procedures

f. Troubleshooting

3.3.1.3 Engineering/Maintenance Personnel Training

Accomplish the training program as specified. Training shall be conducted on site at a location designated by the Government. Provide a one day training session to train 6 engineering personnel in the functional operations of the system. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. System configuration

e. Alarm formats

f. Failure recovery procedures

g. Troubleshooting and repair

h. Maintenance and calibration

i. System programming and configuration

-- End of Section --

SECTION 26 32 15.00 10

DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES
10/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-10	(2010; Change 2010; Change 2011; Errata 2011; Change 2011) Minimum Design Loads for Buildings and Other Structures

ASME INTERNATIONAL (ASME)

ASME B16.11	(2011) Forged Fittings, Socket-Welding and Threaded
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.1	(2012; INT 2-6, 8-10, 13, 15, 17-25, 27-31 and 42-46) Power Piping
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A 106/A 106M	(2008) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 181/A 181M	(2006) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A 234/A 234M	(2007) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,

	Welded and Seamless
ASTM D 975	(2008ae1) Standard Specification for Diesel Fuel Oils

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

EGSA 101P	(1995) Engine Driven Generator Sets

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2012) National Electrical Safety Code
IEEE C57.13.1	(2006) Guide for Field Testing of Relaying Current Transformers
IEEE Std 1	(2000; R 2005) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms
IEEE Std 115	(1995; R 2002) Test Procedures for Synchronous Machines: Part I: Acceptance and Performance Testing; Part II: Test Procedures and Parameter Determination for Dynamic Analysis
IEEE Std 120	(1989; R 2007) Master Test Guide for Electrical Measurements in Power Circuits
IEEE Std 43	(2000; R 2006) Testing Insulation Resistance of Rotating Machinery
IEEE Std 519	(1992; Errata 2004) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-80	(2008) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.11	(2007) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA MG 1	(2011; Errata 2012) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 110	(2013) Standard for Emergency and Standby Power Systems
NFPA 30	(2012) Flammable and Combustible Liquids Code
NFPA 37	(2006) Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2014) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J537	(2000) Storage Batteries

UNDERWRITERS LABORATORIES (UL)

UL 1236	(2006) Standard for Safety Battery Chargers for Charging Engine-Starter Batteries
UL 1446	(2007) Systems of Insulating Materials - General

1.2 SYSTEM DESCRIPTION

a. Provide and install each engine-generator set complete and totally functional, with all necessary ancillary equipment to include: air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Install each engine-generator set ONLY after receipt of a copy of the final Air Construction Permit from the Florida Department of Environmental Protection (FDEP). The Government will obtain this permit. The first step of the 2-step permit application has been submitted. The final application requires data on the actual generator to be installed. This data will be obtained from the submittals required herein. The Contractor shall submit the Air Construction Permit application to FDEP through the NASA Environmental Assurance Branch (EAB).

b. Each set shall consist of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and other necessary ancillary equipment which may be mounted separately. Sets having a capacity of 750 kW or smaller shall be assembled and attached to the base prior to shipping. Sets over 750 kW capacity may be shipped in sections. Each set component shall be environmentally suitable for the location shown and shall be the manufacturer's standard product offered in catalogs for commercial or industrial use. Any nonstandard products or components and the reason for their

use shall be specifically identified in paragraph SUBMITTALS.

c. Engine-generator sets and associated main fuel tank specified in Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS, shall together form a Standby Power System installed in accordance with NFPA 110.

d. Each generator set shall be Standby rated and emissions shall be certified by the manufacturer to meet EPA Tier 2 requirements.

e. Auxiliary equipment with each generator set includes but is not limited to the following:

Fuel day tank.

Fuel filter manifold (Raycor or equal)

Battery charger.

Dual redundant engine starting motors and batteries.

Starting aids (heaters).

Generator winding heater.

Enclosure lights and convenience receptacles.

Power panelboard.

1.2.1 Rated Output Capacity

Each engine-generator set shall provide power equal to the sum of Service Load plus the machine's efficiency loss and associated ancillary equipment loads.

Each engine-generator set shall be sized to meet the following capacity and performance requirements:

a. Maximum running load of 800 kW/1,000 kVA at 480Y/277 volts and 60 Hz frequency.
b. Peak Transient Load: 759 SkW/886 SkVA.
c. Maximum Transient Load Step: 106 SkW/177 SkVA.
d. Maximum Running Non-linear Load: 735 RkVA.

The overall load is comprised of 8 block load steps:

Block Load Step 1 (ATS-1, <10 second transfer):
Load type: Emergency egress lighting and fan coil units serving IT racks with Paging and Area Warning system.
Load characteristics: Mostly lights and mechanical units.
Load step running load: 46 kW/50 kVA.
Load step transient: 900 SkW/121 SkVA.
Allowable voltage dip: 30%.
Allowable frequency dip: 30%.

Block Load Step 2 (ATS-2, <10 second transfer):
Load type: Uninterruptible power supplies (UPS), 100 kVA.
Load characteristics: 25% walk-in, 10% battery recharge.
Load step running load: 96 kW/113 kVA.
Load step transient: 24 SkW/28 SkVA.

Allowable voltage dip: 10%.
Allowable frequency dip: 10%.

Block Load Step 3 (ATS-FP):
Load type: Fire pump.
Load characteristics: Fire pump.
Load step running load: 80 kW/90 kVA.
Load step transient: 57 SkW/177 SkVA.
Allowable voltage dip: 20%.
Allowable frequency dip: 20%.

Block Load Step 4 (Future Phase 2 ATS-5, <10 second transfer):
Load type: Emergency egress lighting and fan coil units serving IT racks with Paging and Area Warning system.
Load characteristics: Mostly lights and mechanical units.
Load step running load: 33 kW/37 kVA.
Load step transient: 58 SkW/86 SkVA.
Allowable voltage dip: 20%.
Allowable frequency dip: 20%.

Block Load Step 5 (Future Phase 2 ATS-6, <10 second transfer):
Load type: Uninterruptible power supplies (UPS), 100 kVA.
Load characteristics: 25% walk-in, 10% battery recharge.
Load step running load: 96 kW/113 kVA.
Load step transient: 24 SkW/28 SkVA.
Allowable voltage dip: 10%.
Allowable frequency dip: 10%.

Block Load Step 6 (ATS-3):
Load type: Legally Required Standby, mostly mechanical loads (chilled water pumps, stairwell and elevator pressurization system) and elevators
Load characteristics: Mostly variable frequency drives (VFD)
Load step running load: 175 kW/194 kVA.
Load step transient: 106 SkW/158 SkVA.
Allowable voltage dip: 20%.
Allowable frequency dip: 20%.

Block Load Step 7 (Future Phase 2 ATS-7):
Load type: Legally Required Standby, mostly mechanical loads (chilled water pumps, stairwell and elevator pressurization system) and elevators.
Load characteristics: Mostly variable frequency drives (VFD).
Load step running load: 170 kW/189 kVA.
Load step transient: 89 SkW/130 SkVA.
Allowable voltage dip: 20%.
Allowable frequency dip: 20%.

Block Load Step 8 (ATS-4):
Load type: Optional Standby.
Load characteristics: Elevators.
Load step running load: 52 kW/58 kVA.
Load step transient: 64 SkW/116 SkVA.
Allowable voltage dip: 20%.
Allowable frequency dip: 20%.

1.2.2 Power Ratings

Power ratings shall be as specified and in accordance with EGSA 101P.

1.2.3 Transient Response

The engine-generator set governor and voltage regulator shall cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set shall respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

1.2.4 Reliability and Durability

Each engine-generator set shall have both an engine and a generator capable of delivering the specified power on a continuous basis (100% of the required power output for an unlimited number of hours per year). Two like engines and two like generators shall be cited that have performed satisfactorily in a stationary power plant, independent and separate from the physical location of the manufacturer's and assembler's facilities, for standby without any failure to start, including all periodic exercise. Each like engine and generator shall have had no failures resulting in downtime for repairs in excess of 72 hours during two consecutive years of service. Like engines shall be of the same model, speed, bore, stroke, number and configuration of cylinders, and rated output capacity. Like generators shall be of the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.

1.2.5 Engine-Generator Set Enclosure

The engine-generator set enclosure shall be walk-in type, corrosion resistant and fully weather resistant, painted in accordance with Section 09 90 00 PAINTS AND COATINGS. The enclosure shall contain all set components and provide ventilation to permit operation at Service Load under secured conditions. Doors shall be provided for access to controls and equipment requiring periodic maintenance or adjustment. Removable panels shall be provided for access to components requiring periodic replacement. The enclosure shall be capable of being removed without disassembly of the engine-generator set or removal of components other than the exhaust system. The enclosure shall be of the walk-in type. The enclosure shall reduce the noise of the generator set to within the limits specified in the paragraph SOUND LIMITATIONS. Anchor enclosure as required to meet the wind load requirements.

1.2.5.1 Wind Load Requirements

Engine-Generator set enclosure shall be designed to withstand wind loads and debris impact in accordance with the Florida Building Code and ASCE 7-10, including the following criteria:

a. Ultimate design wind speed (VULT): 160 mph (3 second gust).
b. Nominal design wind speed (VASD): 124 mph (3 second gust).
c. Building risk category: IV.
d. Wind exposure category: C.

Submit design analysis and supporting calculations performed in support of specified enclosure signed and sealed by Florida registered Structural Engineer.

1.2.6 Vibration Isolation

The engine-generator set shall be provided with a vibration-isolation system in accordance with the manufacturer's standard recommendation. Vibration-isolation systems shall be designed and qualified (as an integral part of the base and mounting system in accordance with the seismic parameters specified. Where the vibration-isolation system does not secure the base to the structure floor or unit foundation, seismic restraints shall be provided in accordance with the seismic parameters specified.

1.2.7 Harmonic Requirements

Non-linear loads to be served by each engine-generator set are as indicated. The maximum linear load demand (kVA @ PF) when non-linear loads will also be in use is as indicated.

1.2.8 Starting Time Requirements

Upon receipt of a signal to start, each engine generator set will start, reach rated frequency and voltage and be ready to assume load within the time specified. For standby sets used in emergency power applications, each engine generator set will start, reach rated frequency and voltage, and power will be supplied to the load terminals of the automatic transfer switch within the starting time specified.

1.2.9 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Drawings; G

Detailed drawings, as specified.

Acceptance; G

Drawings which accurately depict the as-built configuration of the installation, upon acceptance of the diesel-generator set installation. Revise layout drawings to reflect the as-built conditions and submit them with the as-built drawings.

Air Construction Permit; G

a. Prepare a complete Air Construction Permit application package that must be signed and sealed by a Florida registered

professional engineer.

b. Submit the draft application package to the NASA EAB for review.

c. Incorporate comments identified by the NASA EAB into the application package (in coordination with the professional engineer).

d. Submit the final application package to the NASA EAB who will obtain signatures from the Center Director's Office and submit the application package to FDEP.

e. Prepare responses (in coordination with the professional engineer) to any requests for additional information (RAI) from FDEP regarding the permit application package.

f. Submit RAI responses to the NASA EAB for submission to FDEP.

g. When FDEP issues the Construction Air Permit, the NASA EAB will forward the Construction Air Permit to the contractor.

SD-03 Product Data

Harmonic Requirements; G

Description of the generator features which mitigate the effects of the non-linear loads listed.

Heat Exchanger

Manufacturers data to quantify heat rejected to the space with the engine generator set at rated capacity.

Generator; G

Manufacturer's standard data for each generator (prototype data at the specified rating or above is acceptable), listing the following information:

a. Direct-Axis sub-transient reactance (per unit).

b. The generator kW rating and short circuit current capacity (both symmetric and asymmetric).

Manufacturer's Catalog; G

Manufacturer's standard catalog data describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance.

Site Welding

A copy of qualifying procedures and a list of names and identification symbols of qualified welders and welding operators. A letter listing the welder qualifying procedures for each welder, complete with supporting data such as test procedures used, what was tested to, and a list of the names of all welders and their identification symbols.

Spare Parts; G

List of spare parts, as specified.

Onsite Training

A letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the video taping service to be provided, and the kind and quality of the tape to be left with the Contracting Officer at the end of the instructional period.

Vibration-Isolation; G

Vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor. Description of seismic qualification of the engine-generator mounting, base, and vibration isolation.

Posted Data and Instructions; G

Posted data including wiring and control diagrams showing the key mechanical and electrical control elements, and a complete layout of the entire system.

Instructions; G

Instructions including: the manufacturers pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches). Instructions shall be weatherproof, laminated in plastic, and posted where directed.

Experience; G

Statement showing that each component manufacturer has a minimum of 3 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler has a minimum of 3 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

Field Engineer; G

A letter listing the qualifications, schools, formal training, and experience of the field engineer.

General Installation; G

A copy of the manufacturer's installation procedures and a detailed description of the manufacturer's recommended break-in procedure.

SD-05 Design Data

Performance Criteria; G

Calculations of the engine and generator output power capability, including efficiency and parasitic load data.

Sound Limitations; G

Sound power level data for the packaged unit operating at 100 percent load in a free field environment. The data should demonstrate compliance with the sound limitation requirements of this specification.

Day Tank; G

Calculations for the capacity of each day tank, including allowances for recirculated fuel, usable tank capacity, and duration of fuel supply.

Power Factor; G

The generator capability curve showing generator kVA output capability (kW vs. kvar) for both leading and lagging power factors ranging from 0 to 1.0.

Time-Delay on Alarms; G

The magnitude of monitored values which define alarm or action set points, and the tolerance (plus and/or minus) at which the devices activate the alarm or action for items contained within the alarm panels.

Battery Charger; G

Battery charger sizing calculations.

SD-06 Test Reports

Factory Inspection and Tests; G

Six complete reproducible copies of the factory inspection result on the checklist format specified in paragraph FACTORY INSPECTION AND TESTS.

Factory Tests; G

a. A letter giving notice of the proposed dates of factory inspections and tests at least 14 days prior to beginning tests.

b. A detailed description of the manufacturer's procedures for factory tests at least 14 days prior to beginning tests.

c. Six copies of the Factory Test data described below in 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size (8-1/2 by 11 inch minimum), showing grid lines, with full resolution.

(1) A detailed description of the procedures for factory tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

(4) The date of testing.

(5) A list of the parameters verified.

(6) The condition specified for the parameter.

(7) The test results, signed and dated.

(8) A description of adjustments made.

Onsite Inspection and Tests; G

a. A letter giving notice of the proposed dates of onsite inspections and tests at least 14 days prior to beginning tests.

b. A detailed description of the Contractor's procedures for onsite tests including the test plan and a listing of equipment necessary to perform the tests. Submission shall be at least days prior to beginning tests.

c. Six copies of the onsite test data described below in 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size (8-1/2 by 11 inch minimum), showing grid lines, with full resolution.

(1) A detailed description of the procedures for onsite tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

(4) The date of testing.

(5) A list of the parameters verified.

(6) The condition specified for the parameter.

(7) The test results, signed and dated.

(8) A description of adjustments made.

SD-07 Certificates

Cooling System; G

A letter which certifies that the engine-generator set and cooling system function properly in the ambient temperature specified, stating the following values:

a. The maximum allowable inlet temperature of the coolant fluid.

b. The minimum allowable inlet temperature of the coolant fluid.

c. The maximum allowable temperature rise in the coolant fluid through the engine.

Vibration Isolation; G

Torsional analysis including prototype testing or and calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, ± 10 percent.

Prototype Test

Manufacturer's standard certification that prototype tests were performed for the generator model proposed.

Reliability and Durability

A reliability and durability certification letter from the manufacturer and assembler to prove that existing facilities are and have been successfully utilizing the same components proposed to meet this specification, in similar service. Certification may be based on components, i.e. engines used with different models of generators and generators used with different engines, and does not exclude annual technological improvements made by a manufacturer in the basic standard-model component on which experience was obtained, provided parts interchangeability has not been substantially affected and the current standard model meets the performance requirements specified. Provide a list with the name of the installations, completion dates, and name and telephone number of a point of contact.

Emissions; G

A certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. At a minimum this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and for hazardous air pollutants (HPAs).

Sound Limitations; G

A certification from the manufacturer stating that the sound emissions meet the specification.

Site Visit

A letter stating the date the site was visited and listing discrepancies found.

Current Balance; G

A certification stating that the flywheel has been statically and dynamically balanced and is capable of being rotated at 125 percent of rated speed without vibration or damage.

Materials and Equipment

A certification stating that where materials or equipment are specified to comply with requirements of UL, written proof of such compliance has been obtained. The label or listing of the specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

Inspections

A letter certifying that all facilities are complete and functional; that each system is fully functional; and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use.

Cooling System

Certification that the engine-generator set and cooling system function properly in the ambient temperatures specified.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

Six copies of the operation manual (approved prior to commencing onsite tests) in 8-1/2 by 11 inch binders, having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each system or subsystem. Sections shall be separated by heavy plastic dividers with tabs which identify the material in the section. Drawings shall be folded blue lines, with the title block visible, and placed in 8-1/2 by 11 inch plastic pockets with reinforced holes. One full size reproducible mylar of each drawing shall accompany the booklets. Mylars shall be rolled and placed in a heavy cardboard tube with threaded caps on each end. The manual shall include: step-by-step procedures for system startup, operation, and shutdown; drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems together with their controls, alarms, and safety systems; the manufacturer's name, model number, and a description of equipment in the system. The instructions shall include procedures for interface and interaction with related systems to include automatic transfer switches. Each booklet shall include a CDROM containing an ASCII file of the procedures.

Maintenance Procedures; G

Six copies of the maintenance manual containing the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each item listed. Each section shall be separated by a heavy plastic divider with tabs. Drawings shall be folded, with the title block visible, and placed in plastic pockets with reinforced holes.

a. Procedures for each routine maintenance item.

b. Procedures for troubleshooting.

c. Factory-service, tear-down overhaul, and repair service manuals, with parts lists.

d. A copy of the posted instructions.

e. A component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components specified for nameplates.

f. Six complete reproducible copies of the final relay and protective device settings. The settings shall be recorded with the name of the company and individual responsible for their accuracy. These settings shall include "as installed" values for all adjustable timers and programmable settings.

Special Tools

Two complete sets of special tools required for maintenance (except for electronic governor handset). Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. The tools shall be supplied complete with a suitable tool box. One handset shall be provided for each electronic governor when required to indicate and/or change governor response settings.

Filters

Two complete sets of filters, required for maintenance, shall be supplied in a suitable storage box. These filters shall be in addition to filters replaced after testing.

1.4 QUALITY ASSURANCE

1.4.1 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation shall also conform to the code.

1.4.2 Site Welding

For all welding, qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the Contracting Officer 24 hours in advance of qualification tests which shall be performed at the work site, if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made as a permanent record.

1.4.3 Vibration Limitation

The maximum engine-generator set vibration in the horizontal, vertical, and axial directions shall be limited to 6 mils (peak-peak RMS), with an

overall velocity limit of 0.95 inches/second RMS, for all speeds through 110 percent of rated speed.

1.4.4 Experience

Each component manufacturer shall have a minimum of 3 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler shall have a minimum of 3 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

1.4.5 Field Engineer

The engine-generator set manufacturer or assembler shall furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. The field engineer shall have attended the engine generator manufacturer's training courses on installation and operation and maintenance of engine generator sets.

1.4.6 Detailed Drawings

Submit detailed drawings showing the following:

a. Base-mounted equipment, complete with base and attachments, including anchor bolt template and recommended clearances for maintenance and operation.

b. Complete starting system.

c. Complete fuel system.

d. Complete cooling system.

e. Complete exhaust system.

f. Layout of relays, breakers, programmable controllers,switchgear, and switches including applicable single line and wiring diagrams with written description of sequence of operation and the instrumentation provided.

g. The complete lubrication system, including piping, pumps, strainers, filters, heat exchangers for lube oil and turbocharger cooling, electric heater, controls and wiring.

h. Location, type, and description of vibration isolation devices for all applications.

i. The safety system, together with a detailed description of how it is to work. Wiring schematics, safety devices with a listing of their normal ranges, alarm and shutdown values (to include operation parameters such as pressures, temperatures voltages, currents, and speeds) shall be included.

j. One-line schematic and wiring diagrams of the generator, exciter, regulator, governor, and instrumentation.

k. Layout of each panel.

l. Mounting and support for each panel and major piece of electrical equipment.

m. Engine-generator set lifting points and rigging instructions.

1.5 DELIVERY, STORAGE, AND HANDLING

Properly protect material and equipment, in accordance with the manufacturers recommended storage procedures, before, during, and after installation. Protect stored items from the weather and contamination. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.6 EXTRA MATERIALS

Submit a complete list of spare parts for each piece of equipment and a complete list of all material and supplies needed for continued operation. Lists shall include supply source and current prices. Separate each list into two parts, those elements recommended by the manufacturer to be replaced after 3 years of service, and the remaining elements.

PART 2 PRODUCTS

2.1 NAMEPLATES

Each major component of this specification shall have the manufacturer's name, type or style, model or serial number and rating on a plate secured to the equipment. As a minimum, nameplates shall be provided for:

Engines	Relays
Generators	Transformers (CT & PT)
Regulators	Day tanks
Pumps and pump motors	Governors
Generator Breaker	
Economizers	

Where the following equipment is not provided as a standard component by the diesel engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger
Heaters
Exhaust mufflers
Silencers
Battery
Exciters

2.2 SAFETY DEVICES

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. The safety devices shall be installed so that proper operation of the equipment is not impaired.

2.3 MATERIALS AND EQUIPMENT

2.3.1 Filter Elements

Fuel-oil, lubricating-oil, and combustion-air filter elements shall be manufacturer's standard.

2.3.2 Instrument Transformers

NEMA C12.11.

2.3.3 Pipe (Fuel/Lube-Oil, Compressed Air, Coolant, and Exhaust)

ASTM A 53/A 53M, or ASTM A 106/A 106M steel pipe. Pipe smaller than 2 inches shall be Schedule 80. Pipe 2 inches and larger shall be Schedule 40.

a. Flanges and Flanged Fittings: ASTM A 181/A 181M, Class 60, or ASME B16.5, Grade 1, Class 150.

b. Pipe Welding Fittings: ASTM A 234/A 234M, Grade WPB or WPC, Class 150 or ASME B16.11, 3000 lb.

c. Threaded Fittings: ASME B16.3, Class 150.

d. Valves: MSS SP-80, Class 150.

e. Gaskets: Manufacturer's standard.

2.3.4 Pipe Hangers

MSS SP-58 and MSS SP-69.

2.3.5 Electrical Enclosures and Panelboards

2.3.5.1 Electrical Enclosures

NEMA ICS 6

2.3.5.2 Panelboards

Provide 208Y/120V, 3-phase, 4-wire panelboard with main breaker, raceways, and wiring for each generator in accordance with Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM AND GROUNDING. Provide all necessary breakers, raceways, and wiring to supply power to all generator auxiliary equipment including:

All heater circuits (water, oil, generator)
Battery charger
Fuel Day tank fuel pumps
Convenience receptacles
Enclosure lights

2.3.6 Electric Motors

Electric motors shall conform to the requirements of NEMA MG 1. Motors shall have sealed ball bearings and a maximum speed of 1800 rpm. Motors used indoors shall have drip-proof frames; those used outside shall be totally enclosed. Alternating current motors larger than 1/2 Hp shall be

of the squirrel-cage induction type for operation on 208 volts or higher, 60 Hz, and three-phase power. Alternating current motors 1/2 Hp or smaller, shall be suitable for operation on 120 volts, 60 Hz, and single-phase power.

2.3.7 Motor Controllers

Motor controllers and starters shall conform to the requirements of NFPA 70 and NEMA ICS 2.

2.4 ENGINE

Each engine shall operate on No. 2-D diesel fuel conforming to ASTM D 975, shall be designed for stationary applications and shall be complete with ancillaries. The engine shall be a standard production model described in the manufacturer's catalog. The engine shall be naturally aspirated, supercharged, or turbocharged. The engine shall be 4-stroke-cycle and compression-ignition type. The engine shall be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. The engine shall have a minimum of two cylinders. Opposed-piston type engines shall have not less than four cylinders. Each block shall have a coolant drain port. Each engine shall be equipped with an overspeed sensor. Each engine shall be equipped with a closed crankcase ventilation filtration system, Racor or equal.

2.5 FUEL SYSTEM

The entire fuel system for each engine-generator set shall conform to the requirements of NFPA 30, NFPA 37 and NFPA 110 and contain the following elements.

2.5.1 Pumps

2.5.1.1 Main Pump

Each engine shall be provided with an engine driven pump. The pump shall supply fuel at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. The fuel flow rate shall be based on meeting the load requirements and all necessary recirculation.

2.5.1.2 Auxiliary Fuel Pump

Provide auxiliary fuel pumps to maintain the required engine fuel pressure, if either required by the installation or indicated on the drawings. The auxiliary pump shall be driven by a dc electric motor powered by the starting/station batteries. The auxiliary pump shall be automatically actuated by a pressure-detecting device.

2.5.2 Fuel Filter

In addition to the engine mounted (spin-on) fuel filter, provide a dual full-flow fuel filter (Racor or equal) for each engine. The filters shall be readily accessible and capable of being changed during engine operation without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

2.5.3 Relief/Bypass Valve

Provide a relief/bypass valve to regulate pressure in the fuel supply line, return excess fuel to a return line and prevent the build-up of excessive pressure in the fuel system.

2.5.4 Day Tank

Each engine shall be provided with a stand-alone dual wall self-supporting day tank. Each day tank shall be provided with connections for fuel supply line, fuel return line, fuel overflow line, local fuel fill port, gauge, vent line, drain line, and float switch assembly for control. A fuel return line cooler shall be provided as recommended by the manufacturer and assembler. The temperature of the fuel returning to the day tank shall be below the flash point of the fuel. A temperature sensing device shall be installed in the fuel supply line. Each engine-generator set provided with weatherproof enclosures shall have its day tank mounted within the enclosure. The fuel fill line shall be accessible without opening the enclosure.

Day tank pumps: Duplex pumps to be mounted within enclosure.

Day tank controller: Controller to be mounted within enclosure.

Day tank accessories: Solenoid Valves: each day tank shall be furnished with dual solenoid valves (with manual bypass), NPT, 100 psi, normally closed, viton soft goods, under control of level controller described below. Day Tank Level Floats: Each day tank shall be furnished with level probe with 5 float switches for level control of day tank. Level probe shall be fully compatible with pump control system. Tank shall be provided with critical high level shutdown that shall disengage motor and close solenoid valve upon sensing high fuel level. Sight Glasses: Carbon steel or brass body, 150 psi rated glass, delrin or nylon wheel, as manufactured by Ernst or McMaster Carr. Furnish on day tank(s) supply and return to main tank and generator supply and return lines to day tank. Temperature Sensor: Provide and program temperature sensor in each generator day tank. Integrate into fuel system PLC. Alarm in Fuel Control System and to BAS at 140 F. Ultrasonic level probe: Provide and program ultrasonic level probe to display actual gallons remaining in day tank. Display shall be local and at Fuel Management and control panel. Double Poppet Foot Valve: Provide double poppet foot valves on day tank suction lines, including return pump suction line or as shown on drawings. Drop Tubes: Provide full height drop tubes for supply, return and fill lines. Mechanical level gauge: Provide Sculley or equal mechanical level gauge. Anti-siphon: Provide Preferred Utilities UL Listed anti-siphon valves on generator suction lines and where shown on drawings. Line size Magnatrol solenoid valves may be used. All solenoid valves shall be furnished with manual override or manual valve bypass. Solenoid valves: Install line size Magnatrol solenoid valves with manual bypass between generator day tanks and generator for anti-siphon function. Valves to open on "generator run" signal and close after generator warmdown. Magnetrol solenoid valves shall be normally closed when de-energized. Flow Switch: Provide flow switch on return pumps and supply pumps to proof flow. Leak Detector: Provide Preferred Utilities model PS-LDS-7101 leak detector in rupture basin and in vent line receiver as shown on drawings. Back Pressure Regulating Valve: Self-operated spring-loaded back pressure regulating valve, model V as manufactured by Preferred Utilities or equal.

2.5.4.1 Capacity, Standby

Each day tank shall have capacity to supply fuel to the engine for an uninterrupted 4-hour period at 100 percent rated load without being refilled, plus any fuel which may be returned to the main fuel storage tank. Minimum tank size shall be 250 gallons. The calculation of the capacity of each day tank shall incorporate the requirement to stop the supply of fuel into the day tank at 90 percent of the ultimate volume of the tank.

2.5.4.2 Drain Line

Each day tank drain line shall be accessible and equipped with a shutoff valve. Self-supporting day tanks shall be arranged to allow drainage into a 12 inch tall bucket.

2.5.4.3 Local Fuel Fill

Each local fuel fill port on the day tank shall be provided with a screw-on cap.

2.5.4.4 Fuel Level Controls

Each day tank shall have a float-switch assembly to perform the following functions:

a. Start the supply of fuel into the day tank when the fuel level is at the "Low" level mark, 75 percent of the rated tank capacity.

b. Stop the supply of fuel into the day tank when the fuel level is at 90 percent of the rated tank capacity.

c. Activate the "Overfill Fuel Level" alarm at 95 percent of the rated tank capacity.

d. Activate the "Low Fuel Level" alarm at 70 percent of the rated tank capacity.

e. Activate the automatic fuel supply shut-off valve located on the fill line of the day tank and shut down the fuel pump which supplies fuel to the day tank at 95 percent of the rated tank capacity. The flow of fuel shall be stopped before any fuel can be forced into the fuel overflow line.

f. Activate the reverse pump by a separate "Overfill Fuel Level" float switch at 95 percent of the rated tank capacity.

g. Stop the reverse pump when the fuel level is at 92 percent of the rated tank capacity.

2.5.4.5 Arrangement

Fuel supply and return arrangement shall be as indicated. The fuel supply line from the day tank to main tank and to the manufacturer's standard engine flexible connection shall be welded pipe.

2.5.5 Fuel Supply System

The fuel supply from the main storage of fuel to the day tank shall be as

specified in Section 33 52 10 SERVICE PIPING, FUEL SYSTEMS, and Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.6 LUBRICATION

Each engine shall have a separate lube-oil system conforming to NFPA 30 and NFPA 37. Each system shall be pressurized by engine-driven pumps. System pressure shall be regulated as recommended by the engine manufacturer. A pressure relief valve shall be provided on the crankcase for closed systems. The crankcase shall be vented in accordance with the manufacturer's recommendation except that it shall not be vented to the engine exhaust system. Crankcase breathers, if provided on engines installed in buildings or enclosures, shall be piped to vent to the outside. The system shall be readily accessible for service such as draining, refilling, etc. Each system shall permit addition of oil and have oil-level indication with the set operating. The system shall utilize an oil cooler as recommended by the engine manufacturer.

2.6.1 Lube-Oil Filter

Provide one full-flow filter for each pump. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

2.6.2 Lube-Oil Sensors

Equip each engine with lube-oil pressure sensors located downstream of the filters and provide signals for required indication and alarms.

2.6.3 Manual Valve

A manual shutoff with plugged outlet port shall be provided at the engine oil drain point to allow connection of hoses for lubricating oil removal.

2.7 COOLING SYSTEM

Provide each engine with its own cooling system to operate automatically while its engine is running. The cooling system coolant shall use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified. The maximum temperature rise of the coolant across each engine shall not exceed that recommended and submitted in paragraph SUBMITTALS.

2.7.1 Coolant Pumps

Coolant pumps shall be the centrifugal type. Each engine shall have an engine-driven primary pump. Secondary pumps shall be electric motor driven and have automatic controllers. Raw-water circulating pump shall be controlled by manual-off-automatic controllers and shall be engine driven.

2.7.2 Heat Exchanger

Each heat exchanger shall be of a size and capacity to limit the maximum allowable temperature rise in the coolant across the engine to that recommended and submitted in paragraph SUBMITTALS for the maximum summer outdoor design temperature and site elevation. Each heat exchanger shall be corrosion resistant, suitable for service in ambient conditions of

application.

2.7.2.1 Fin-Tube-Type Heat Exchanger (Radiator)

Heat exchanger shall be factory coated with corrosive resistant film, provided that correction measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Internal surfaces shall be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers shall be pressure type incorporating a pressure valve, vacuum valve and a cap. Caps shall be designed for pressure relief prior to removal. Each heat exchanger and the entire cooling system shall be capable of withstanding a minimum pressure of 7 psi and shall be protected with a strong grille or screen guard. Each heat exchanger shall have at least two tapped holes; one tapped hole shall be equipped with a drain cock, the rest shall be plugged.

2.7.3 Thermostatic Control Valve

A modulating type, thermostatic control valve shall be provided in the coolant system to maintain the coolant temperature range submitted in paragraph SUBMITTALS.

2.7.4 Temperature Sensors

Each engine shall be equipped with coolant temperature sensors. Temperature sensors shall provide signals for pre-high and high indication and alarms.

2.7.5 Manual Valves

Manual shutoff valves shall be provided at all flexible water hoses such that engine coolant from the radiator does not have to be drained to replace any hose.

2.8 SOUND LIMITATIONS

The noise generated by the diesel generator set operating at 100 percent load shall not exceed the following sound pressure levels in any of the indicated frequencies when measured in a free field at a radial distance of 22.9 feet 7 meters at 45 degrees apart in all directions.

Frequency Band (Hz)	Maximum Acceptable Pressure Level (Decibels)
31	87
63	87
125	77
250	70
500	64
1,000	61
2,000	60
4,000	60
8,000	62

2.9 AIR INTAKE EQUIPMENT

Filters and silencers shall be provided in locations that are convenient for servicing. The silencer shall be of the high-frequency filter type, located in the air intake system as recommended by the engine manufacturer. Silencer shall be capable of reducing the noise level at the air intake so that the indicated pressure levels specified in paragraph SOUND LIMITATIONS will not be exceeded. A combined filter-silencer unit meeting requirements for the separate filter and silencer items may be provided. Expansion elements in air-intake lines shall be rubber.

2.10 EXHAUST SYSTEM

The system shall be separate and complete for each engine. Piping shall be supported to minimize vibration. Where a V-type engine is provided, a V-type connector, with necessary flexible sections and hardware, shall connect the engine exhaust outlets.

2.10.1 Flexible Sections and Expansion Joints

A flexible section shall be provided at each engine and an expansion joint at each muffler. Flexible sections and expansion joints shall have flanged connections. Flexible sections shall be made of convoluted seamless tube without joints or packing. Expansion joints shall be the bellows type. Expansion and flexible elements shall be stainless steel suitable for diesel-engine exhaust gas at the maximum exhaust temperature that is specified by the engine manufacturer. Expansion and flexible elements shall be capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2.10.2 Exhaust Muffler

A chamber type exhaust muffler shall be provided. The muffler shall be constructed of welded steel and designed for outside horizontal mounting. Eyebolts, lugs, flanges, or other items shall be provided as necessary for support in the location and position indicated. Pressure drop through the muffler shall not exceed the recommendations of the engine manufacturer. Outside mufflers shall be zinc coated or painted with high temperature resisting paint. The muffler and exhaust piping together shall reduce the noise level to less than the maximum acceptable level listed for sound limitations in paragraph SOUND LIMITATIONS. The muffler shall have a drain valve, nipple, and cap at the low-point of the muffler.

2.10.3 Exhaust Piping

Horizontal sections of exhaust piping shall be sloped downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction shall be long radius. Exhaust piping, mufflers and silencers installed inside any building shall be insulated in accordance with paragraph THERMAL INSULATION and covered to protect personnel. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing, rain cover.

2.11 EMISSIONS

The finished installation shall comply with Federal, state, and local regulations and restrictions regarding the limits of emissions, as listed here: EPA Tier 2 requirements.

2.12 STARTING SYSTEM

Provide dual redundant engine starting motors, starting motor controls, and battery banks for each engine. The starting system for standby engine generator sets shall be in accordance with NFPA 110 and as follows.

2.12.1 Controls

An engine control switch shall be provided with functions including: run/start(manual), off/reset, and, automatic mode. Start-stop logic shall be provided for adjustable cycle cranking and cool-down operation. The logic shall be arranged for manual starting and fully automatic starting in accordance with paragraph AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION. Electrical starting systems shall be provided with an adjustable cranking limit device to limit cranking periods from 1 second up to the maximum duration.

2.12.2 Capacity

The starting system shall be of sufficient capacity, at the maximum outdoor summer temperature specified to crank the engine without damage or overheating. The system shall be capable of providing a minimum of three cranking periods with 15 second intervals between cranks. Each cranking period shall have a maximum duration of 15 seconds.

2.12.3 Electrical Starting

Manufacturers recommended dc system, utilizing a negative circuit ground.

2.12.3.1 Battery

A starting battery system shall be provided and shall include the battery, battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. The battery shall be in accordance with SAE J537. Critical system components (rack, protection, etc.) shall be sized to withstand the seismic acceleration forces specified. The battery shall be lead-acid 24 volt DC, with sufficient capacity, at the minimum outdoor and maximum outdoor temperature specified, to provide the specified cranking periods. Valve-regulated lead-acid batteries are not acceptable.

2.12.3.2 Battery Charger

A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 24 hours and a floating charge rate for maintaining the batteries at fully charged condition. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage. A timer shall be provided for the equalize-charging-rate setting. A battery is considered to be fully depleted when the output voltage falls to a value which will not operate the engine generator set and its components.

Charger shall incorporate a 4-state charging algorithm to provide trickle charge rate to restore fully discharged batteries, a bulk charge rate to provide fastest possible recharge after normal discharge, an absorption state to return the battery to 100 percent of charge, and a float stage to

maintain a fully-charged battery and supply battery loads when the generator set is not operating. In addition, the charger shall include an equalization timer. Charge rates shall be temperature compensated based on the temperature directly sensed at the battery. The DC output voltage regulation shall be within plus or minus 1 percent. The DC output ripple current shall not exceed 1 amp at rated output current level. The charger shall include the following features:

(a) Two line alphanumeric display with programming keys to allow display of DC output ammeter and voltmeters (5% accuracy or better), display alarm messages, and perform programming;

(b) LED indicating lamp(s) to indicate normal charging condition (green), equalize charge state (amber), and fault condition (red);

(c) AC input overcurrent, over voltage, and undervoltage protection;

(d) DC output overcurrent protection;

(e) Alarm output relay;

(f) Corrosion resistant enclosure.

2.12.4 Starting Aids

The manufacturer shall provide the following methods to assist engine starting.

2.12.4.1 Jacket-Coolant Heaters

A thermostatically controlled electric heater shall be mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3 degrees F of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 208 volts ac.

a. Standby Rated Sets: The control temperature shall be the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.12.4.2 Lubricating-Oil Heaters

A thermostatically controlled electric heater shall be mounted in the engine lubricating-oil system to automatically maintain the oil temperature within plus or minus 3 degrees F of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 120 volts ac.

2.13 GOVERNOR

Each engine shall be provided with an electronic governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100 percent of rated output capacity. The governor shall be configured for safe manual adjustment of the speed/frequency during operation of the engine-generator set, without special tools, from 90 to 110 percent of the rated speed/frequency, over a steady state load range of 0 to 100 percent or rated capacity. Isochronous governors shall maintain the midpoint of the frequency bandwidth at the same value for steady-state loads over the range of zero

to 100 percent of rated output capacity.

2.14 GENERATOR

Each generator shall be of the synchronous type, one or two bearing, conforming to the performance criteria in NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Insulation shall be Class H and maximum temperature rise shall be 105 degrees C. Generator design shall protect against mechanical, electrical and thermal damage due to vibration, 25 percent overspeeds, or voltages and temperatures at a rated output capacity of 110 percent for prime applications and 100 percent for standby applications. Generator ancillary equipment shall meet the short circuit requirements of NEMA MG 1. Frames shall be the drip-proof type. Unit shall be listed per UL 1446

2.14.1 Current Balance

At 100 percent rated output capacity, and load impedance equal for each of the 3 phases, the permissible current difference between any 2 phases shall not exceed 2 percent of the largest current on either of the 2 phases.

2.14.2 Voltage Balance

At any balanced load between 75 and 100 percent of rated output capacity, the difference in line-to-neutral voltage among the 3 phases shall not exceed 1 percent of the average line-to-neutral voltage. For a single-phase load condition, consisting of 25 percent load at unity power factor placed between any phase and neutral with no load on the other 2 phases, the maximum simultaneous difference in line-to-neutral voltage between the phases shall not exceed 3 percent of rated line to neutral voltage. The single-phase load requirement shall be valid utilizing normal exciter and regulator control. The interpretation of the 25 percent load for single phase load conditions means 25 percent of rated current at rated phase voltage and unity power factor.

2.14.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced rated output capacity shall not exceed 10 percent. The RMS of all harmonics shall be less than 5.0 percent and that of any one harmonic less than 3.0 percent of the fundamental at rated output capacity. Each engine-generator shall be designed and configured to meet the total harmonic distortion limits of IEEE Std 519.

2.14.4 Enclosure Heaters

Provide electric space heaters to prevent moisture from condensing within the generator enclosure while the generator is not in operation.

2.15 EXCITER

The generator exciter shall be of the brushless type. Semiconductor rectifiers shall have a minimum safety factor of 300 percent for peak inverse voltage and forward current ratings for all operating conditions, including 110 percent generator output at 104 degrees F ambient. The exciter and regulator in combination shall maintain generator-output voltage within the limits specified.

2.16 VOLTAGE REGULATOR

Each generator shall be provided with a solid-state voltage regulator, separate from the exciter. The regulator shall maintain the voltage within a bandwidth of the rated voltage, over a steady-state load range of zero to 100 percent of rated output capacity for both single generator set and parallel generator set operation. Regulator shall be configured for safe manual adjustment of the engine-generator voltage output without special tools, during operation, from 90 to 110 percent of the rated voltage over the steady state load range of 0 to 100 percent of rated output capacity. Regulation drift shall not exceed plus or minus 0.5 percent for an ambient temperature change of 68 degrees F. The voltage regulator shall have a maximum droop of 2 percent of rated voltage over a load range from 0 to 100 percent of rated output capacity and automatically maintain the generator output voltage within the specified operational bandwidth.

2.17 GENERATOR ISOLATION AND PROTECTION

Devices necessary for electrical protection and isolation of each engine-generator set and its ancillary equipment shall be provided. The generator circuit breaker (IEEE Device 52) ratings shall be consistent with the generator rated voltage and frequency, with continuous, short circuit withstand, and interrupting current ratings to match the generator capacity. The generator circuit breaker shall be manually operated electronic trip type. A set of surge capacitors, to be mounted at the generator terminals shall be provided. Monitoring and control devices shall be as specified in paragraph GENERATOR PANEL and include the following:.

The controls system shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8 to 1200 amps and include adjustable time delay of 0 to 10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.

2.17.1 Devices

Switches, circuit breakers, fuses, relays, and other protective devices shall be as specified in Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.18 SAFETY SYSTEM

Devices, wiring, remote panels, local panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions. The safety system shall be provided with a self-test method to verify its operability. Alarm signals shall have manual acknowledgment and reset devices. The alarm signal systems shall reactivate for new signals after acknowledgment is given to any signal. The systems shall be configured so that loss of any monitoring device shall be dealt with as an alarm on that system element.

2.18.1 Audible Signal

The audible alarm signal shall sound at a frequency of 70 Hz at a volume of 75 dB at 10 feet. The sound shall be continuously activated upon alarm

and silenced upon acknowledgment. Signal devices shall be located as shown.

2.18.2 Visual Signal

The visual alarm signal shall be a panel light. The light shall be normally off, activated to be blinking upon alarm. The light shall change to continuously lit upon acknowledgement. If automatic shutdown occurs, the display shall maintain activated status to indicate the cause of failure and shall not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms shall be red; all other alarms shall be amber.

2.18.3 Alarms and Action Logic

2.18.3.1 Shutdown

Simultaneous activation of the audible signal, activation of the visual signal, stopping the engine, and opening the generator main circuit breakers shall be accomplished.

2.18.3.2 Problem

Activation of the visual signal shall be accomplished.

2.18.4 Local Alarm Panel

A local alarm panel shall be provided with the following shutdown and alarm functions in accordance with NFPA 110 level 1 and including the listed Corps of Engineer requirements mounted either on or adjacent to the engine generator set.

Device/Condition /Function	What/Where/Size	NFPA 110 Level 1	Corps of Engrs Required
Shutdowns w/Alarms			
High engine temperature	Automatic/jacket/ water/cylinder	SD/CP VA	SD VA
Low lube-oil pressure	Automatic/pressure/ level	SD/CP VA	SD VA
Overspeed Shutdown& Alarm	(110 percent (± 2 percent of rated speed)	SD/CP VA	SD VA
Overcrank, Failure to start	Automatic/Failure to start when used	SD/CP VA SD/CP VA	
Day tank overfill limit indication & transfer pump shutdown (95 percent volume)	Automatic/Day Tank/Level		SD(Pump) CP VA

Device/Condition /Function	What/Where/Size	NFPA 110 Level 1	Corps of Engrs Required
Red emergency stop switch	Manual Switch	SD/CP VA	SD VA
Alarms			
Low fuel level	Main tank, 3 hrs remaining	CP VA	CP VA
Pre-High Temperature	jacket water/ cylinder	CP VA	CP VA
Pre-Low Lube-oil Pressure			CP VA
High battery Voltage		CP VA	
Low battery Voltage		CP VA	
Battery charger AC Failure	AC supply not available	CP VA	
Control switch not in AUTO		CP VA	

SD - Shut Down
CP - On Control Panel
VA - Visual Alarm
AA - Audible Alarm
O - Optional

2.18.5 Time-Delay on Alarms

For startup of the engine-generator set, time-delay devices shall be installed bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. The lube-oil time-delay device shall return its alarm to normal status after the engine starts. The coolant time-delay device shall return its alarm to normal status 5 minutes after the engine starts.

2.19 ENGINE GENERATOR SET CONTROLS AND INSTRUMENTATION

Devices, wiring, remote panels, local panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions.

2.19.1 Controls

Provide a local control panel with controls in accordance with NFPA 110 level 1 mounted either on or adjacent to the engine generator set.

Device/Condition/ Function	Corps Requirement	NFPA 110 Level 1
Controls		
Switch: run/start - off/reset - auto	CP	
Emergency stop switch & alarm	CP	
Lamp test/indicator test	CP	CP VA
Common alarm contacts/ fault relay		X
Panel lighting	CP	
Audible alarm & silencing/reset switch	CP	
Voltage adjust for voltage regulator	CP	

2.19.2 Engine Generator Set Metering and Status Indication

Provide a local panel with devices in accordance with NFPA 110 level 1 and as follows mounted either on or adjacent to the engine generator set .

Device/Condition/ Function	Corps Requirement	NFPA 110 Level 1
Genset Status & Metering		
Genset supplying load		CP VA
System ready		
Engine oil pressure	CP	
Engine coolant temperature	CP	
Engine RPM (tachometer)	CP	
Engine run hours (non-resettable)	CP	
AC volts (generator), 3-phase	CP	
AC amps (generator), 3 - phase	CP	
Generator Frequency	CP	
Phase selector switches (amps & volts)	CP	
Watts/kW		
Voltage Regulator Adjustment	CP	

X - Required

CP - On Control Panel
VA - Visual Alarm
AA - Audible Alarm
STD- Manufacturers Standard Offering
O - Optional

Each generator and its auxiliary systems shall be monitored by the low voltage main switchboard, reference Section 26 23 00 SWITCHBOARD. Provide the following dry contact connections and wiring to the main switchboard PLC:

Generator in AUTO
Generator in MANUAL
Generator OFF
Generator output breaker OPEN/CLOSED.
Low temperature (starting aid trouble)
Generator Running
Generator Alarm
Generator Fault
Low Day Tank Fuel
Low Main Tank Fuel
Day Tank Leak Alarm
Main Tank Leak Alarm
Battery Charger Alarm
Generator Start/Stop Circuit Selector Switch Position
Portable Generator Start/Stop Circuit Selector Switch Position

2.20 PANELS

Each panel shall be of the type and kind necessary to provide specified functions. Panels shall be mounted on the engine-generator set base by vibration/shock absorbing type mountings. Instruments shall be mounted flush or semiflush. Convenient access to the back of panels shall be provided to facilitate maintenance. Instruments shall be calibrated using recognized industry calibration standards. Each panel shall be provided with a panel identification plate which clearly identifies the panel function. Each instrument and device on the panel shall be provided with a plate which clearly identifies the device and its function as indicated. Switch plates shall clearly identify the switch-position function.

2.20.1 Enclosures

Enclosures shall be designed for the application and environment, conforming to NEMA ICS 6. Locking mechanisms shall be keyed alike.

2.20.2 Analog

Analog electrical indicating instruments shall be in accordance with ANSI C39.1. Unit-mounted instruments shall be the manufacturer's standard with an accuracy of not less than 98 percent. The instrument's operating temperature range shall be minus 4 to plus 158 degrees F. Distorted generator output voltage waveform of a crest factor less than 5 shall not affect metering accuracy for phase voltages, hertz and amps.

2.20.3 Electronic

Electronic indicating instruments shall be true RMS indicating instruments, 100 percent solid state, state-of-the-art, microprocessor controlled to provide specified functions. Control, logic, and function devices shall be compatible as a system, sealed, dust and water tight, and shall utilize modular components with metal housings and digital instrumentation. An interface module shall be provided to link data via ethernet Base 100T from the electronic panel and translate alarm, fault

and status conditions to set of relay contacts. Instrument accuracy shall be not less than 98 percent for unit mounted devices throughout a temperature range of minus 4 to 158 degrees F. Data display shall utilize LED or back lit LCD. Additionally, the display shall provide indication of cycle programming and diagnostic codes for troubleshooting. Numeral height shall be 0.5 inch .

2.20.4 Parameter Display

Indication or readouts of the tachometer, lubricating-oil pressure, ac voltmeter, ac ammeter, frequency meter, and safety system parameters shall be provided. A momentary switch shall be specified for other panels.

2.21 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION

Fully automatic operation shall be provided for the following operations: engine-generator set starting and load transfer upon loss of normal source; retransfer upon restoration of the normal source; sequential starting; and stopping of each engine-generator set after cool-down. Devices shall automatically reset after termination of their function.

2.21.1 Automatic Transfer Switch

Automatic transfer switches shall be in accordance with Section 26 36 23.00 20 AUTOMATIC TRANSFER SWITCH.

2.21.2 Monitoring and Transfer

Devices shall be provided to monitor voltage and frequency for the normal power source and each engine-generator set, and control transfer from the normal source and retransfer upon restoration of the normal source. Functions, actuation, and time delays shall be as described in Section 26 36 23.00 20 AUTOMATIC TRANSFER SWITCH.

2.22 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION

Complete facilities shall be provided for manual starting and testing of each set without load, loading and unloading of each set.

2.23 BASE

The base shall be constructed of steel. The base shall be designed to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base shall permit skidding in any direction during installation and shall withstand and mitigate the effects of synchronous vibration of the engine and generator. The base shall be provided with suitable holes for anchor bolts and jacking screws for leveling.

2.24 THERMAL INSULATION

Thermal insulation shall be provided per manufacturer's requirements and as indicated.

2.25 PAINTING AND FINISHING

The engine-generator set shall be cleaned, primed and painted in accordance with the requirements of Section 09 90 00 PAINTS AND COATINGS.

Note that this section requires specific procedures and NACE inspection. Include documentation of NACE inspection in Factory Inspection submittal below.

2.26 FACTORY INSPECTION AND TESTS

Perform the factory tests on each engine-generator set. The component manufacturer's production line test is acceptable as noted. Each engine-generator set shall be run not less than 1 hour at rated output capacity prior to inspections. Inspections shall be completed and all necessary repairs made, prior to testing. Engine generator controls and protective devices that are provided by the generator set manufacturer as part of the standard package shall be used for factory tests. When controls and switchgear are not provided as part of the generator set manufacturer's standard package, the actual controls and protective devices provided for the project are not required to be used during the factory test. The Contracting Officer may provide one or more representatives to witness inspections and tests.

2.26.1 Factory Inspection

Inspections shall be performed prior to beginning and after completion of testing of the assembled engine-generator set. Inspectors shall look for leaks, looseness, defects in components, proper assembly, etc. and any item found to be in need of correction shall be noted as a necessary repair. The following checklist shall be used for the inspection:

INSPECTION ITEM	GOOD	BAD	NOTES
1. Drive belts			
2. Governor and adjustments			
3. Engine timing mark			
4. Starting motor			
5. Starting aids			
6. Coolant type and concentration			
7. Radiator drains			
8. Block coolant drains			
9. Coolant fill level			
10. All coolant line connections			
11. All coolant hoses			
12. Combustion air filter			
13. Combustion air silencer			
14. Lube oil type			
15. Lube oil sump drain			
16. Lube-oil filter			
17. Lube-oil-level indicator			
18. Lube-oil-fill level			
19. All lube-oil line connections			
20. All lube-oil lines			
21. Fuel type and amount			
22. All fuel-line connections			
23. All fuel lines			
24. Fuel filter			
25. Coupling and shaft alignment			
26. Voltage regulators			
27. Battery-charger connections			
28. All wiring connections			
29. Instrumentation			
30. Hazards to personnel			

31. Base
32. Nameplates
33. Paint
34. Exhaust-heat recovery unit

2.26.2 Factory Tests

On engine-generator set tests where the engine and generator are required to be connected and operated together, the load power factor shall be the power factor specified in the engine generator set parameter schedule. Electrical measurements shall be performed in accordance with IEEE Std 120. Definitions of terms are in accordance with IEEE Std 100. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation shall be in accordance with IEEE Std 1. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Tests specifically for the generator may be performed utilizing any prime mover.

a. Insulation Resistance for Stator and Exciter Test, IEEE Std 115 and IEEE Std 43, to the performance criteria in NEMA MG 1, Part 22. Generator manufacturer's production line test is acceptable.

b. High Potential Test, in accordance with IEEE Std 115 and NEMA MG 1, test voltage in accordance with NEMA MG 1. Generator manufacturer's production line test is acceptable.

c. Winding Resistance Test, Stator and Exciter, in accordance with IEEE Std 115. Generator manufacturer's production line test is acceptable.

d. Overspeed Vibration Test, in accordance with IEEE Std 115 to the performance criteria in NEMA MG 1. The test shall be performed at 110 percent of rated speed for 5 minutes. The vibration shall be measured at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Vibration amplitude and speed shall be recorded at one minute intervals.

e. Phase Balance Voltage Test, to the performance criteria specified in paragraph GENERATOR. This test can be performed with any prime mover. Generator manufacturer's production line test results are acceptable.

(1) Start and operate the generator at no load.

(2) Adjust a regulated phase voltage (line-to-neutral) to rated voltage.

(3) Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(4) Apply 75 percent rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(5) Apply rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(6) Calculate average line-neutral voltage and percent deviation of individual line-neutral voltages from average for each load condition.

f. Current Balance on Stator Winding Test, by measuring the current on each phase of the winding with the generator operating at 100 percent of Rated Output Capacity, with the load impedance equal for each of the three phases: to the performance criteria specified in paragraph GENERATOR.

g. Voltage Waveform Deviation and Distortion Test in accordance with IEEE Std 115 to the performance criteria specified in paragraph GENERATOR. High-speed recording instruments capable of recording voltage waveform deviation and all distortion, including harmonic distortion shall be used. Representation of results shall include appropriate scales to provide a means to measure and interpret results.

h. Voltage and Frequency Droop Test. Verify that the output voltage and frequency are within the specified parameters as follows:

(1.) With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency. Record the generator output frequency and line-line and line-neutral voltages.

(2.) Increase load to Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

3. Calculate the percent droop for voltage and frequency with the following equations:

$$\text{Voltage droop percent} = \frac{\text{(No-Load Volts)} - \text{(Rated Capacity volts)}}{\text{(Service-Load Volts)}} \times 100$$

$$\text{Frequency droop percent} = \frac{\text{(No-Load Hertz)} - \text{(Rated Capacity hertz)}}{\text{(Service-Load hertz)}} \times 100$$

4. Repeat steps 1 through 3 two additional times without making any adjustments.

i. Frequency and Voltage Stability and Transient Response. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

1. Ambient temperature (at 15 minute intervals).

2. Generator output current (before and after load changes).

3. Generator output voltage (before and after load changes).

4. Frequency (before and after load changes).

5. Generator output power (before and after load changes).

6. Graphic representations shall include the actual instrument trace of voltage and frequency showing: charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

(1.) Perform and record engine manufacturer's recommended prestarting checks and inspections.

(2.) Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

(3.) With the unit at no load, apply the Maximum Step Load Increase.

(4.) Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

(5.) Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.

(6.) Apply the Maximum Step Load Increase.

(7.) Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

(8.) Repeat steps 3. through 7.

j. Test Voltage Unbalance with Unbalanced Load (Line-to-Neutral) to the performance criteria specified in paragraph GENERATOR. Prototype test data is acceptable in lieu of the actual test. This test may be performed using any prime mover.

(1.) Start and operate the generator set at rated voltage, no load, rated frequency, and under control of the voltage regulator. Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(2.) Apply the specified load between terminals L_1-L_2, L_2-L_0, and L_3-L_0 in turn. Record all instrument readings at each line-neutral condition.

(3.) Express the greatest difference between any two of the line-to-line voltages and any two of the line-to-neutral voltages as a percent of rated voltage.

(4.) Compare the largest differences expressed in percent with the maximum allowable difference specified.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the job, perform a Site Visit to verify the information shown on the drawings, before performing any work. Notify the Contracting Officer in writing of any discrepancies.

3.2 GENERAL INSTALLATION

Installation shall provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Installation of pipe, duct, conduit, and ancillary equipment shall be configured to facilitate easy removal and replacement of major components and parts of the engine-generator set. All generator engine and auxiliary components shall be installed per the manufacturer's instructions.

3.3 PIPING INSTALLATION

Piping shall be welded. Connections at valves shall be flanged. Connections at equipment shall be flanged except that connections to the diesel engine may be threaded if the diesel-engine manufacturers standard connection is threaded. Except where otherwise specified, welded flanged fittings shall be utilized to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Connections to equipment shall be made with vibration-isolation-type flexible connectors. Piping and tubing shall be supported and aligned to prevent stressing of flexible hoses and connectors. Pipes extending through the roof shall be properly flashed. Piping shall be installed clear of windows, doors and openings, to permit thermal expansion and contraction without damage to joints or hangers, and shall be installed with a 1/2 inch drain valve with cap at each low point.

3.3.1 Support

Hangers, inserts, and supports shall be of sufficient size to accommodate any insulation and shall conform to MSS SP-58 and MSS SP-69. Supports shall be spaced not more than 7 feet on center for pipes 2 inches in diameter or less, not more than 12 feet on center for pipes larger than 2 inches but smaller than 4 inches in diameter, and not more than 17 feet on center for pipes larger than 4 inches in diameter. Supports shall be provided at pipe bends or change of direction.

3.3.1.1 Ceiling and Roof

Exhaust piping shall be supported with appropriately sized Type 41 single pipe roll and threaded rods; all other piping shall be supported with appropriately sized Type 1 clevis and threaded rods.

3.3.1.2 Wall

Wall supports for pipe shall be made by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

3.3.2 Flanged Joints

Flanges shall be Class 125 type, drilled, and of the proper size and configuration to match the equipment and diesel engine connections. Flanged joints shall be gasketed and made up square and tight.

3.3.3 Cleaning

After fabrication and before assembly, piping interiors shall be manually wiped clean of debris.

3.3.4 Pipe Sleeves

Pipes passing through construction such as ceilings, floors, or walls shall be fitted with sleeves. Each sleeve shall extend through and be securely fastened in its respective structure and shall be cut flush with each surface. The structure shall be built tightly to the sleeve. The inside diameter of each sleeve shall be minimum 1/2 inch, and where pipes pass through combustible materials 1 inch larger than the outside diameter of the passing pipe or pipe insulation/covering.

3.4 ELECTRICAL INSTALLATION

Electrical installation shall comply with NFPA 70, IEEE C2, and Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS. For vibration isolation, flexible fittings shall be provided for conduit, cable trays, and raceways attached to engine-generator sets; metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set shall be flexible stranded conductor; and terminations of conductors on the engine generator set shall be crimp-type terminals or lugs.

3.5 ONSITE INSPECTION AND TESTS

Perform generator testing specified in Section 01 91 13 COMMISSIONING separately, and in addition to, all testing specified in this section.

3.5.1 Test Conditions

3.5.1.1 Data

Measurements shall be made and recorded of all parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, adjustments, replacements, or repairs shall be made and the step repeated until satisfactory results are obtained. Unless otherwise indicated, data shall be recorded in 15 minute intervals during engine-generator set operation and shall include: readings of all engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set. Electrical measurements shall be performed in accordance with IEEE Std 120. Definitions of terms are in accordance with IEEE Std 100. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulations shall be in accordance with IEEE Std 1.

3.5.1.2 Power Factor

For all engine-generator set operating tests the load power factor shall

be the power factor specified in the engine-generator set parameter schedule .

3.5.1.3 Contractor Supplied Items

Provide equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors. Loadbanks for testing shall be both resistive and reactive in loading characteristics. Provide loadbanks for tests specified under this section and for tests specified under Section 01 91 13 COMMISSIONING.

3.5.1.4 Instruments

Readings of panel gauges, meters, displays, and instruments provided as permanent equipment shall be verified during test runs, using test instruments of greater precision and accuracy. Test instrument accuracy shall be within the following: current plus or minus 1.5 percent, voltage plus or minus 1.5 percent, real power plus or minus 1.5 percent, reactive power plus or minus 1.5 percent, power factor plus or minus 3 percent, frequency plus or minus 0.5 percent. Test instruments shall be calibrated by a recognized standards laboratory within 30 days prior to testing.

3.5.1.5 Sequence

The sequence of testing shall be as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Field testing shall be performed in the presence of the Contracting Officer. Tests may be scheduled and sequenced in order to optimize run-time periods; however, the following general order of testing shall be followed: Construction Tests; Inspections; Pre-operational Tests; Safety Run Tests; Performance Tests; and Final Inspection.

3.5.2 Construction Tests

Individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer shall be performed prior to connection to the engine-generator set.

3.5.2.1 Piping Test

a. Lube-oil and fuel-oil piping shall be flushed with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.

b. Fuel piping which is external to the engine-generator set shall be tested in accordance with NFPA 30. All remaining piping which is external to the engine-generator set shall be pressure tested with air pressure at 150 percent of the maximum anticipated working pressure, but not less than 150 psi, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, the test shall be performed before the insulation is applied.

3.5.2.2 Electrical Equipment Tests

a. Low-voltage cable insulation integrity tests shall be performed for cables connecting the generator breaker to the automatic transfer switch . Low-voltage cable, complete with splices, shall be tested

for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

1. R in megohms = (rated voltage in kV + 1) x 304,800/(length of cable in meters)

2. R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

3. Each cable failing this test shall be repaired or replaced. The repair cable shall be retested until failures have been eliminated.

3.5.3 Inspections

Perform the following inspections jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Checks applicable to the installation shall be performed. The results of those which are physical inspections (I) shall be documented and submitted in accordance with paragraph SUBMITTALS. Present manufacturer's data for the inspections designated (D) at the time of inspection. Inspections shall verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Manufacturer's statements shall certify provision of features which cannot be verified visually.

1.	Drive belts.	(I)
2.	Governor type and features.	(I)
3.	Engine timing mark.	(I)
4.	Starting motor.	(I)
5.	Starting aids.	(I)
6.	Coolant type and concentration.	(D)
7.	Radiator drains.	(I)
8.	Block coolant drains.	(I)
9.	Coolant fill level.	(I)
10.	Coolant line connections.	(I)
11.	Coolant hoses.	(I)
12.	Combustion air filter.	(I)
13.	Intake air silencer.	(I)
14.	Lube oil type.	(D)
15.	Lube oil sump drain.	(I)
16.	Lube-oil filter.	(I)
17.	Lube-oil level indicator.	(I)
18.	Lube-oil fill level.	(I)
19.	Lube-oil line connections.	(I)
20.	Lube-oil lines.	(I)
21.	Fuel type.	(D)
22.	Fuel-level.	(I)
23.	Fuel-line connections.	(I)
24.	Fuel lines.	(I)
25.	Fuel filter.	(I)
26.	Access for maintenance.	(I)
27.	Voltage regulator.	(I)

28. Battery-charger connections. (I)
29. Wiring & terminations. (I)
30. Instrumentation. (I)
31. Hazards to personnel. (I)
32. Base. (I)
33. Nameplates. (I)
34. Paint. (I)
35. Exhaust-heat system. (I)
36. Exhaust muffler. (I)
39. Access provided to controls. (I)
40. Enclosure is weather resistant. (I)
41. Engine & generator mounting bolts (application). (I)

3.5.4 Pre-operational Tests

3.5.4.1 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the installation coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.1.

3.5.4.2 Insulation Test

Generator and exciter circuits insulation resistance shall be tested in accordance with IEEE Std 43. Stator readings shall be taken at the circuit breaker, to include generator leads to automatic transfer switch. Results of insulation resistance tests shall be recorded. Readings shall be within limits specified by the manufacturer. Mechanical operation, insulation resistance, protective relay calibration and operation, and wiring continuity of automatic transfer switch assembly shall be verified. Precautions shall be taken to preclude damaging generator components during test.

3.5.4.3 Engine-Generator Connection Coupling Test

When the generator provided is a two-bearing machine, the engine-generator connection coupling shall be inspected and checked by dial indicator to prove that no misalignment has occurred. The dial indicator shall measure variation in radial positioning and axial clearance between the coupling halves. Readings shall be taken at four points, spaced 90 degrees apart. Solid couplings and pin-type flexible couplings shall be aligned within a total indicator reading of 0.0005 to 0.001 inch for both parallel and angular misalignment. For gear-type or grid-type couplings, 0.002 inch will be acceptable.

3.5.5 Safety Run Test

For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated safety tests shall be repeated.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

c. Activate the manual emergency stop switch and verify that the engine stops.

d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine-generator set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If either temperature reading exceeds the value required for an alarm condition, activate the manual emergency stop switch.

f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine generator-set at no load until the output voltage and frequency stabilize.

i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

k. Operate the engine generator-set for at least 2 hours at 75 percent of Service Load.

l. Verify proper operation and setpoints of gauges and instruments.

m. Verify proper operation of ancillary equipment.

n. Manually adjust the governor to increase engine speed past the overspeed limit. Record the RPM at which the engine shuts down.

o. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.

p. Manually adjust the governor to increase engine speed to within 2 percent of the overspeed trip speed previously determined and operate at that point for 5 minutes. Manually adjust the governor to the rated frequency.

q. Manually fill the day tank to a level above the overfill limit. Record the level at which the overfill alarm sounds. Verify shutdown of the fuel transfer pump. Drain the day tank down below the overfill limit.

r. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine.

s. Attach a manifold to the engine oil system (at the oil pressure sensor port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. The engine's oil pressure sensor shall be moved from the engine to the manifold. The manifold shutoff valve shall be open and bleed valve closed.

t. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.

u. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.

v. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100 percent of Service Load. Record the maximum sound level in each frequency band at a distance of 75 feet from the end of the exhaust and air intake piping directly along the path of intake and discharge for horizontal piping; or at a radius of 75 feet from the engine at 45 degrees apart in all directions for vertical piping. If a sound limiting enclosure is not provided, the muffler and air intake silencer shall be modified or replaced as required to meet the sound limitations of this specification. If the sound limitations can not be obtained by modifying or replacing the muffler and air intake silencer, notify the Contracting Officers Representative and provide a recommendation for meeting the sound limitations.

w. Manually drain off fuel slowly from the day tank to empty it to below the low fuel level limit and record the level at which the audible alarm sounds. Add fuel back to the day tank to fill it above low level alarm limits.

3.5.6 Performance Tests

In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated tests shall be repeated.

3.5.6.1 Continuous Engine Load Run Test

Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, the entire test shall be repeated. The engine load run test shall be accomplished principally during daylight hours, with an average ambient temperature during the current month. After each change in load in the following test, measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range. Data taken at 15 minute intervals shall include the following:

Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.

Pressure: Lube-oil.

Temperature: Coolant, Lube-oil, Exhaust, Ambient.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.

c. Operate the engine generator-set for 2 hours at 75 percent of Service Load.

d. Increase load to 100 percent of Service Load and operate the engine generator-set for 4 hours.

f. Decrease load to 100 percent of Service Load and operate the engine generator-set for 2 hours or until all temperatures have stabilized.

g. Remove load from the engine-generator set.

3.5.6.2 Voltage and Frequency Droop Test

For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. Record the generator output frequency and line-line and line-neutral voltages following each load change.

a. With the generator operating at no load, adjust voltage and

frequency to rated voltage and frequency.

b. Increase load to 100 percent of Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

c. Calculate the percent droop for voltage and frequency with the following equations.

$$\text{Voltage droop percent} = \frac{\text{No-load volts} - \text{rated output capacity volts}}{\text{Rated output capacity volts}} \times 100$$

$$\text{Frequency droop percent} = \frac{\text{No load hertz} - \text{rated output capacity hertz}}{\text{Rated output capacity volts}} \times 100$$

d. Repeat steps a. through c. two additional times without making any adjustments.

3.5.6.3 Voltage Regulator Range Test

a. While operating at no load, verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.

b. Increase load to 100 percent of Rated Output Capacity. Verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.

3.5.6.4 Governor Adjustment Range Test

a. While operating at no load, verify that the governor adjusts from 90 to 110 percent of rated frequency.

b. Increase load to 100 percent of Rated Output Capacity. Verify that the governor adjusts from 90 to 110 percent of rated frequency.

3.5.6.5 Frequency and Voltage Stability and Transient Response

Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

(1.) Ambient temperature (at 15 minute intervals).

(2.) Generator output current (before and after load changes).

(3.) Generator output voltage (before and after load changes).

(4.) Frequency (before and after load changes).

(5.) Generator output power (before and after load changes.

(6.) Graphic representations shall include the actual instrument

trace of voltage and frequency showing:

Charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

c. With the unit at no load, apply the Maximum Step Load Increase.

d. Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

e. Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.

f. Apply the Maximum Step Load Increase.

g. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

h. Repeat steps c. through g.

3.5.7 Automatic Operation Tests for Stand-Alone Operation

Test the automatic loading system to demonstrate automatic starting, of each engine-generator set. The loads for this test shall utilize the actual loads to be served, and the loading sequence shall be the indicated sequence. Perform this test for a minimum of two successive, successful tests. Data taken shall include the following:

(1.) Ambient temperature (at 15 minute intervals).

(2.) Generator output current (before and after load changes).

(3.) Generator output voltage (before and after load changes).

(4.) Generator output frequency (before and after load changes).

a. Initiate loss of the primary power source and verify automatic sequence of operation.

(1.) Loss of normal power for each individual automatic transfer switch.

(2.) Loss of normal power for all automatic transfer switches as a group.

b. Restore the primary power source and verify sequence of operation.

c. Verify resetting of controls to normal.

3.6 ONSITE TRAINING

Conduct training course for operating staff as designated by the Contracting Officer. The training period shall consist of a total 24 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. All operation and maintenance manuals shall be approved and made available for the training course. All posted instructions shall be approved and posted prior to the beginning date of the training course. The training course schedule shall be coordinated with the Using Service's work schedule, and submitted for approval 14 days prior to beginning date of proposed beginning date of training. The course instructions shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate routine maintenance procedures as described in the operation and maintenance manuals. Two copies of a video tape of the manufacturers operating and maintenance training course shall be submitted.

3.7 FINAL TESTING AND INSPECTION

a. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

b. Increase the load in steps no greater than the Maximum Step Load Increase to 100 percent of Service Load, and operate the engine-generator set for at least 30 minutes. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.

c. Remove load and shut down the engine-generator set after the recommended cool down period.

d. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Any corrective action shall be verified for effectiveness by running the engine for 8 hours at Service Load, then re-examining the oil and filter.

e. Remove the fuel filter and examine the filter for trash, abrasive foreign particles, etc.

f. Visually inspect and check engine and generator mounting bolts for tightness and visible damage.

g. Replace air, oil, and fuel filters with new filters.

3.8 POSTED DATA AND INSTRUCTIONS

Posted Data and Instructions shall be posted prior to field acceptance testing of the engine generator set. Two sets of instructions/data shall be typed in 8-1/2 x 11 inch format, laminated in weatherproof plastic, and placed in three-ring vinyl binders. The binders shall be placed as

directed by the Contracting Officer. The instructions shall be in place prior to acceptance of the engine generator set installation. First set shall include a one-line diagram, wiring and control diagrams and a complete layout of the system. Second set shall include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches).

3.9 ACCEPTANCE

Final acceptance of the engine-generator set will not be given until the Contractor has successfully completed all tests and all defects in installation material or operation have been corrected.

-- End of Section --

SECTION 26 33 53.00 20

UNINTERRUPTIBLE POWER SUPPLY (UPS) - REV. A
04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 587	(1980) Guide for Surge Voltages in Low-Voltage AC Power Circuits
IEEE C2	(2012) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 801-2	(1991; Edition 2) Electromagnetic Compatibility for industrial-Process Measurement and Control equipment - Part 2: Electrostatic Discharge Requirements
IEC 62040-3	(2001) Uninterruptible Power System (UPS) - Part 3: Method of Specifying the Performance and Test Requirements
IEC 62040-2	(2006) Uninterruptible Power System (UPS)

- Part 2: Electromagnetic Compatibility (EMC) Requirements

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; Corr 1 2009) Quality Management Systems- Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA PE 1	(2003) Uninterruptible Power Systems (UPS) Specification and Performance Verification

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2006; Reprint Feb 2011) Surge Protective Devices
UL 1778	(2005; Reprint Oct 2011) Uninterruptible Power Systems

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

The Kennedy Complex Control System (KCCS) is a combination of hardware and software components that are used to monitor and control Power, HVAC, Water and Waste and Pneumatic Utilities across the Kennedy Space Center.

Citect is an Industrial Controls, Supervisory Control and Data Acquisition (SCADA) software application that is used to monitor and control the I/O devices connected to the KCCS network. The Citect application provides the Human Machine Interface (HMI) to display, trend, alarm and control and/or monitor the I/O points connected to or through the I/O devices. Information is transferred to and from the Citect server over a dedicated Ethernet controls network using Modbus TCP/IP as the transportation protocol.

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

UPS Drawings; G

UPS Installation; G

Battery Monitoring System Installation; G

SD-03 Product Data

UPS Module; G

Submittal shall include manufacturer's information for each component, device, and accessory provided with the transformer.

Factory Testing; G

UPS System; G

Battery Monitoring System; G

SD-06 Test Reports

Work Plan; G

Factory Test Plan; G

Performance Test Plan; G

Factory Tests; G

Performance Tests Report; G

Factory Tests Report; G

SD-09 Manufacturer's Field Reports

Initial Inspection and Tests; G

Performance Tests; G

SD-10 Operation and Maintenance Data

UPS Operation and Maintenance, Data Package 5; G

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

Installation

1.5 PERFORMANCE REQUIREMENTS

1.5.1 Normal Operation

Utilizing commercial AC power, the critical load shall be continuously supplied by the Inverter. The Inverter shall power the load while

regulating both voltage and frequency. The Rectifier shall derive power from the commercial AC source and shall supply DC power to the Inverter. Simultaneously, the Battery Charger shall charge the battery.

1.5.2 Emergency Operation (Loss or deviation of AC Input Power)

Whenever the ac input power source deviates from the specified tolerances or fails completely, the inverter shall draw its power from the battery system and shall supply AC power to the critical load without any interruption or switching. The battery shall continue to supply power to the inverter for the specified protection time or until return of ac input source. At the same time, an alarm shall sound to alert operating personnel and a trouble signal shall be sent over the communication network, allowing startup of a secondary power source or orderly shutdown of the critical load.

1.5.3 Return of AC Input Power Source

When stable ac input power source returns the rectifier/charger shall resume operation and shall simultaneously supply the inverter with dc power and recharge the battery. This shall be an automatic function and shall cause no disturbance to the critical load.

1.5.4 Failure of AC Input Power to Return

Should the ac input power fail to return before the battery voltage reaches the discharge limit, the UPS system shall disconnect from the critical load to safeguard the battery.

1.5.5 Transfer to Bypass AC Power Source

When the UPS controller senses an overload or degradation of the inverter output, the bypass switch shall automatically transfer the critical load from the inverter output to the bypass ac power source without an interruption of power.

1.5.6 Retransfer to Inverter

The static bypass switch shall be capable of automatically retransferring the load back to the inverter output after the inverter output has returned to normal conditions. Retransfer shall only occur if the two sources are synchronized.

1.5.7 UPS Bypass Maintenance

Manual closure of the maintenance bypass switch shall transfer the critical load from the bypass ac power source to the maintenance bypass ac power source without disturbing the critical load bus. UPS module shall be capable of manual return to normal operation after completion of maintenance.

1.5.8 Battery Maintenance

The battery protective device shall provide the means of disconnecting the battery from the rectifier/charger and inverter for maintenance. The UPS module shall continue to function and meet the performance criteria specified except for the battery back-up time function.

1.5.9 UPS Load Bank Connection

An exterior load bank connection shall be provided in order to allow full-load testing of the UPS unit. The UPS unit shall be able to be load tested while the loads are placed in maintenance bypass source. The exterior enclosure shall be weather and water-proof with Cam-lok type female connectors. The device shall be fully rated for the load being applied to the UPS.

1.5.10 Energy Saver Feature

The UPS shall continuously monitor the voltage and frequency of the bypass source. When the source parameters are within acceptable limits, the UPS will utilize a minimal/optimal combination of its internal subsystems to ensure acceptable power is always delivered to the critical load, at a system efficiency of 99 percent or greater, over the range of 10 percent to 100 percent load. The Energy Saver System shall be enabled by the user, and shall be adjustable. It shall incorporate a "High Alert Mode" to automatically (without user intervention) provide maximum power conditioning any time bypass source variation levels exceed preset, adjustable limits. When Energy Saver System is utilized, the UPS must attenuate ANSI/IEEE C62.41-type line transients to within IEC and ITIC limits. The Energy Saver System shall be able to distinguish between upstream (utility) faults and downstream (load) faults, and react appropriately to protect and support the critical load, without interruption.

1.6 QUALITY ASSURANCE

The manufacturer shall have a documented quality assurance program including:

a. Inspections of incoming parts, modular assemblies and final product.

b. Final test procedure for the product including proof of performance specifications.

c. On-site test procedure shall include an inspection of controls and indicators after installation of the equipment.

d. ISO 9001 quality certification.

1.6.1 UPS Drawings

Detail drawings consisting of a complete list of equipment and materials, manufacturer's descriptive and technical literature, battery sizing calculations per IEEE 485, installation instructions, single-line diagrams, ladder-type schematic diagrams, elevations, layout drawings, and details required to demonstrate that the system has been coordinated and will function properly as a unit.

1.6.2 UPS Installation

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall

indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.3 Work Plan

Submit 6 copies of schedules of dates for factory tests, installation, field tests, and operator training for the UPS system. Furnish a list of instrumentation equipment for factory and field test reports.

1.6.4 Factory Test Plan

Submit 6 copies of factory test plans and procedures at least 21 calendar days prior to the tests being conducted. Provide detailed description of test procedures, including test equipment and setups, to be used to ensure the UPS meets the performance specification and explain the test methods to be used. As a minimum, the test procedures shall include the test required under the paragraph entitled "Factory Testing."

1.6.5 Performance Test Plan

Submit 6 copies of test plans and procedures at least 15 calendar days prior to the start of field tests. Provide detailed description and dates and times scheduled for performance of tests, and detailed description of test procedures, including test equipment (list make and model and provide functional description of the test instruments and accessories) and setups of the tests to be conducted to ensure the UPS meets the performance specification. Explain the test methods to be used. As a minimum, the test procedures shall include the tests required under the paragraph entitled "Performance Tests."

1.6.6 Factory Tests Report

Submit 6 copies of factory test report within 45 calendar days after completion of tests. Receive approval of test prior to shipping unit. Factory test reports shall be signed by an official authorized to certify on behalf of the UPS manufacturer of that the system meets specified requirements in accordance with the requirements set forth in paragraph entitled "Factory Testing". Test reports in shall be in booklet form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports shall state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.6.7 Performance Tests Report

Submit report of test results as specified by paragraph entitled "Performance Tests" within 15 calendar days after completion of tests. Field test reports shall be signed by an official authorized to certify on behalf of the UPS manufacturer that the system meets specified requirements in accordance with the requirements set forth in paragraph entitled "Performance Tests". Test reports in shall be in booklet form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports shall state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.6.8 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.8.1 Reference Standard Compliance

Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.

1.6.8.2 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.6.9 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.6.9.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.9.2 Material and Equipment Manufacturing Date

Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 DELIVERY AND STORAGE

Equipment placed in storage shall be protected from humidity and temperature variations, moisture, water intrusion, dirt, dust, or other contaminants. In harsh environments where temperatures exceed non-operational parameters established within this specification, the equipment storage facility shall be environmentally controlled to ensure temperature parameters are within equipment specification. Documentation of same shall be provided to the Government when storage is implemented.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Conditions

The UPS and battery system shall be capable of withstanding any combination of the following external environmental conditions without mechanical or electrical damage or degradation of operating characteristics.

a. Operating Temperature: 32 degrees F to 104 degrees F excluding batteries..

b. Storage Temperature: - -13 degrees F to 1 degrees F. Prolonged storage above 104 degrees F will cause rapid battery self-discharge..

c. Relative Humidity (operating and storage): 5 to 9 percent maximum non-condensing..

1.8.2 Sound Pressure Levels

Noise generated by the UPS under normal operation shall not exceed 65dbA at 1 meter from any operator surface, measured at 77degrees F and full load.

1.8.3 Verification of Dimensions

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.9 SPECIAL TOOLS

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

1.10 OPERATION AND MAINTENANCE MANUALS

1.10.1 Additions to UPS Operation and Maintenance Manuals

In addition to requirements of Data Package 5, include the followings on the actual UPS system provided:

a. An outline drawing, front, top, and side views.

b. Prices for spare parts and supply list.

c. Routine and field acceptance test reports.

d. Date of Purchase.

1.11 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 UPS SYSTEM DESCRIPTION

The UPS system shall conform to UL 1778, IEC 62040-3, NEMA PE 1, IEEE 587, CISPR 22 and shall consist of UPS module, battery system, battery protective device, static bypass transfer switch, controls and monitoring. Input ac power shall be connected to the normal source ac input of the UPS module. Alternate power source shall be connected to bypass/maintenance bypass. The battery shall be connected to the dc input of the UPS module through the battery protective device. The ac output of the UPS system shall be connected to the critical loads. Provide Powerware 9390 120 kVA.

2.1.1 Control Power

Provide dual control power supplies. The control power circuit shall have suitable protection, appropriately marked and located in the immediate vicinity of the input protective device.

2.1.2 EMI/RFI Protection

The components and the system shall be designed to minimize the emission of electromagnetic waves that may cause interference with other equipment.

2.1.3 Internal Wiring

Wiring practices, materials, and coding shall be in accordance with the requirements of NFPA 70, OSHA, and other applicable standards. Wire runs shall be protected in a manner which separates power and control wiring. Control wiring shall be minimum No. 16 AWG extra-flexible stranded copper. Logic-circuit wiring may be smaller. Ribbon cables shall be minimum No. 22 AWG. Control wiring shall have permanently attached wire numbers.

2.1.4 Internal Assembly

The printed circuit board (PCB) subassemblies shall be mounted in pull-out and/or swing-out trays where feasible. Cable connections to the trays shall be sufficiently long to allow easy access to all components. Where not feasible to mount PCB subassemblies in pull-out or swing-out trays, they shall be firmly mounted inside the enclosure. Every PCB subassembly shall be monitored. Self-test and diagnostic circuitry shall be included in the logic circuits such that a fault can be isolated down to the PCB subassembly level.

2.1.5 Cabinets

UPS system shall be installed in cabinets of heavy-duty structure meeting the NEMA PE 1 standards for floor mounting. UPS module cabinet shall be structurally adequate for forklift handling or lifting. Removable lifting eyes shall be provided on top of each cabinet. UPS module cabinet shall

have hinged and lockable doors on the front only, with assemblies and components accessible from the front. Operating controls shall be located outside the locked doors. Input, output, and battery cables shall be installed through the top or bottom of the cabinet. Barriers shall be provided between UPS and manual bypass cabinet.

2.1.5.1 Cabinet Finish

Equipment cabinet shall be cleaned, primed and painted in the manufacturer's standard colors, in accordance with accepted industry standards. Cabinets shall be labeled in accordance with NFPA 70 for arc flash hazard with warning sign reading: "Warning-Potential Arc Flash Hazard. Appropriate PPE and Tools Required when working on this equipment" or similar wording.

2.1.5.2 Live Parts (300 Volts and Above)

Live parts (300 volts and above) that are exposed when front access doors are open shall be adequately protected or covered to minimize the chance of accidental contact.

2.1.6 Safety

UPS shall be equipped with instruction plates including warnings and cautions, suitably located, and describing any special or important procedures to be followed in operating and servicing the equipment. The control panel display shall also provide warning messages prior to performing a critical function.

2.1.7 UPS System Load Profile

The UPS system shall be compatible with the load characteristics defined in the LOAD PROFILE below and load configuration. Compensation for UPS/load interaction problems resulting from nonlinear loads or transformer and motor inrush shall be provided.

LOAD PROFILE

Type of load: data processing equipment.

Size of load: 120 kVA, 480 voltage.

Steady-state characteristics: 0.9 lagging power factor.

2.2 UPS SYSTEM RATINGS

Unless stated otherwise, the parameters listed are under full output load at 0.9 power factor, with batteries fully charged and floating on the dc bus and with nominal input voltage.

2.2.1 System Capacity

120 kVA, 250 kW.

2.2.2 Battery Capacity

Discharge time to end voltage: 15 minutes, at 77 degrees F. End voltage at full discharge shall be 1.67 volts per cell. Battery shall be capable of delivering 150 percent of full rated UPS load at initial start-up.

2.2.3 Static Switch

65,000 amperes symmetrical interrupting capacity.

2.2.4 Module Bus Bracing

Braced for 65,000 amperes symmetrical interrupting capacity.

2.2.5 AC Input

a. Voltage 480 volts line-to-line.

b. Number of phases: 3-phase, 3-wire, plus ground.

c. Voltage Range: Plus 10 percent, minus 15 percent, without affecting battery float voltage or output voltage.

d. Frequency: 60 Hz, plus or minus 5 percent.

e. Power walk-in: Ramp-up to full utility load adjustable from 3 seconds to 60 seconds..

f. Total harmonic current distortion (THD): less than 5.0 percent..

g. Input surge protection: per IEEE 587 (IEEE C62.41.1).

h. Input power factor: 0.99 lagging.

2.2.6 AC Output

a. Voltage 480 volts line-to-line, 3-phase plus Neutral plus ground.

b. Steady-state voltage regulation (in inverter) shall be within +/-1% average from nominal output voltage.

c. Transient voltage response shall be less than +/-5% from nominal voltage for load step from 10 percent to 100 percent.

d. Linear load harmonic distortion: output voltage THD less than 5 percent for 100 percent non-linear load when tested using the non-linear load per IEC 62040-3.

e. Manual output voltage adjustment shall be +/-3 percent from nominal.

f. Line synchronization range shall be +/-3Hz, adjustable to +/-0.5Hz.

g. Frequency regulation shall be +/-0.1Hz free running.

h. Frequency slew rate shall be adjustable up to 0.7Hz per second maximum.

i. Phase angle control:

(1) Balanced linear load shall be +/-1 degree from nominal 120 degrees
(2) Unbalanced linear loads shall be less than +/-3 degrees from average phase voltage for 100 percent load unbalance.

j. Phase voltage control:

(1) a. Balanced linear loads shall be +/-1 percent from average phase voltage

(2) b. Unbalanced linear loads shall be less than +/-5 percent for 100% load unbalanced.

k. Overload current: With nominal line and fully charged battery the unit shall operate with up to 110 percent of resistive/inductive load for 10 minutes, up to 125 percent for 30 seconds, and greater than 125 percent for 10 seconds (up to Inverter current limit).

l. Fault clearing current: 1000 percent RMS for 20 milliseconds, 600 percent for 50 milliseconds. With bypass intervention. Inverter 200 percent phase-to-phase for 10 cycles.

m. Static transfer time: No break, completed in less than 4 milliseconds.

n. EMC Suppression: the UPS shall meet IEC 62040-2, Category C3.

o. Electrostatic discharge (ESD): The UPS shall meet IEC 801-2. The UPS shall withstand a 25kV pulse without damage and with no disturbance or adverse effect to the critical load.

p. Efficiency: The UPS efficiency shall be up to 94.5 percent.

2.3 UPS MODULE

2.3.1 General Description

UPS module shall consist of a rectifier, inverter, battery charger, static Bypass, and associated Control and Monitor Panel with their associated synchronizing equipment, protective devices, surge suppression, and accessories as required for operation.

2.3.1.1 Interchangeability

The subassemblies in one UPS module shall be interchangeable with the corresponding modules within the same UPS, and from one UPS system to another of identical systems.

2.3.2 Rectifier/Charger Unit

Each rectifier/charger shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The rectifier/charger shall be a high-frequency Pulse Width Modulation (PWM) design, using Insulated Gate Bi-polar Transistors (IGBTs). The modular design of the UPS shall permit safe and fast removal and replacement of the rectifier/charger module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode.

2.3.2.1 Surge Protection

A surge suppression device shall be installed at the UPS input to protect against lightning and switching surges. Internal components shall be protected from surges that enter at each ac input connection including main input, static bypass transfer switch, and maintenance bypass/isolation switch. Surge suppressors shall protect internal components according to IEEE C62.41.1 and IEEE C62.41.2, Category B. Surge suppressors shall be UL 1449 approved to fail in "safe" mode.

2.3.2.2 Sizing

Rectifier/charger unit shall be sized for the following two simultaneous operating conditions:

a. Supplying maximum 15% of load.

b. Recharging a fully-discharged battery to 90 percent of rated ampere-hour capacity within ten times the discharge time after normal ac power is restored.

2.3.2.3 Battery Charging Current

a. Battery-charging current shall be voltage regulated and current limit shall be adjustable from 10% to 15 % of the UPS full load input current regardless of the actual load on the UPS. After the battery is recharged, the rectifier/charger unit shall maintain the battery at full float charge until the next operation under input power failure. Battery charger shall be capable of providing equalizing charge to the battery.

2.3.2.4 DC Ripple

Rectifier/charger unit shall minimize ripple current and voltage supplied to the battery; the ripple current into the battery shall not exceed 3 percent RMS of the inverter input rated current; the ripple voltage into the battery shall not exceed 0.5% peak-to-peak.

2.3.2.5 DC Voltage Adjustment

Rectifier/charger unit shall have manual means for adjusting dc voltage for battery equalization, to provide voltage within plus 10 percent of nominal float voltage.

2.3.2.6 Battery Isolation Protective Device

System shall have a dc protective device to isolate the module from the battery system. The protective device size and interrupting rating shall be as required by system capacity and shall incorporate a shunt trip as required by circuit design.

2.3.3 Inverter Unit

Inverter unit shall be a solid-state device deriving its power from the dc bus (rectifier or battery source) and providing ac power within specified limits to the critical load. Inverter shall utilize microprocessor controlled solid state multilevel Pulse Width Modulation (PWM) controlled IGBT power transistor technology to shape the ac output with high speed switching. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return the UPS to normal mode..

2.3.3.1 Output Overload

The inverter shall be able to sustain an overload as specified across its output terminals. The inverter shall not shut off, but shall continue to operate within rated parameters, with inverse-time overload shutdown protection. If the overload condition persists beyond the rated parameters of the inverter, the inverter shall current limit, load shall

be transferred to the bypass source, and the inverter shall disconnect automatically from the critical load bus.

If the bypass source is not available and the overload/fault condition continues, the inverter shall current limit for a limited time as determined by the manufacturer and shall shut down to protect the internal components.

2.3.3.2 Output Frequency Control

The inverter shall normally operate in phase-lock and synchronism with the bypass source. When the bypass source frequency deviates by more than ±0.5 Hz, the internal frequency oscillator shall automatically take control and become the new frequency reference. Upon restoration of the bypass source within the required tolerance, the inverter shall synchronize back with that source at a slew rate not exceeding the specified rate. The oscillator shall be temperature compensated and shall be manually adjustable.

2.3.3.3 Output Protective Device

The output protective device shall be capable of shunt tripping or opening on an applied control signal and shall have the proper frame size and trip rating to supply overload current as specified. The inverter output protective device shall work in conjunction with the bypass protective device for both manual and automatic load transfers to and from bypass power.

2.3.4 External Protection

UPS module shall have built-in self-protection against undervoltage, overvoltage, overcurrent and surges introduced on the ac input source and/or the bypass source. The UPS shall also have built-in self-protection against overvoltage and voltage surges introduced at the output terminals by paralleled sources, load switching, or circuit breaker operation in the critical load distribution system.

2.3.5 Internal Protection

UPS module shall be self-protected against overcurrent, sudden changes in output load and short circuits at the output terminals. UPS module shall be provided with output reverse power detection which shall cause the module to be disconnected from the critical load bus when output reverse power is present. UPS module shall have built-in protection against permanent damage to itself and the connected load for predictable types of failure within itself and the connected load. At the end of battery discharge limit, the module shall shut down without damage to internal components.

2.4 STATIC BYPASS TRANSFER CIRCUIT

A high speed naturally commutated static bypass transfer circuit shall be provided as an integral part of the UPS and shall consist of a static switch, made up of two reverse-paralleled SCRs (silicon-controlled rectifiers) or IGBT per phase conductor, and a bypass protective device or bypass switch, made up of a contactor or motor operated circuit breaker. The bypass protective device shall be in parallel with the static switch. The inverter output protective device shall disconnect and isolate the inverter from the bypass transfer circuit.

The control logic shall contain an automatic transfer circuit that senses the status of the inverter logic signals and alarm conditions and provides an uninterrupted transfer of the load to the bypass ac power source, without exceeding the transient limits specified herein, when a malfunction occurs in the UPS or when an external overload condition occurs. The power section of the static bypass transfer circuit shall be provided as a plug-in type assembly to facilitate maintenance. The static bypass transfer circuit shall be used to connect the input bypass ac power source to the critical load when required, and shall have the following features:

2.4.1 Uninterrupted Transfer

The static bypass transfer switch shall automatically cause the bypass ac power source to assume the critical load without interruption when the bypass control logic senses one of the following conditions and the UPS inverter output is synchronized to the bypass ac power source:

a. Output overload period expired.

b. Critical bus voltage out of limits.

c. Internal over temperature period expired.

d. Total battery discharge.

e. UPS failure.

2.4.2 Manual Transfer

It shall be possible to make a manually-initiated static transfer from the system status and control panel. The transfer shall be make-before-break utilizing the bypass switch.

2.4.3 Automatic Uninterrupted Forward Transfer

The static bypass transfer switch shall automatically forward transfer, without interruption after the UPS inverter is turned "on", or after an instantaneous overload-induced reverse transfer has occurred and the load current has returned to less than the unit's 100 percent rating.

2.4.4 Overload Ratings

The static bypass transfer switch shall withstand the following overload current conditions:

a. 125 percent of UPS output rating for 10 seconds.

b. 110 percent of UPS output rating for 30 seconds.

c. 102 percent of UPS output rating for 10 minutes.

d. Greater than 125 percent for 10 cycles.

2.4.5 Static Switch Disconnect

A static switch disconnect shall be incorporated to isolate the static bypass transfer switch assembly so it can be removed for servicing. The

switch shall be equipped with auxiliary contacts.

2.5 MAINTENANCE BYPASS SWITCH

2.5.1 General

2.5.2 Load Transfer

The maintenance bypass switch shall provide the capability of transferring the critical load from the UPS static bypass transfer switch to maintenance bypass and then back to the UPS static bypass transfer switch with no interruption to the critical load.

2.6 MODULE CONTROL PANEL

The UPS module shall be provided with a control/indicator backlit LCD display panel. The display panel shall be on the front of the UPS module. Controls, meters, alarms and indicators for operation of the UPS module shall be on this panel. The display panel shall be menu driven for browsing all the screens. Controls shall be microprocessor based. The front panel display shall show a system mimic diagram with an outlined power path, current operating mode and event logs.

2.6.1 Module Meters

2.6.1.1 Monitored Functions

The following functions shall be monitored and displayed, but not limited to:

a. Input voltage, phase-to-phase (all three phases).

b. Input current, all three phases.

c. Input frequency.

d. Battery voltage.

e. Battery current (charge/discharge).

f. Output voltage, phase-to-phase and phase-to-neutral (all three phases).

g. Output current, all three phases.

h. Output frequency.

i. Output kilowatts.

j. Elapsed time meter to indicate hours of operation, 6 digits.

k. Bypass voltage, phase-to-phase and phase-to-neutral (all three phases).

l. Output kilovars.

m. Output kilowatt hours, with 15-minute demand attachment.

n. Battery temperature.

o. Output Percentage load.

p. Remaining battery time.

2.6.2 Module Controls

Display a System Controls screen that allows selection of operating mode, normal, bypass, charger on/off and Power Module on/off.

2.6.3 Module Alarm Indicators

The UPS control panel shall provide indicator LED's for NORMAL, BYPASS, BATTERY AND ALARM modes.

2.6.4 Module Emergency OFF Button

The module shall provide a means to disconnect the module from the system, via its input protective device, output protective device, and battery protective device. It shall be with a two-step procedure for confirmation to perform such operation.

2.7 SELF-DIAGNOSTIC CIRCUITS

2.7.1 Battery Management System

The UPS shall contain a battery management system which has the following features:

The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.

The battery management system shall automatically test the battery string(s) to ensure that the battery is capable of providing greater than 80% of its rated capacity. Testing the batteries shall not jeopardize the operation of the critical load. Upon detection of the battery string(s) not capable of providing 80%, the UPS system will alarm that the battery needs attention/replacement. The battery test shall be able to detect the following:

Open battery string

Shorted battery string

Battery capacity (runtime) less than 80% of "new" battery capacity

The UPS shall be able to communicate battery test and monitoring data through its Ethernet communication port to KCCS.

An optional temperature sensor shall be available to monitor the ambient temperature internal to the battery cabinet. If the ambient temperature increases, the UPS system charger shall automatically reduce the charging voltage to a level recommended by the battery manufacturer. If the ambient temperature is decreased, the UPS shall automatically increase the battery charge voltage to that recommended by the battery manufacturer.

2.7.2 Energy Saving Feature

The Energy Saver feature shall optimize the internal components of the UPS power train to maximize system efficiency when the bypass source is within the following (adjustable) limits: Voltage: +/- 10%, and Frequency: +/- 3Hz. Steady-state voltage regulation (in inverter) shall be within +/- 5Hz. Frequency regulation shall be +/-3 Hz when bypass source is within limits in above. The system shall be able to make transfers to double-conversion in 2 milliseconds or less whenever the bypass source reaches the limits established without any impact to the loads.

2.8 REMOTE MONITORING PANEL

2.8.1 Indicators

Control Panel shall include the following LED indicators:

a. NORMAL.

b. BATTERY.

c. BYPASS.

d. ALARM.

2.8.2 Audible Alarm

Any single indicator shall also turn on the audible alarm. An audible alarm reset button shall be included. This reset button shall not affect nor reset the alarm on the module.

2.9 COMMUNICATIONS AND DATA ACQUISITION

The UPS shall be equipped with field configurable communications bays that will accommodate a minimum of two (2) communication devices.

A Base 10T/100T communications and data acquisition port/card shall be provided. This port/card shall allow the system parameters, status, alarm indication and control panel functions specified to be remotely monitored and controlled.

Additionally, a second communication port shall be provided for use with the following:

a. A set of six Form C remote alarm contacts rated not to exceed 28VDC or 277VAC, 5A, shall be provided for remote alarm monitoring.

b. Provide KCCS compatible protocol to interface with KCCS Citect Scada System via via KNET/KITS transmission via Modbus TCP/IP.

All the communication ports and contacts shall be capable of simultaneous communication. All hardware interfaces shall be "hot-swappable".

2.10 TEMPERATURE CONTROL

2.10.1 General

Cabinet and enclosure ventilation shall be adequate to ensure that components are operated within their ratings. Forced-air cooled rectifier,

inverter, and control unit will be acceptable. The cooling fans shall continue operation if UPS input power is lost. Redundancy shall be provided so that failure of one fan or associated circuit breaker will not cause an overheat condition. Cooling air shall enter the lower front of the cabinets and exhaust at the top. Blower power failure shall be indicated as a visual and audible alarm on the control panel.

2.10.2 Blower Power Source

Blower power source shall be internally derived with automatic transfer arrangement.

2.10.3 Temperature Sensors

Temperature sensors shall be provided to monitor the air temperature. Separate sensors shall also monitor the transformer temperature. Critical equipment over-temperature indication shall start a timer that shall shut down the UPS system if the temperature does not return below the setpoint level recommended by the UPS manufacturer.

2.11 BATTERY SYSTEM

2.11.1 General

Battery system shall contain the battery cells, racks, battery disconnect, battery monitor and cabinet, if required. A storage battery with sufficient ampere-hour rating to maintain UPS output at full capacity for the specified duration shall be provided for each UPS module. The battery shall be of heavy-duty, industrial design suitable for UPS service. The cells shall be provided , intercell connectors and cables, cell-lifting straps, cell-numbering sets, and terminal grease. Intercell connectors shall be sized to maintain terminal voltage within voltage window limits when supplying full load under power failure conditions. Cell and connector hardware shall be stainless steel of a type capable of resisting corrosion from the electrolyte used.

2.11.2 Battery Ratings

a. Type: Lead Acid.

b. Specific gravity when fully charged: 1.215.

c. End voltage 1.67 volts per cell (adjustable).

d. Float voltage: 2.27 volts per cell.

e. Equalizing voltage: 2.31 volts per cell (adjustable).

2.11.3 Battery Construction

The battery shall be of the valve-regulated, high-rate discharge, sealed, non-gassing. The batteries shall be flame retardant in accordance with UL94V2 requirements.

2.11.4 Battery Cabinet

The battery pack assembly shall be furnished in a battery cabinet matching the UPS cabinet. The battery cabinet shall be designed to allow for checking the torque on the connections in the battery system and to

provide adequate access for annual housekeeping chores. External wiring interface shall be through the bottom or top of the assembly.

2.11.5 Cell-Terminal Covers

Acid-resistant transparent cell-terminal covers not exceeding 6 feet in length and with vent holes drilled on top where needed shall be provided.

2.11.6 Battery Disconnect

Each battery pack assembly shall have factory mounted a DC rated circuit breaker provided in enclosure and located in line with the assembly. Switch shall be complete with line side and load side bus bars for connection to battery cells. Switch or breaker shall be rated as required by system capacity, and shall have an external operator that is lockable in the "off" position and have shunt trip.

2.11.7 Battery Monitoring System

A stand-alone battery monitoring system, Alber or approved equal, shall be provided for each battery pack assembly. At a minimum, this device shall monitor the following parameters:

a. Total system voltage.

b. Ambient room temperature.

c. c. Battery temperature

d. Auto detects battery discharges based on overall volts or discharge current and stores data for real-time or accelerated playback.

e. Resistance test of all cells/jars and intertiers, and stores results for trending analysis.

The system shall be Windows 2000 and XP compatible; Network compatible, Modbus TCP/IP, compatible with KCCS Citect Scada System. Provide all necessary hardware.

The monitor shall also record the total accumulated discharge minutes and accumulated battery system discharge kW hours.

During normal operations the system shall scan and log all parameters every 1 to 5 seconds (adjustable) and compare them to user-programmed alarm levels. If parameters are outside the user defined limits then the system shall alarm. If a discharge is detected, the system shall start a data logging mode and store battery voltages and discharge current.

The system shall be able to perform a battery resistance test at user defined intervals. All readings, alarms and status events shall be stored in memory for future analysis.

2.12 FACTORY TESTING

The UPS system shall be factory tested to meet the requirements specified using a test battery (not the battery to be supplied with the system). UPS module shall be factory load tested as an independent assembly with 3-phase ac input power and with battery power for a minimum of 1 hour, with meter readings taken every 10 minutes. Load shall be balanced at

rated kVA and rated power factor. Factory tests for the UPS module shall be run under full load, and will be witnessed by the Government. Should a malfunction occur, the problem shall be corrected and the test shall be repeated. As a
minimum, the factory tests shall include the parameters described in paragraphs ac Input, ac Output, Transient Response and Efficiency. The tests shall encompass all aspects of operation, such as module failure, static bypass operation, battery failure, input power failure and overload ratings. The Contracting Officer shall be notified in writing at least 3 weeks before testing. Factory-test time shall not be used for system debugging and/or checkout. Such work shall be done prior to notifying the Government that the system is ready for testing. Factory tests shall be performed during normal business hours.

2.12.1 Transient Tests

Transient tests shall be conducted using high-speed oscillograph type recorders to demonstrate the operation of the components to the satisfaction of the Government. These tests shall include 50 percent to 100 percent load changes, manual transfer, and manual retransfer. A recording instrument equipped with an event marker shall be used.

2.12.2 Efficiency Tests

Testing for efficiency shall be performed at no load and 100 percent load , 1.0 power factor, with battery fully charged and floating on the dc bus, with nominal input voltage, and with module connected to represent actual operating conditions.

2.13 CABLE LUGS AND TERMINATIONS

2.13.1 Cable Lugs

Provide appropriate compression type lugs on all ac and dc power connections to the UPS system and battery as required. Aluminum or bare copper cable lugs are not suitable.

2.13.2 Terminations

Terminals shall be supplied for making power and control connections. Terminal blocks shall be provided for field wiring terminals. Terminal blocks shall be heavy-duty, strap-screw type. Terminal blocks for field wiring shall be located in one place in each module. Control wiring shall be extended to the terminal block location. No more than two wires shall land on any terminal point. Where control wiring is attached to the same point as power wiring, a separate terminal shall be provided. If bus duct is used, bus stubs shall be provided where bus duct enters cabinets.

2.14 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, colors as specified. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 1.0 by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.15 MANUFACTURER'S NAMEPLATES

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.16 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.1.1 Control Cable

UPS control wiring shall be installed in individual separate rigid steel conduits, unless connections are made between side by side matching cabinets of UPS. Tag control wires with numeric identification tags corresponding to the terminal strip location to where the wires are connected. In addition to manufacturer's requirements, provide four additional spare conductors between UPS module and remote alarm panel in same conduit.

3.1.2 Grounding Conductor

Provide an insulated equipment grounding conductor in feeder and branch circuits. Conductor shall be separate from the electrical system neutral conductor. Ground battery racks and battery breaker cabinets with a separate equipment grounding conductor to the UPS cabinet.

3.1.3 UPS Output Conductors

Isolate the UPS output conductors from the UPS cabinet to the critical load panels and from other conductors by installing in separate conduit. Isolation shall prevent inductive coupling from other conductors.

3.1.4 Conduit Entries

Conduit entries shall use the available conduit areas shown on manufacturer's installation drawings. Conduit entries shall not be made through the front, side or rear panels of the UPS or Maintenance Bypass Cabinet.

3.1.5 Battery Cabinet Assembly

Battery cabinets are typically factory assembled for up to 100 KVA UPS systems. Battery cabinets for larger units typically require assembly at the site. Installation of battery cabinets shall conform to the manufacturer's instructions.

3.1.6 Battery Installation

Installation of batteries shall conform to the manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

Contractor shall notify Contracting Officer in writing at least 45 calendar days prior to completion of the UPS system installation. At this time the Contractor, will schedule the UPS manufacturer's technical representative to inspect the completed installation. The UPS technical representative shall provide instruction for activity personnel as specified in paragraph titled "DEMONSTRATION".

3.2.1 Installation Preparation

The following items shall be completely installed by the Contractor and be operational prior to the arrival of the UPS representative for inspection, unit start-up and testing:

a. Ventilation equipment in the UPS and battery rooms.

b. Battery cabinets and cells. This is not applicable for maintenance-free battery.

c. Battery connections including cell-to-cell, tier-to-tier, and rack-to-rack connections, with correct polarity;

d. DC power and control connections between UPS and battery circuit breaker, with correct polarity;

e. DC power connection between battery circuit breaker and battery, with correct polarity;

f. Clockwise phase rotation of ac power connections;

g. AC power to rectifier input bus;

h. AC power to UPS bypass input bus;

i. AC power to UPS maintenance bypass circuit breaker;

j. AC power from UPS output to UPS maintenance bypass output circuit breaker;

k. Remote monitors and control wiring;

l. UPS system and battery system properly grounded;

m. Control connections between UPS module and UPS maintenance bypass cabinet;

n. Clean and vacuum UPS and battery room floors, battery cells, and UPS equipment, both inside and outside.

o. Ensure that shipping members have been removed.

3.2.2 Initial Inspection and Tests

The UPS technical representative and the Contracting Officer, in the

presence of the Contractor, will inspect the completed installation. The Contractor shall correct construction or installation deficiencies as directed. Perform acceptance checks in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections, performed in accordance with NETA ATS.

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with drawings, specifications and approved shop drawings.

(2) Inspect physical and mechanical condition. Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware. Inspect the displays for scratches, dark pixels or uneven brightness.

(3) Inspect anchorage, alignment, grounding, and required clearances.

(4) Verify that fuse sizes and types correspond to drawings.

(5) Verify the unit is clean inside and out.

(6) Test all electrical and mechanical interlock systems for correct operation and sequencing.

(7) Inspect bolted electrical connections for high resistance using one of the following methods:

(a) Use a micro-ohmmeter.

(b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(c) Perform thermography survey.

(8) Verify operation of forced ventilation.

(9) Verify that vents are clear and new clean filters are installed.

3.2.3 Performance Tests

Provide equipment, test instruments, power, load bank, cables, materials and labor required for tests. Contracting Officer will witness all tests and the tests shall be subject to his approval. Perform tests in accordance with the manufacturer's recommendations and include the following electrical tests.

3.2.3.1 UPS Unit Performance Tests

Upon completion of battery activation procedures, Contractor shall connect load bank to UPS output. Load bank required shall be determined by the following:

UPS KVA RATING X 0.8 = KW of LOAD BANK

Performance test is to be run under the supervision of the UPS technical representative. UPS unit shall be operated under full load for a minimum of one hour. Contractor shall be required to operate feeder and bypass power feeder breakers during testing of the UPS.

a. Electrical Tests

(1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

(2) Test static transfer from inverter to bypass and back. Use normal load, if possible.

(3) Set free running frequency of oscillator.

(4) Test dc undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.

(5) Test alarm circuits.

(6) Verify synchronizing indicators for static switch and bypass switches.

(7) Perform electrical tests for UPS system breakers.

(8) Perform electrical tests for UPS system batteries.

b. Test Values

(1) Compare bolted connection resistances to values of similar connections.

(2) Verify bolt-torque levels.

(3) Micro-ohm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

c. Load Test

The installed system shall be load tested by means of resistive load banks. The system shall be continuously tested at full load for a maximum of 1 hour.
Provide resistive load banks of total kW load of equipment to facilitate startup under load conditions, and to conduct load tests described above. Instrument readings shall be recorded every 1 minute for the following:

(1) Input voltage (all three phases).

(2) Input current (all three phases).

(3) Input frequency.

(4) Battery voltage.

(5) Output voltage (all three phases).

(6) Output current (all three phases).

(7) Output kilowatts.

(8) Output frequency.

The Contractor shall furnish.

3.3 DEMONSTRATION

3.3.1 Instructing Government Personnel

Furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. Provide 8 hours of instruction for maintenance personnel.

3.4 NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6 DISPOSAL

Upon completion of UPS installation and testing, Contractor shall remove and dispose of empty, partially full and excess acid drums, including shipping containers, obsolete batteries, and obsolete UPS modules. Removal shall be accomplished off-base and in conformance with local laws and regulations regarding disposal of hazardous material.

-- End of Section --

SECTION 26 36 23.00 20

AUTOMATIC TRANSFER SWITCHES
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 802.3	(2005; R 2006) Standard for Information Technology Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks Specific Requirements - Part 3; Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1008	(2012) Transfer Switch Equipment
UL 508	(1999; Reprint Apr 2010) Industrial Control Equipment

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, and Section 26 08 00 APPARATUS INSPECTION AND TESTING, apply to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Automatic Transfer Switch Drawings; G

KCCS Monitoring and Control System Integration; G
Include hardware, software, and interconnection drawings which include details of the power sources and communications pathways for devices accessed by KCCS. Submit read/write register list that is available through TCP/IP Modbus and/or RS-485 Modbus for remote KCCS monitoring.

SD-03 Product Data

Automatic Transfer Switches; G
Include Product Catalog Data Sheets, Technical Data Sheets, and Replacement Parts List.

SD-06 Test Reports - Submit procedures for approval prior to testing. Submit procedures with final results after testing is complete.

Acceptance Checks and Tests; G

Functional Acceptance Tests; G

SD-07 Certificates

Proof of UL Listing; G

Controls Specialist Qualifications; G
Include the qualifications of the controls engineer that will perform the KCCS system integration and overall system validation.

SD-08 Manufacturer's Instructions

Automatic Transfer Switches; G
Include installation and operation and maintenance instructions

SD-10 Operation and Maintenance Data

Automatic Transfer Switches, Data Package 5; G

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Include final as-built read/write register list that is available through TCP/IP Modbus and/or RS-485 Modbus for remote KCCS monitoring.

Submit one unbound and five bound copies to include as-built documentation for all previously submitted documentation including Shop Drawings, Product Data, Test Reports, Manufacturer's Instructions, and Certificates. Include an Adobe pdf file of the entire manual data package on a compact disc.

1.4 QUALITY ASSURANCE

1.4.1 Proof of UL Listing

Submit proof of listing to UL 1008.

1.4.2 Automatic Transfer Switch Drawings

Drawings shall include outline, arrangement, and detail drawings. Detail drawings shall include manufacturer's name and catalog number, electrical ratings, total system transfer and re-transfer sequence of operation statement, reduced normal supply voltage at which transfer to the alternate supply is initiated, transfer delay times, short-circuit current rating, control wiring diagrams, power wiring diagrams showing all phases (including neutral and ground), detail of all control and power interconnections, testing instructions, acceptable conductor type for terminals, tightening torque for each wire connector, and other required UL 1008 markings.

1.5 DEFINITIONS

The Kennedy Complex Control System (KCCS) is a combination of hardware and software components that are used to monitor and control Power, HVAC, Water and Waste and Pneumatic Utilities across the Kennedy Space Center.

CITECT is an Industrial Controls, Supervisory Control and Data Acquisition (SCADA) software application that is used to monitor and control the I/O devices connected to the KCCS network. The CITECT application provides the Human Machine Interface (HMI) to display, trend, alarm, control and/or monitor the I/O points connected to or through the I/O devices. Information is transferred to and from the CITECT server over a dedicated Ethernet controls network using Modbus TCP/IP as the transportation protocol.

1.6 ENGINEERING SERVICES

The Contractor shall provide a Controls Specialist to oversee the integration and validation of the integration of the automatic transfer switch control system into the KCCS system. Submit the Controls Specialist qualifications for approval. Submit shop drawings of the KCCS monitoring and control system integration.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCHES

Provide three-pole, 2-position; mechanically held and interlocked automatic transfer switches for use in emergency systems in accordance with UL 1008. Each automatic transfer switch shall be rated for total system transfer and have the current and voltage ratings as indicated. The rating of the switch shall be adequate for withstanding the effects of the indicated RMS symmetrical fault current when protected by the indicated over-current device without contact welding.

The switch operating mechanism shall be electrically operated from the source, to which it is transferring, shall have quick-make, quick-break, load break contacts, and shall be mechanically held in both positions. Provide switches utilizing circuit breakers rated for continuous duty, bolted in place, and capable of transferring in 100 milliseconds or less. Switch shall utilize molded- or insulated-case switches with no over-current trip functions. Transfer switches shall have manual operating means provided for maintenance and servicing and externally operable without opening the enclosure. The manual operating means shall affect the opening and closing of the switch contacts at the same rate of speed as that caused by the automatic operation of the switch. Automatic

transfer switches provided with by-pass/isolation switches shall be mounted on a draw-out mechanism so that the automatic transfer switch can be removed from the enclosure. The switch enclosure shall comply with UL 508, NEMA Type 1, and shall be equipped with an equipment ground bus.

2.1.1 By-Pass/Isolation Switches

Include by-pass/isolation switches for the indicated automatic transfer switches. Provide by-pass/isolation switches in accordance with UL 1008 that can be used to manually select an available power source to feed load circuits and to permit total isolation of the automatic transfer switch. The by-pass/isolation switch shall be rated for total system transfer and have the same current rating, voltage rating, number of poles, and withstand and closing rating as the associated automatic transfer switch.

2.1.2 Automatic Transfer Switch Controls

Provide all necessary controls operable by a front panel user interface. Load current and source voltages shall be displayed via front panel and remotely via the KCCS interface.

2.1.2.1 Controls for Utility-Generator Automatic Transfer Switch

Provide all necessary controls to start the generator set upon loss of the normal (utility) source, transfer the load to the generator set upon reaching rated voltage and frequency, re-transfer the load when the normal (utility) source returns, and stop the generator set. The switch shall include the following control features.

a. Three-phase normal source voltage sensing circuit with adjustable dropout, 75-93 percent of nominal, and pickup, 85-100 percent of nominal.

b. Engine starting control contacts with adjustable commit-to-start delay circuit, 0.5-6.0 seconds.

c. Adjustable 3-phase voltage/frequency sensing circuits, set for 75 to 98 percent of nominal, for enabling load transfer to normal and emergency sources.

d. Transfer to emergency source time delay for transfer switches as indicated, adjustable 0-5 seconds.

e. Re-transfer to normal source time delay, adjustable 1-30 minutes. Switch shall re-transfer to normal source immediately upon its return if the emergency source has failed.

f. Programmable exerciser to allow automatic starting of the generator set and subsequent load transfer. Exercise periods shall be selectable for enabled/disabled and for 1 to 24 hours per day for 0 to 7 days a week. Exerciser function shall be capable of being activated both locally at the switch using standard operator interfaces and remotely using a dry contact interface. When the dry contact interface is used, the exercise period shall not end until the dry contacts are released. Upon generator failure in exercise mode, the ATS shall immediately switch back to available normal utility power.

g. Adjustable time delay transition or in-phase monitor feature for indicated transfer switches to allow safe transfer of highly inductive

loads between two non-synchronized sources.

2.1.2.2 Controls for Fire Pump Service Automatic Transfer Switch

Provide the following additional controls features:

a. Phase reversal of the normal source shall initiate transfer to the emergency/alternate source.

b. Transfer switch shall have surge protective device in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.1.3 Front Panel Devices

Provide devices mounted on cabinet front consisting of:

a. Mode selector switch with the following positions and associated functions;

1. TEST - Simulates loss of normal/preferred source system operation.

2. NORMAL - Transfers system to normal/preferred source bypassing re-transfer time delay.

b. Lamps or display indicating connected source and normal/preferred source are available.

c. Auxiliary contacts for indicating connected source and normal/preferred source available.

e. Lamps or display indicating that the by-pass/isolation switch is in the "normal by-pass", "alternate by-pass", or "isolated" position.

2.1.4 Control Contacts and Remote Monitoring

a. Auxiliary contacts and control transfer relay contacts shall have a minimum continuous current rating of not less than 10-amperes inductive at 120 volts ac. Provide the following auxiliary contacts wired to a common output terminal board:

1. Emergency position contacts, normally open when the switch is in the normal position, that close when the switch is in the emergency position.

2. Normal position contacts, normally closed when the switch is in the normal position, that open when the switch is in the emergency position.

3. Emergency source contacts, normally open when the emergency source is de-energized that close when the emergency source is available.

4. Normal source contacts, normally open when the normal source is de-energized that close when the normal source is available.

5. ATS Fault condition.

6. Phase reversal contacts on Fire Pump Automatic Transfer Switch.

b. Provide an integrated TCP/IP MODBUS hardware as part of the ATS

controller.

1. This system must comply with the applicable portions of IEEE Std 802.3. The manufacturer must demonstrate that the communications system provided under this project will communicated efficiently with the latest version of CITECT software. Efficiently implies that the data will be transmitted and received such that the response time to the KCCS workstation will be less than 4 seconds. Provide all required communications and a laptop with KCCS CITECT software.

2. The interface shall provide the following status points as a minimum - NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, POSITION STATUS, and FAULT CONDITION.

3. Develop the CITECT GUI screens to monitor and control the new data points on any new or modified ATS's that communicate to KCCS. A Government sample will be provided to the Contractor to use for development of the new operator screens. The government will integrate new screens into the existing KCCS network. The modification to the project shall include but not be limited to creating variable tags, alarm tags, trend tags, modifying/building "genies and super genies' and modifying/creating user interface screens.

4. A programming/interface software, installation and programming instruction manuals, hardware, jumpers and/or plugs required to make customer field configuration and establish KCCS communications shall be provided with each switch.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall conform to the requirements of NFPA 70 and manufacturer's recommendation.

3.2 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the automatic transfer switch.

3.2.1 Manufacturers O&M Information

The manufacturers O&M information required by the paragraph entitled "SD-10 Operation and Maintenance Data", shall have been submitted to and approved by the Contracting Officer.

3.2.2 Test Equipment

All test equipment and instruments shall be on hand prior to scheduling field tests, or subject to Contracting Officer's approval, evidence shall be provided to show that arrangements have been made to have the necessary equipment and instruments on site prior to field testing.

3.3 FIELD QUALITY CONTROL

Give Contracting Officer 15 days's notice of dates and times scheduled for tests which require the presence of the Contracting Officer. The

Contracting Officer will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The contractor shall be responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The contractor shall provide labor, equipment, apparatus, including test load, and consumables required for the specified tests. Calibration of all measuring devices and indicating devices shall be certified. The test load shall be a combination of the normal connected facility load, and resistive load banks (resistor or inductive) sized to equal to the supplying generator's rating. Perform the following field tests in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.3.1 Automatic Transfer Switch Acceptance Checks and Tests

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Confirm correct application of manufacturer's recommended lubricants.

4. Verify that manual transfer warnings are attached and visible.

5. Verify tightness of all control connections.

6. Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey is not required.

7. Perform manual transfer operations.

8. Verify positive mechanical interlocking between normal and alternate sources.

b. Electrical Tests

1. Measure contact-resistance.

2. Perform insulation-resistance on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole for one minute. Perform tests in both source positions.

3. Verify settings and operations of control devices.

4. Calibrate and set all relays and timers.

3.3.2 Functional Acceptance Tests

Functional Acceptance Tests shall be coordinated with Section 26 32 15.00 10DIESEL-GENERATOR SET STATIONARY 100-2500 KW WITH AUXILIARIES and shall include simulating power failure and demonstrating the following operations for each automatic transfer switch. Contractor shall show by demonstration in service that the automatic transfer switches are in good operating condition, and function not less than five times.

a. Perform automatic transfer tests:

1. Simulate loss of normal/preferred power.

2. Return to normal/preferred power.

3. Simulate loss of emergency power.

4. Simulate all forms of single-phase conditions.

5. Verify with a laptop that all listed registers are able to effectively communicate with no noticeable time delay to KCCS using CITECT.

b. Verify correct operation and timing of the following functions:

1. Normal source voltage-sensing relays.

2. Engine start sequence.

3. Time delay upon transfer.

4. Alternate source voltage-sensing relays.

5. Automatic transfer operation.

6. Interlocks and limit switch function.

7. Time delay and retransfer upon normal power restoration.

Engine cool down and stop test after retransfer to normal.

-- End of Section --

SECTION 26 41 00.00 40

LIGHTNING PROTECTION SYSTEM
11/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code
NFPA 780	(2011) Standard for the Installation of Lightning Protection Systems

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-59213	(Rev A) Splice Connectors

UNDERWRITERS LABORATORIES (UL)

UL 96	(2005; Reprint Oct 2010) Standard for Lightning Protection Components
UL 96A	(2007; Reprint Jul 2012) Standard for Installation Requirements for Lightning Protection Systems
UL Electrical Constructn	(2011) Electrical Construction Equipment Directory

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

Grounding system material, installation, and testing requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING applies to this section with additions and modifications specified herein.

Surge suppression material, installation, and testing requirements of Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES applies to this section with additions and modifications specified herein.

1.2.1 Verification of Dimensions

Contractor shall become familiar with all details of work, verify all dimensions in field, and shall advise Contracting Officer of any discrepancy before performing work. Make no departures without prior approval of Contracting Officer.

1.2.2 System Requirements

Materials shall consist of standard products of a manufacturer regularly engaged in production of lightning protection systems and manufacturer's latest UL approved design. Lightning protection system and materials shall conform to NFPA 70, NFPA 780, UL 96 and UL 96A.

Design air terminal spacing for a 100-Foot radius protected zone.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overall lightning protection system; G

Each major component; G

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Air Terminals; G

Main and Bonding Conductors; G

Clamp-Type Connectors; G

Lightning Protection Components; G

Hardware; G

Accessories

SD-06 Test Reports

Grounding system test; G

Lightning protection system inspection; G

SD-07 Certificates

UL listing or label; G

Submit Certificates in accordance with paragraph entitled, "System Ratings," of this section.

1.4 QUALITY ASSURANCE

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Contracting Officer.

1.4.1 Installation Drawings

a. Coordinate or incorporate with grounding system shop drawing, material, installation, and testing requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING.

b. Submit installation shop drawing for the overall lightning protection system. Drawings shall include physical layout of the equipment, dimensions, mounting details, relationship to other parts of the work, and wiring diagram.

c. Submit detail drawings for each major component to include manufacturer's descriptive and technical literature, catalog cuts, and installation instructions.

d. All Shop Drawings shall be computer aided design (CAD) generated. With each submittal, provide a CD with a complete copy of the drawings in PDF format.

e. Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made. Provide digital media compact disc (CD) with all submittals including .DWG or .DXF CAD source files as well as PDF format files for all drawings.

1.4.2 UL Listing or Label

Submit proof of compliance. Label of or listing in UL Electrical Constructnis acceptable evidence. In lieu of label or listing, submit written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that items have been tested and conform to requirements and testing methods of Underwriters Laboratories.

1.5 SITE CONDITIONS

Contractor will become familiar with details of the work, verify dimensions in the field, and advise Contracting Officer of discrepancies before performing work. Deviations from contract drawings will not be made without prior approval of Contracting Officer.

1.6 MANDATORY INSPECTION POINTS

Prior to concealing any ground connection above or below ground the following shall occur.

a. Provide 48 hour minimum notice for NASA inspections.

b. Submit to the NASA COTR all test results for grounding and bonding connections to be concealed.

c. Update as-built condition on the working copies of the installation drawing submittal.

PART 2 PRODUCTS

2.1 MATERIALS

Do not use a combination of materials that forms an electrolytic couple of

such nature that corrosion is accelerated in presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, provide conductors with protective tinned coatings. Where a mechanical hazard is involved, or protect conductors by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is provided, electrically bond conductor to conduit or tubing at the upper and lower ends by clamp type connectors or welds (including exothermic). Use UL listed bi-metal connectors when connecting aluminum lightning protection roof and down conductors to copper grounding systems.

Lightning protection equipment, Accessories, and Hardware shall conform to NFPA 70, NFPA 780, and UL 96.

2.1.1 Main and Bonding Conductors

NFPA 780 and UL 96 Class II.

Conductors shall be as specified in NFPA 780. Minimum size of main conductors shall be 115,000 circular mils. Minimum size of secondary and bonding conductors shall be 43,000 mils.

2.1.2 Copper

For Class II materials (structures exceeding 75 ft in height), provide copper main conductors that do not weigh less than 375 pounds per thousand feet, have a cross section area of not less than and minimum strand size of not less than 15 AWG. Provide loop conductors that are comprised of copper conductors not smaller than No. 4/0 AWG.

2.1.3 Aluminum

For Class II materials (structures exceeding 75 ft in height), provide aluminum main conductors that do not weigh less than 190 pounds per thousand feet, have a cross section area of not less than and minimum strand size of not less than 13 AWG.

Do not allow aluminum to contact the earth and do not use in any other manner that will contribute to rapid deterioration of the metal. Observe appropriate precautions at connections with dissimilar metals in accordance with NFPA 70 Article 110-14. Provide aluminum cable conductors for bonding and interconnecting metallic bodies to main cable that are at least equivalent to strength cross-sectional area of a No. 4 AWG aluminum wire.

2.2 COMPONENTS

2.2.1 Air Terminals

Provide terminals in accordance with UL 96, except provide Class II for Class I and Class II applications. Support air terminals more than 24 inches in length by suitable brace, with guides, not less than one-half the height of the terminal.

Air terminals shall be 1/2-inch diameter, blunt tip or round tip type, with length and location as indicated. Fasten air terminals to a connector with a male threaded stud on which the female threaded air-terminal shaft shall be mounted

Air terminals shall be not less than 24-inches high above the object to protect, tapered to a point. Separate points are not required on top of air terminals, but if used, the points shall be of substantial construction and securely attached by screw or slip joints. Air terminals more than 24-inches high shall be supported by a suitable brace with guide(s) not less than one-half the height of the air terminal.

2.2.2 Ground Rods

Provide ground rods in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING.

2.2.3 Connections and Terminations

Provide connectors for splicing conductors that conform to UL 96, class as applicable. Conductor connections can be made by clamps or welds (including exothermic). Provide style and size connectors required for the installation of corrosion-resistant material (bimetallic) affording protection against electrolysis when joining dissimilar metals. Only use clamp-type connectors for the connection of the roof conductor to the air terminal and to the guttering. All other connections, bonds, and splices shall be done by exothermic welds or by high compression fittings. List the exothermic welds and high compression fittings for the purpose. The high compression fittings shall be the type which require a hydraulically operated mechanism to apply a minimum of 10,000 psi.

2.2.4 Connector Fittings

Provide connector fittings for "end-to-end", "Tee", or "Y" splices that conform to NFPA 780.

2.2.5 Lightning Protection Components

Provide bonding plates, air terminal supports, chimney bands, clips, and fasteners that conform to UL 96 classes as applicable.

2.3 CLAMP-TYPE CONNECTORS

Clamp connectors for splicing conductors shall conform to UL 96 and CID A-A-59213, Class 2 non-insulated, style and size as required for the installation. Connectors shall be of corrosion-resistant material and shall afford protection against electrolysis.

2.4 LIGHTNING PROTECTION COMPONENTS

Lightning protection components, such as bonding plates, air terminal supports, chimney bands, clips, and fasteners shall conform to UL 96, classes as applicable.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

Lightning protection system consists of air terminals, roof conductors, down conductors, ground connections, grounding electrodes and ground loop conductor. Install lightning protection system in accordance with NFPA 780, and UL 96A. Electrically interconnect lightning protection system to form the shortest distance to ground. Do not use nonconducting parts of the

structure as part of the building's lightning protection system. Expose conductors on the structures except where conductors are required to be in protective sleeves. Interconnect secondary conductors with grounded metallic parts within the building. Make interconnections within side-flash distances at or above the level of the grounded metallic parts.

3.1.1 Air Terminals

Provide air terminal design and support conforming to NFPA 780. Rigidly connect terminals to, and make electrically continuous with, roof conductors by means of pressure connectors or crimped joints of T-shaped malleable metal. Provide pressure connector or crimped joint with a dowel or threaded fitting to connect ground rod conductor with air terminal. Set air terminals at ends of structures not more than 2 feet from ends of ridges and corners of roofs. Do not exceed 25 feet in spacing of 2 foot high or greater air terminals on ridges, parapets, and around perimeter of building with flat roofs. When necessary to exceed this spacing, use taller air terminals and the rolling sphere method. On large flat, or gently sloping roofs, as defined in NFPA 780, place air terminals at points meeting the 100-Foot radius rolling sphere method requirement. Secure air terminals against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces which are permanently and rigidly attached to the building or structure. Metal projections and metal parts of buildings such as smokestacks and other metal objects that are at least 3/16 inch thick and that do not contain hazardous materials, need not be provided with air terminals. However, bond these metal objects to a lightning conductor through a metal conductor of the same unit weight per length as the main conductor. Where metal ventilators are installed, mount air terminals thereon, where practical. Bond air terminals, erected by necessity adjacent to a metal ventilator, to the ventilator near the top and bottom. Where nonmetallic spires, steeples, or ventilators are present, mount air terminals to the side. In addition, where spires or steeples project more than 10 feet above the building, continue conductor from air terminal to nearest down conductor securely connect thereto. Where metal ventilators are installed, mount air terminals thereon, where practicable. Any air terminal erected by necessity adjacent to a metal ventilator shall be bonded to the ventilator near the top and bottom. Where metal ventilators are installed with air terminals mounted thereon, the air terminal shall not be more than 24 inch away from the farther edge or corner. If the air terminal is farther than this distance, add an additional air terminal in order to meet this requirement. Where metal ventilators are installed with air terminals mounted adjacent, the air terminal shall not be more than 24 inches away from the farther edge or corner. If the air terminal is farther than this distance, add an additional air terminal in order to meet this requirement.

3.1.2 Roof Conductors

Connect roof conductors directly to the roof or ridge roll. Avoid sharp bends or turns in conductors. Do not make turns of less than 8 inches radius. Preserve horizontal or downward course on conductors. Rigidly fasten conductors every 3 feet along the roof and down the building to the ground. Rigidly connect metal ventilators to the roof conductor at two places. Make connections electrically continuous. Course roof conductors along contours of flat roofs, ridges, parapets, and edges; and where necessary, over flat surfaces, in such a way as to join each air terminal to all the rest. Connect roof conductors surrounding tank tops, decks, flat surfaces, and flat roofs to form a closed loop.

3.1.3 Down Conductors

Make down conductors electrically continuous from air terminals and roof conductors to grounding electrodes. Course down conductors over outer extreme portions of the building, such as corners, with consideration given to location of ground connections and air terminals. Provide each building or structure not less than two down conductors located as widely separated as practicable, such as at diagonally opposite corners. Structures exceeding 250 feet in perimeter, provide at least one additional down conductor for each 100 feet of perimeter or fraction thereof. Provide enough conductors so that the average distance between them along the perimeter is not greater than 100 feet. Structures exceeding 50 feet in height, provide at least one additional down conductor for each additional 60 feet of height or fraction thereof, except that this application will not cause down conductors to be placed about the perimeter of the structure at intervals of less than 50 feet. Install additional down conductors when necessary to avoid "dead ends" or branch conductors ending at air terminals, except where the air terminal is on a roof below the main protected level and the "dead end" or branch conductor is less than 16 feet in length and maintains a horizontal or downward coursing. Equally and symmetrically spaced down conductors about the perimeter of the structure. Protect conductors where necessary, to prevent physical damage or displacement to the conductor. Protect down conductors by placing in conduit for a minimum distance of 72 inch above finished grade level. If the conduit is metal, bond the down conductor at the top and bottom of the conduit.

3.1.4 Interconnection of Metallic Parts

Connect metal doors, windows, and gutters directly to ground or down conductors using not smaller than No. 6 copper conductor, or equivalent. Where there is probability of unusual wear, mechanical injury, or corrosion, provide conductors with greater electrical capacity than normal or protect the conductor. Provide mechanical ties or pressure connectors between grounds and metal doors and windows.

3.1.5 Ground Connections

Securely connect conductor forming continuations of down conductors from structure to grounding electrode in a manner to ensure electrical continuity between the two. Aluminum down conductor to copper earth electrode conductor transition shall be made above grade and shall be accessible without the use of ladders or lift equipment. Provide a ground connection for each down conductor. Attach copper down conductor section to ground rods by welding (including exothermic) or, in a ground test well, by clamping. Provide clamps suitable for direct burial. Protect ground connection from mechanical injury. Bond metal water pipes and other large underground metallic objects together with all grounding mediums. In making ground connections, take advantage of all permanently moist places where practicable, although avoid such places when area is wet with waste water that contains chemical substances, especially those corrosive to metal.

3.1.6 Grounding Electrodes

Provide grounding electrode for each down conductor consisting of adriven ground rod. Set ground rods not less than 3 feet nor more than 10 feet, from the structure. Lay ground loop around the perimeter of the structure

in a trench not less than 30 inches below grade, at a distance not less than 3 feet nor more than 10 feet from the nearest point of the structure. Install a ground loop in earth undisturbed by excavation, not earth fill, and do not locate beneath roof overhang, or wholly under paved areas or roadways where rainfall cannot penetrate to keep soil moist in the vicinity of the cable. Make connections between ground conductors and grounds or ground loop, and between ground loop and grounds electrically continuous.

3.2 APPLICATIONS

3.2.1 Nonmetallic Exterior Walls with Metallic Roof

Bond metal roof sections together which are insulated from each other so that they are electrically continuous. Connect air terminals so that they are electrically continuous with the metal roof as well as the roof conductors and down conductors. Bond ridge cables and roof conductors to the roof at upper and lower edges of roof and at intervals not to exceed 100 feet. Bond down conductors to roof conductors and to lower edge of metal roof. Where metal of roof is in small sections, make connections between air terminals and down conductors to at least four sections of the metal roof. Make connections electrically continuous and have a surface contact of at least 3 square inches.

3.2.2 Metal Roofs with Metal Walls

Bond metal roof and metal walls so that they are electrically continuous and considered as one unit. Connect air terminals to and make them electrically continuous with the metal roof as well as the roof down conductors. Bond all roof conductors and down conductors to metal roof or metal walls at upper and lower edges at intervals not to exceed 100 feet. Make all connections electrically continuous and have surface contact of at least 3 square inches.

3.2.3 Steel Frame Building

Make the steel framework of the building electrically continuous. All down conductor sections connecting to a building shall be copper and e lectrical continuity shall be provided by exothermic welding unless another specific method is indicated. Aluminum down conductor to copper down conductor transition shall be made above the roof level and shall be accessible. Connect air terminals to the structural steel framework at the ridge. Provide short runs of conductors to join air terminals to the metal framework so that proper placing of air terminals is maintained. Separate down conductors from air terminals to ground connections are not required. Where water system enters the building, securely connect structural steel framework and water system at point of entrance by a ground connector. Make connections to pipes by means of ground clamps with lugs. Make connections to structural framework by means of nut and bolt or welding. Make connections between columns and ground connections at bottom of steel columns. Make ground connections to grounds or ground loop runs from not less than one-half of the columns distributed equally around perimeter of structure at intervals averaging not more than 60 feet. When no water system enter the structure, run ground connections from steel columns distributed equally around the perimeter of the structure at intervals averaging not more than 60 feet. Bond metal doors, windows, gutters, and similar metal installation to steel work of the building. Provide a grounding electrode for each ground connection.

3.3 INTERFACE WITH OTHER STRUCTURES

3.3.1 Interconnection of Metal Bodies

Protect metal bodies of conductance if not within the zone of protection of an air terminal. All metal bodies of conductance having an area of 400 square inches or greater or a volume of 1000 cubic inches or greater shall be bonded to the lightning protection system using main size conductors and a bonding plate having a surface contact area of not less than 3 square inches. Metal bodies of inductance shall be bonded at their closest point to the lightning protection system using secondary bonding conductors and fittings. A metal body that exceeds 5 feet in any dimension, that is situated wholly within a building, and that does not at any point come within 6 feet of a lightning conductor or metal connected thereto shall be independently grounded.

3.4 FIELD QUALITY CONTROL

3.4.1 Grounding System Test

Test the earth electrode grounding system in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING.

Provide test reports showing results of all bonding resistance tests and ground electrode resistance tests. Cross reference each measurement to an alpha-numeric designation indicated on the installation drawing submittal. Reports shall be in Microsoft Word or Excel format; provide compact disc with all files on as-built submittal.

Test the resistance of all bonding connections using a high current micro-ohmmeter specifically designed for measuring resistances in from micro-Ohm to Ohm ranges (up to 10 Amp Test current, 1 micro-Ohm to 20 Ohm range). A test report shall be submitted for approval prior to construction and test data shall be recorded on this form and submitted for record including the following measurements:

3.4.1.1 Prior to concealment:

a. Across each ground grid exothermic weld connection (T-tap, cross, and ground rod connection). Measure between the different conductors or materials joined.

b. Between structural steel and the nearest connecting ground rod prior to the application of corrosion control.

c. Across each bonding jumper installed across structural steel members prior to the application of corrosion control.

d. Bonding resistance of each air terminal to its structural steel connection prior to the application of corrosion control.

3.4.1.2 With the system complete:

a. Bonding resistance across all connectors and bonding jumpers.

b. Bonding resistance of grounding conductors installed for surge suppressors and other equipment to the nearest test well.

c. Bonding resistance from each air terminal to a ground well.

3.4.2 Lightning Protection System Inspection

Make visual inspections to verify that there are no loose connections which may result in high resistance joints, and that conductors and system components are securely fastened to their mounting surfaces and are protected against accidental mechanical displacement.

3.4.3 SYSTEM RATINGS

Submit certificates showing compliance with UL requirements for "Master Label" ratings.

Lightning-protection systems conforming to the installation requirements of UL 96A shall be qualified for a UL "Master Label" rating. Installed lightning-protection system shall be inspected and approved by a certified UL inspector.

3.5 INSPECTION

The lightning protection system will be inspected by the Contracting Officer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Contracting Officer.

-- End of Section --

SECTION 26 51 00.00 40

INTERIOR LIGHTING
02/13

PART 1 GENERAL

Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2012a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A580/A580M	(2013a) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2009a) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B633	(2011) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24	(1978; R 2005) California's Energy Efficiency Standards for Residential and Nonresidential Buildings

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IES)

IES HB-10	(2011) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2012) National Electrical Safety Code
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and

	Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/IEC C78.81	(2010) American National Standard for Electric Lamps--Double-Capped Fluorescent Lamps--Dimensional and Electrical Characteristics
ANSI/IEC C78.901	(2005) American National Standard for Electric Lamps - Single Base Fluorescent Lamps--Dimensional and Electrical Characteristics
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C82.11	(2011) Lamp Ballasts - High-Frequency Fluorescent Lamp Ballasts

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

UNDERWRITERS LABORATORIES (UL)

UL 1598	(2008; Reprint Oct 2012) Luminaires
UL 935	(2001; Reprint Nov 2011) Standard for Fluorescent-Lamp Ballasts

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. Average life is the time after which 50 percent has failed and 50 percent has survived under normal conditions.

c. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as

otherwise designated. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Employ the terminology, classifications, and methods prescribed by the IES HB-10, as applicable, for the lighting system specified in data, drawings, and reports.

SD-03 Product Data

Fluorescent Lighting Fixtures; G

Fluorescent Electronic Ballasts; G

Fluorescent Lamps; G

LED Based Lighting Fixtures; G

SD-04 Samples

LED Based Lighting Fixtures; G

SD-07 Certificates

Energy Star Documentation; G

SD-10 Operation and Maintenance Data

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, which have been in satisfactory commercial or industrial use for 2-years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size, on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.2.1 Alternative Qualifications

Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.2.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than 3-years prior to date of delivery to site, unless specified otherwise.

1.4.3 Energy Efficiency Data

Comply with National Energy Policy Act and Energy Star requirements for designated lighting products. Submit Energy Star documentation for exit signs. Include data indicating lumens per watt efficiency and color rendition index of light source.

1.5 WARRANTY

Support the equipment items with service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.5.1 Electronic Ballast Warranty and LED Driver

Furnish the electronic ballast and LED drivermanufacturer's warranty, for not less than 5-years from the date of manufacture of the electronic ballast. Ballast assembly in the lighting fixture, transportation, and on-site storage is not to exceed 12-months, thereby permitting 4-years of the ballast 5-year warranty to be in service and energized. State in the warranty that the manufacturer agrees to exchange a malfunctioning ballast and promptly ship the replacement to the using Government facility, said replacement ballast being identical to, or an improvement upon, the original design of the malfunctioning ballast.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

Furnish lighting fixtures completely assembled with wiring and mounting devices and ready for installation at the locations noted. Design and equip recessed fixtures in suspended ceilings for installation in the type of ceiling in which the fixture is installed. Design fixtures to be supported independent of the ceiling. Equip fixtures with the lamps required.

Ensure lighting fixtures conform to UL 1598.

2.2 COMPONENTS

2.2.1 Fluorescent Lighting Fixtures

2.2.1.1 Fluorescent Lamp Electronic Ballasts

Submit fluorescent electronic ballasts catalog data. As an option, submit the fluorescent fixture manufacturer's electronic ballast specification

information in lieu of the actual ballast manufacturer's catalog data. Include published specifications and sketches. This information may be supplemented by catalog data if required, containing a list of vendors with vendor part numbers.

Provide electronic ballasts, meeting as a minimum, the following characteristics:

a. Provide ballasts complying with UL 935, NEMA ANSLG C82.11, NFPA 70, and CEC Title 24 unless specified otherwise. Ensure transient immunity as recommended by IEEE C62.41.1 and IEEE C62.41.2 by providing 100 percent electronic high frequency type ballasts with no magnetic core and coil components. Design ballast for the wattage of the lamps used in the indicated application. Design ballasts to operate on the voltage system to which they are connected.

b. A power factor of 0.95 (minimum).

c. Operates at a frequency of 20,000 Hertz (minimum), and is compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. Provide ballasts operating at or above 40,000 Hertz where available.

d. Light regulation of plus or minus 10 percent lumen output with a plus or minus 10 percent input voltage regulation. Ensure ballasts have 10 percent flicker (maximum) using any compatible lamp.

e. A ballast factor between 0.77 (minimum) and 1.00 (maximum). Current crest factor - 1.7 (maximum).

f. UL listed Class P with a sound rating of "A."

g. Include circuit diagrams and lamp connections displayed on the ballast.

h. Provide programmed start ballast unless otherwise indicated. Programmed start ballasts may operate lamps in a series circuit configuration. Provide series/parallel wiring for programmed start ballasts where available.

i. Provide programmed start ballasts for compact fluorescent fixtures.

j. Provide ballasts for T-5 and smaller lamps with end-of-life protection circuits as required by ANSI/IEC C78.81 and ANSI/IEC C78.901 as applicable.

k. Provide ballasts capable of starting and maintaining operation at a minimum of 0 degrees F unless otherwise indicated.

l. Provide electronic ballasts with a full replacement warranty of 5 years from date of manufacture as specified in paragraph entitled, "Electronic Ballast Warranty," of this section.2.2.1.2 Fluorescent Lamps

a. Provide linear fluorescent lamps as scheduled , CRI of 75 (minimum), with an average rated life of 20,000 hours.

Average rated life is based on 3 hours operating per start.

2.2.1.3 Compact Fluorescent Fixtures

Provide compact fluorescent fixtures manufactured specifically for compact fluorescent lamps with ballasts integral to the fixture. Providing assemblies designed to retrofit incandescent fixtures is prohibited except when specifically indicated for renovation of existing fixtures. Provide fixtures using lamps as indicated, with a minimum CRI of 80.

2.2.2 LED Based Lighting Fixtures

Housings shall be constructed to allow all electrical components accessible and replaceable. LEDs shall be mounted on removable panels/circuit boards for ease of maintenance and replacement. Drivers shall be easily removable for maintenance.

Housing surface temperatures shall not exceed 60 degrees C in a 30 degrees C ambient.

Drivers shall be compatible with specified controls. 0-10V drivers shall default to 100% "on" when used without 0-10V signals (on-off only control).

Fixtures shall have no noticeable flicker throughout the entire dimming range and shall be capable of starting under a dimmed condition without first cycling to full brightness.

Fixture shall meet or exceed EMI and RFI limits set by FCC (Part 18) with driver and control wiring installed.

a. Infant Abduction and similar systems are particularly sensitive to RF interference. Locations where these systems are used shall be tested by owner to ensure non-interference.

Drivers shall be thermally protected and Class A sound rated.

Provide fixture with lamps having minimum CRI of 85.

2.2.3 Surface-Mounted Fixtures

Design the surface-mounted fixtures to be fastened to wall or ceiling flush-mounted outlet boxes. Do not subject combustible ceiling materials to temperatures in excess of 195 degrees F.

2.2.4 Recessed Fixtures

Design recessed fixtures in suspended ceilings for the type of ceiling construction in which the fixture is installed. Do not subject combustible ceiling materials to temperatures in excess of 195 degrees F. Where recessed fixtures are supported on suspended ceilings, provide a minimum of four support rods per fixture with no support further than 6 inches from the edge of the fixture. Do not support fixtures by acoustic panels.

2.2.5 Pendant-Mounted Fixtures

Equip pendant-mounted fixtures with stems and swivel ball-and-socket self-aligning hangers. Allow a minimum of a 20 -degree angle swing for all ceiling canopies, and fixture-hanging devices, made of seamless brass,

aluminum, steel, corrosion-resistant steel tubing, or steel conduit not less than 1/2 inch in diameter. Stem length, material, and finish are as noted.

2.2.6 Recess- And Flush-Mounted Fixtures

Provide type that can be relamped from the bottom, with access to ballast from the bottom, with trim for the exposed surface of flush-mounted fixtures as indicated.

2.2.7 Suspended Fixtures

Install hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Use cadmium-plated steel hangers with a swivel-ball tapped for the conduit size indicated. Provide hangers which allow fixtures to swing within an angle of 45 degrees. Brace pendants 4-feet or longer provided in shops or hangers to limit swinging. Provide single-unit suspended fluorescent fixtures with twin-stem hangers. Provide multiple-unit or continuous row fluorescent fixtures with tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Provide rods with a minimum 0.18-inch diameter.

2.3 EQUIPMENT

2.3.1 Equipment Identification

2.3.1.1 Manufacturer's Nameplate

Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent is not acceptable.

2.3.1.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Clearly mark all luminaires for operation of specific lamps and ballasts according to proper lamp type. Note the following lamp characteristics in the format:

a. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

b. Start type (programmed start) for fluorescent and compact fluorescent luminaires.

c. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Ensure all markings related to lamp type are clear and located where they are readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Clearly mark ballasts indicating multi-level outputs and indicate proper terminals for the various outputs.

2.3.2 Support Hangers for Lighting Fixtures in Suspended Ceilings

2.3.2.1 Wires

Use wires that are: galvanized regular coating, soft temper, 0.1055-inches in diameter (12 gage). Ensure wires conform to ASTM A641/A641M.

2.3.2.2 Wires, for Humid Spaces

Ensure wires conform to ASTM A580/A580M, with composition 302 or 304 steel, and annealed stainless steel 0.1055-inches in diameter (12 gage).

2.3.2.3 Straps

Provide galvanized steel, 1 X 3/16-inch straps, conforming to ASTM A653/A653M, with a light commercial zinc coating, or conform to ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

2.3.2.4 Rods

Provide zinc or cadmium coated, threaded, steel rods, 3/16-inch diameter.

2.3.3 Factory Applied Finish

Provide electrical equipment with factory-applied painting systems which, as a minimum, meet the requirements of the NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Field Applied Painting

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Specify painting in Section 09 90 00 PAINTS AND COATINGS.

3.2 INSTALLATION

Ensure all electrical installations conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2.1 Lamps

Deliver lamps to the project in the original cartons. Install just prior to project completion. Replace lamps installed and used for working light during construction prior to turnover to the Government if more than 15 percent of their rated life has been used. Test the lamps for proper operation prior to turn-over and replace if necessary with new lamps from the original manufacturer. Provide 10 percent spare lamps of each type from the original manufacturer.

3.2.2 Lighting Fixtures

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures. Secure fixtures in accordance with manufacturers' directions and approved drawings, in conformance with

the requirements of NFPA 70. Mounting heights specified or indicated are to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Independently support recessed and semi-recessed fixtures from the building structure by a minimum of four wires or rods per fixture and locate near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Independently support round fixtures smaller in size than the ceiling grid from the building structure by a minimum of four wires or rods per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires or rods for lighting fixture support in this section. Lighting fixtures installed in suspended ceilings are to comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

3.2.3 Suspended Fixtures

Provide suspended fixtures with 45 degree swivel hangers so that they hang plumb and locate with no obstructions within the 45 degree range in all directions. Provide the stem, canopy and fixture capable of a 45 degree swing. Brace pendants, rods, or chains 4-feet or longer excluding fixture, to prevent swaying, using three cables at 120 degree separation. Provide suspended fixtures in continuous rows with internal wireway systems for end to end wiring and properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Use aligning splines on extruded aluminum fixtures to assure hairline joints. Support steel fixtures to prevent "oil-canning" effects. Ensure fixture finishes are free of scratches, nicks, dents, and warps, and matching the color and gloss specified. Finish pendants to match furniture. Select aircraft cable made from stainless steel. Install canopies finished to match the ceiling and are low profile unless otherwise shown. Ensure maximum distance between suspension points is 10-feet or as recommended by the manufacturer, whichever is less.

3.3 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

3.4 FIELD TESTING

Perform operational tests in the presence of the Contracting Officer and in accordance with referenced standards in this section.

-- End of Section --

SECTION 26 53 00.00 40

EXIT SIGNS
11/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code
NFPA 70	(2014) National Electrical Code

U.S. DEPARTMENT OF ENERGY (DOE)

DOE LT-4	(2000) How to Buy Energy-Efficient Exit Signs

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Material, Equipment, and Fixture Lists shall be submitted for the following showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the following in accordance with paragraph entitled, "General Requirements," of this section.

Exit Lighting Fixtures; G
Accessories

SD-02 Shop Drawings

Installation drawings shall be submitted for Exit Lighting Fixtures in accordance with the paragraph entitled, "Installation," of this section.

Outline drawings shall be submitted for Exit Lighting Fixtures indicating overall physical features, dimensions, ratings, service

requirements, and weights of equipment.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Exit Lighting Fixtures; G
Accessories; G

SD-06 Test Reports

Test reports shall be submitted showing results of Operational Tests; G of exit lighting systems.

SD-07 Certificates

Certificates shall be submitted showing compliance with the following requirements.

Efficiencies

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Emergency exit lighting fixtures shall conform to NFPA 101, and as specified.

Exit lighting fixtures shall be furnished completely assembled with wiring and mounting devices and ready for installation at the locations indicated. Ceiling-mounted fixtures shall be designed to be supported independent of the ceiling. Fixtures shall be equipped with lamps.

2.1.1 Efficiencies

Exit lighting fixtures shall have efficiencies in accordance with the recommended levels specified in DOE LT-4.

2.2 LIGHT EMITTING DIODES (LEDs) EXIT LIGHTING FIXTURES

Provide universal mount LED exit signs in equipment rooms. In all other areas provide architectural LED edge-lit exit signs. Exit lighting fixtures shall include sheet metal enclosures with frames, green light emitting diodes (LEDs) and mounting brackets. Fixtures shall be single or double faced, as shown with right, left, and double chevrons as needed. Mounting plates shall be suitable for securing the fixture to a 4 inch outlet box. Fixture features shall include continuous charging, automatic switching to standby batteries upon loss of power, overload protection, short circuit protection, test switch, low voltage disconnect, switch controlled left and right LED directional arrows, and shall be field connectable to operate from 115 or 277 volts. Brightness shall not be less than ten (10) candlepower. All components shall have a five year warranty. The energy consumption shall be 5 watts or less; qualified to US EPA's Energy Star Program.

2.3 ENCLOSURE

The assembled tamperproof enclosure shall be 20-gauge cold-rolled steel

housing with universal mounting capability; KO pattern in top and end; injection molded clear acrylic panels with chamfered edges; bottom edge hot-stamped with a silverized reflector for uniform illumination.

Each sign shall bear a permanently attached nameplate bearing the Manufacturer's Name and Address and Date of Manufacture (in addition to information required by listed authorities.

2.3.1 Face

Each face of the sign shall be a non-colored translucent panel covered by an opaque 1/8 inch red ABS plastic stencil bearing the word "EXIT" in 6 by 3/4 inch letters and including a universal directional arrow which indicates the direction of the exit (left, right or both ways).

2.3.2 Illumination

Illumination of the sign shall be by means of sealed glass tubes, internally phosphor coated and filled with tritium gas. Tubes shall be securely bonded to the enclosure and cushioned against mechanical shock. Luminous areas shall have a minimum initial brightness of 0.15 foot lamberts and a guaranteed minimum brightness after ten years of 0.080 foot lamberts.

2.3.3 Mounting Accessories

Each sign shall be supplied with tamperproof hardware for wall mounting. Edge on for double face, flat for single face or double face for ceiling mount.

PART 3 EXECUTION

3.1 INSTALLATION

Permanently fix in place the exit lights and install wiring for each unit in accordance with NFPA 70.

Unit equipment shall be connected to the same panel branch circuit serving generator backed-up emergency lighting fixtures in the area, or if not available, the same panel branch circuits serving the normal lighting in the area. Connect exit lights ahead of area switches.

3.2 FIELD TESTING

Exit lighting shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

Operational Tests, including 90-minute battery operation for unit equipment, shall be performed in accordance with referenced standards in this section.

-- End of Section --

SECTION 26 56 00

EXTERIOR LIGHTING
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IES)

IES HB-10	(2011) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C136.13	(2004; R 2009) American National Standard for Roadway Lighting Equipment, Metal Brackets for Wood Poles
ANSI C136.21	(2004; R 2009) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
ANSI C136.3	(2005; R 2009) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

UNDERWRITERS LABORATORIES (UL)

UL 1598	(2008; Reprint Oct 2012) Luminaires

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics

terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

b. Average life is the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

c. Groundline section is that portion between one foot above and 2 feet below the groundline.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire drawings; G

SD-03 Product Data

Energy Efficiency

Luminaires; G

Lamps; G

Ballasts; G

Brackets

SD-05 Design Data

Design Data for luminaires; G

SD-06 Test Reports

Operating test

Submit operating test results as stated in paragraph entitled "Field Quality Control."

SD-08 Manufacturer's Instructions

SD-10 Operation and Maintenance Data

1.4 QUALITY ASSURANCE

1.4.1 Drawing Requirements

1.4.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data shall accompany shop drawings.

1.4.2 Design Data for Luminaires

a. Distribution data according to IES classification type as defined in IES HB-10.

b. Computerized horizontal illumination levels in footcandles at ground level, taken every 10 feet. Include average maintained footcandle level and maximum and minimum ratio.

c. Amount of shielding on luminaires.

1.4.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 SUSTAINABLE DESIGN REQUIREMENTS

1.5.1 Energy Efficiency

Comply with National Energy Policy Act and Energy Star requirements for lighting products. Submit data indicating lumens per watt efficiency and color rendition index of light source.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 26 51 00.00 40 INTERIOR LIGHTING.

2.2 LUMINAIRES

UL 1598. Provide luminaires as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness characteristics, and of equal finish and quality will be acceptable as approved.

2.3 BRACKETS AND SUPPORTS

ANSI C136.3, ANSI C136.13, and ANSI C136.21, as applicable. Pole brackets shall be not less than 1 1/4 inch aluminum secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head.

2.4 EQUIPMENT IDENTIFICATION

2.4.1 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.4.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Luminaires shall be clearly marked for operation of specific lamps and ballasts according to proper lamp type. The following lamp characteristics shall be noted in the format "Use Only _____":

a. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

c. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.

d. ANSI ballast type (M98, M57, etc.) for HID luminaires.

e. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.5 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 GROUNDING

Ground noncurrent-carrying parts of equipment including luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.1.2 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.2 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that the equipment operates in accordance with the requirements of this section.

-- End of Section --

SECTION 26 56 13.00 40

LIGHTING POLES AND STANDARDS
11/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LTS-5	(2009; Errata 2009; Amendment 1 2010; Amendment 2 2011) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B108/B108M	(2012; E 2012) Standard Specification for Aluminum-Alloy Permanent Mold Castings

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IES)

IES HB-10	(2011) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2012) National Electrical Safety Code
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 263	(1973) ISO Inch Screw Threads - General Plan and Selection for Screws, Bolts and Nuts - Diameter Range 0.06 to 6 inch

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C136.21	(2004; R 2009) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires

ANSI C136.3 (2005; R 2009) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) Grounding and Bonding Equipment

1.2 DEFINITIONS

Groundline section is that portion between one foot above and 2 feet below the groundline. Refer to IEEE Stds Dictionary for additional related definitions and terminology.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Poles; G

Installation Details

SD-03 Product Data

Aluminum poles; G

Brackets; G

Anchorage Systems; G

SD-05 Design Data; G; G,

Poles;

Manufacturer's Catalog Data; G

Manufacturer's color charts and chips; G

Factory Color Finish; G

Material Safety Data Sheets; G

SD-07 Certificates

SD-08 Manufacturer's Instructions

Foundation requirements; G

Mounting details; G

Submit instructions prior to installation.

SD-10 Operation and Maintenance Data

SD-11 Closeout Submittals

Warranty; G

Record drawings; G

1.4 QUALITY ASSURANCE

1.4.1 Drawing Requirements

1.4.1.1 Poles

Include dimensions, wind load determined in accordance with AASHTO LTS-5, pole deflection, pole class, and other applicable information conforming to IES HB-10.

1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, which have been in satisfactory commercial or industrial use for 2 years prior to bid opening under similar circumstances and of similar size, and have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section. Submit 3 copies of all mounting details.

1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not allowed, unless specified otherwise.

1.4.4 Pre-Installation Conference

After submittals are received and approved, but before installation is performed, the Contracting Officer will hold a pre-installation conference

to review the following:

a. The drawings, including Poles,showing complete Installation Details, and specifications.
Include details for the following for review:

foundation requirements
anchorage systems
manufacturer's catalog data including mounting and bracket details
Factory Color Finish

Submit manufacturer's color charts and chips, approximately 4 by 4 inches, showing full range of colors, textures and patterns available for aluminum poles with factory applied finishes.

b. Finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to pole and luminaire installation, including manufacturer's written instructions and verification of pole system assembly wind load classification listings.

d. Governing regulations and requirements for insurance, certificates, tests and inspections if applicable. Include certification for pole system assembly wind load rating classification. Safety plan review must include applicable Material Safety Data Sheets.

e. Temporary protection requirements for pole assembly during and after installation.

f. Pole system observation and repair procedures after complete installation. Include review of sample Enamel Repair Paint.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle poles, and all related accessories and other manufactured items in a manner to prevent damage or deformation.

1.5.1 Aluminum Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.6 WARRANTY

Provide support for the equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

AND GROUNDING. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 26 51 00.00 40 INTERIOR LIGHTING.

2.2 POLES

Provide poles designed for wind loading of 160 miles per hour determined in accordance with AASHTO LTS-5 while supporting luminaires and all other appurtenances indicated. Provide effective projected areas of luminaires and appurtenances used in calculations specific to the actual products provided on each pole. Provide embedded anchor type bases designed for use with underground supply conductors. Provide an oval-shaped handhole having a minimum clear opening of 2.5 by 5 inches. Secure handhole cover with stainless steel captive screws. Provide metal poles with an internal grounding connection accessible from the handhole near the bottom of each pole. Do not install scratched, stained, chipped, or dented poles.

2.2.1 Aluminum Poles

2.2.1.1 Finish

Provide aluminum poles with a dark anodic bronze finish, manufactured of corrosion resistant aluminum alloys conforming to AASHTO LTS-5 for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3,5) for cast alloys. Do not paint.

Provide aluminum castings conforming to ASTM B108/B108M. Provide seamless extruded or spun seamless type poles with minimum 0.188 inch wall thickness, with tenon end to support luminaire indicated.

2.2.1.2 Grounding Connection Provisions

Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Provide aluminum standard with a 1/2-inch square nut, 13 threads per inch, as specified in ISO 263, welded to the inside of the pole for ground connections.

2.2.1.3 Ground Rods

Provide ground rods made of solid copper conforming to UL 467 not less than 3/4 inch in diameter by 20 feet in length of the sectional type driven full length into earth.

2.2.1.4 Top Cover and Bases

Fit tops of shafts with a round or tapered cover. Mount bases with anchor bolts, made of cast 356-T6 aluminum alloy in accordance with ASTM B 108, machined to receive the lower end of shaft. Weld the joint between shaft and base. Provide cast 356-T6 aluminum alloy base cover in accordance with ASTM B 108. Provide hardware, except anchor bolts, made with either 2024-T4 anodized aluminum alloy or stainless steel.

2.2.1.5 Transport and Handling Protection

Ensure manufacturer's standard provision is made for protecting the finish during shipment and installation. Minimum protection consists of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

2.3 BRACKETS AND SUPPORTS

Provide brackets and supports conforming to ANSI C136.3, and ANSI C136.21, as applicable, with pole brackets not less than 1 1/4 inch aluminum secured to pole. Slip-fitter or pipe-threaded brackets may be used, if brackets are coordinated to luminaires provided. Provide identical brackets for use with one type of luminaire. Provide brackets for pole-mounted street lights which correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Provide special mountings or brackets as indicated of metal which will not promote galvanic reaction with luminaire head.

2.4 FOUNDATIONS FOR LIGHTING POLES

Provide foundations for lighting poles in accordance with manufacturer's recommendations. Submit Equipment Foundation Data in accordance with referenced standards in this section.

2.4.1 Concrete Foundations

Proportion, mix, and place concrete materials to provide a minimum 28-day compressive strength of 4,000 pounds per square inch.

Provide concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.4.1.1 Anchor Bolts

Provide galvanized high strength steel rod anchor bolts, with a lower deformed 90 degree bend and threaded top conforming to ASTM A36/A36M, having a minimum yield strength of 50,000 psi; with the top 12 inches of the rod galvanized in accordance with ASTM A153/A153M.

PART 3 EXECUTION

3.1 INSTALLATION

Provide electrical installations conforming to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 Aluminum Poles

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end. Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods are as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.

3.2 INSTALLATION OF POLE FOUNDATIONS

3.2.1 Excavation

Restrict excavation in size to that which will provide sufficient working space for installation of concrete forms. Should soil conditions at the bottom of the excavation be unsuitable as a foundation, as determined by

the Contracting Officer, take the excavation down to firm soil and fill to required grade with concrete or satisfactory soil materials as directed.

Perform excavations in a manner to prevent surface, subsurface, and ground water from flowing into the excavation. Use pumps or other dewatering methods necessary to convey the water away from the excavation work below ground-water level.

3.2.2 Formwork

Construct forms of wood, plywood, steel, or other acceptable materials fabricated to conform to the configuration, line, and grade required. Reinforce formwork to prevent deformation while concrete is being placed and consolidated. Wet or coat formwork with a parting agent before placing concrete.

3.2.3 Setting of Anchor Bolts

Set anchor bolts or rods with exposed threaded ends vertically positioned in the concrete using a template supplied by the pole manufacturer in accordance with the lighting standard manufacturer's recommendations.

3.2.4 Concrete Placement

Level and steel trowel concrete bearing surface to a smooth, hard, dense finish surface. After form work is removed, protect the exposed concrete with impervious paper or burlap material and keep wet for the full curing period.

3.3 POLE SETTING

Install poles, with their bases level so that poles are plumb. Once the concrete has cured, set the pole on the foundation, level on the foundation bolts, and secure with the holding nuts. Grout the space between the foundation and the pole base. Conform concrete and grout work to Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide concrete strength of 4000 psi at 28 days.

3.4 GROUNDING

Provide grounding conforming to NFPA 70, the contract drawings, and the following:

a. Provide soft-drawn, stranded copper grounding conductors.

b. Drive ground rods into the earth so that after the installation is complete, the top of the ground rod will be approximately 1 foot below finished grade, except in handholes.

3.4.1 Ground Rods

Measure the resistance to ground using the fall-of-potential method described in IEEE 81. The maximum resistance of a driven ground rod is not to exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes interconnected with grounding conductors, to achieve the specified ground resistance. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting

Officer immediately. Fusion weld connections below grade. Fusion weld or use UL 467 approved connectors for above grade connections.

3.4.2 Items to be Grounded

Ground all ground conductors, metallic conduits, junction boxes, and noncurrent-carrying metallic parts of equipment. Make connections above grade with solderless connectors, and fusion weld those below grade.

3.4.3 Lighting Pole

Provide one ground rod at each pole. Connect bases of metal or concrete lighting poles to ground rods by means of No. 2 AWG bare copper wire. Ground lighting fixture brackets on wood and concrete poles to a No. 6 AWG bare copper grounding conductor connected to the ground rod.

3.4.4 Ground Resistance Measurements

Measure the resistance to ground by the fall-of-potential method described in IEEE 81.

3.4.5 Record Drawings

Maintain and keep up to date, a separate set of drawings, elementary diagrams and wiring diagrams of the lighting to be used for "record" drawings, showing all changes and additions to the lighting system. In addition to being complete and accurate, keep this set of drawings separate and do not use for installation purposes. Upon completion of the record drawings, a representative of the Government will review the as-built work with the Contractor. If the as-built work is not complete, the Contractor will be so advised and complete the work as required.

-- End of Section --

SECTION 26 60 13.00 40

LOW-VOLTAGE MOTORS
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(1990; R 2008) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990; R 2008) Load Ratings and Fatigue Life for Ball Bearings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2004) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
NETA MAINT	(2011) Standard for Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; Cor 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011; Errata 2012) Motors and Generators

U.S. DEPARTMENT OF ENERGY (DOE)

DOE CI-1	(2001) How to Buy a Premium Energy-Efficient Electric Motor

1.2 ADMINISTRATIVE REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sample Warranty; G

Equipment and Performance Data; G

Manufacturer's Instructions; G

SD-02 Shop Drawings

Informational Drawings; G

SD-03 Product Data

Motor Enclosures; G

Motor Design Data; G

SD-07 Certificates

Factory Test Results; G

Efficiency; G

Power-Factor; G

Service Factor; G

Temperature Rating; G

Noise; G

Full-Load; G

Locked-Rotor; G

Insulation Resistance; G

Winding Resistance; G

High-Potential Tests; G

SD-08 Manufacturer's Instructions

Motors; G

SD-10 Operation and Maintenance Data

Operating and Maintenance Manual; G

SD-11 Closeout Submittals

Warranty; G

1.4 DELIVERY, STORAGE, AND HANDLING

Ensure all motors and related equipment are packaged and protected to prevent any damage during shipping, after acceptance of delivery, storage, and handling at the project site. Include manufacturer's instructions for proper handling and uncrating with the shipment of the Low-Voltage Motor(s).

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide Low-Voltage Motors of a sufficient size for the duty to be performed not exceeding the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions. Submit equipment and performance data and informational drawings.

2.1.1 Motor Types

Provide Low-Voltage Motors of the following types:

a. 1/3 HP and smaller, single phase - capacitor start

b. 1/2 HP and larger, three-phase - induction squirrel-cage type, NEMA Design B, having normal starting torque and low starting current

2.1.2 Design Requirements

Provide Low-Voltage Motors (LVM) designed for across-the-line starting with torque characteristics to carry the specified rated starting load. Ensure LVM have factory-sealed ball bearings with an L-10 rated life of not less than 30,000 hours in accordance with ABMA 9 or ABMA 11. Motors used with variable frequency drives shall be inverter duty rated and shall be suitable for operation over entire speed range indicated.

Ensure design, fabrication, testing, allowable balance limits and performance of polyphase induction motors are in accordance with NEMA MG 1 and ISO 1940-1 and meets or exceeds the requirements as specified herein.

Provide the following motor design data prior to final turnover:

a. Number of motor rotor bars

b. Stator slots

c. Rotational speed

d. Number of cooling fan blades

e. RPM of motor

f. Bearing manufacturer

g. Bearing type

h. Bearing style

i. Number of balls/elements

j. Number of commutator bars

k. Commutator brushes

l. SCR firing frequencies

2.1.2.1 Sizes Of Motors

Provide motors of a sufficient size for the duty to be performed, and not exceeding the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions.

2.1.2.2 Efficiency

Ensure motors have efficiencies in accordance with the recommended levels specified in DOE CI-1.

Ensure efficiency labeling is in accordance with NEMA MG 1.

2.1.3 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, ensure adjustments have been made to the motor size, wiring and conduit systems, disconnect devices, and circuit protection to accommodate the equipment actually installed, at no additional cost to the Government. Provide control and protective devices in accordance with Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.2 VOLTAGE RATINGS

Provide motors with the following minimum voltage ratings:

MOTOR SIZE			MOTOR
MOTOR TYPE	HORSEPOWER	SERVICE	VOLTAGE RATING
Fractional horsepower, single-phase	1/3 and smaller	120/208-volt, 3-phase, 4-wire	115-volt, 60-hertz
Fractional and integral horsepower, 3-phase	1/2 and larger	120/208-volt, 3-phase, 4-wire	200-volt, 3-phase 60-hertz
Fractional and integral horsepower, 3-phase	1/2 and larger	480-volt, 3-phase, 3-wire	230/460-volt, 3-phase, 60-hertz

2.3 TEMPERATURE RATING AND INSULATION

Provide motors designed for continuous operation at the rated full load in an ambient temperature of 104 degrees F , with an insulation level of at least Class B.

2.4 MOTOR ENCLOSURES

2.4.1 Indoor Type Enclosures

For motors installed in indoor, clean, dry, nonhazardous locations, provide the following:

a. Open-type drip-proof enclosures

For motors installed in indoor, wet, nonhazardous locations, provide the following:

a. Open splash-proof enclosures

For motors installed in indoor, nonhazardous locations where it is necessary to protect the motor from dirt, moisture, chemical fumes, or other harmful ingredients in the surrounding atmosphere, provide either of the following type of enclosure:

a. Totally enclosed, not fan-cooled, enclosures not equipped for cooling by means external to the enclosing parts.

b. Totally enclosed fan-cooled enclosures for exterior cooling by means of a fan or fans integral with the machine but external to the enclosing parts.

2.4.2 Outdoor Type Enclosures

For motors installed in outdoor, nonhazardous locations, provide waterproof enclosures.

2.5 SERVICE FACTOR

Ensure service factor of general purpose and other open ac motors is in accordance with NEMA MG 1.

Provide totally enclosed ac motors with a service factor of 1.15 . Provide ac motors used with variable frequency drives with a service factor of 1.0.

2.6 FACTORY TESTS

Factory test all motors in accordance with the requirements of NEMA MG 1. Ensure polyphase induction motors are factory-tested in accordance with IEEE 112, Method B, consisting of measurements of voltage, frequency, speed, and current under no-load conditions; voltage, frequency, and current under locked-rotor conditions; and efficiency, noise, power factor, and thermal protection. Verify routine tests on wound-rotor induction motors include the measurement of wound-rotor open-circuit voltage across the slip rings under locked-rotor conditions. Provide written documentation of electrical tests including winding resistance, insulation resistance, and high-potential tests. Submit certified copies of factory test results for approval prior to shipment from the factory. Previous test reports on identical motors are not acceptable for these tests.

PART 3 EXECUTION

3.1 INSTALLATION

Install, align, and connect motors in accordance with the equipment manufacturer's instructions.

Mount motors with bolts. Ensure motor feet are coplanar within 0.001 inch, and base mounting points are accessible and adjustable to enable machine alignment. For motors over 7.5 hp, provide alignment jack bolts installed to enable alignment.

Recheck alignment of motors and adjust as required after the motor has been in operation for not less than 48 hours.

3.2 ALIGNMENT

Before attempting alignment, demonstrate that the load does not have any load/force imposed by the piping system. Minimum alignment values (below) are for motor and load at normal running temperatures. Ensure values are compensated for thermal growth. Correct limited movement of the motor or load (commonly known as bolt-bound) to ensure alignment capability. Do not undercut hold down bolts in order to perform adjustment.

Provide commercially die-cut shims, without seams or folds, made of corrosion resistant stainless steel. Use no more than four shims at any single point.

Align motor and load to the following minimum specifications:

Speed(RPM)	Close-Coupled Offset (mils)	Close-Coupled Angle(mils/in.)	Spool Piece Angle (mils/in. @ coupling pt.)
600	6.0	2.0	3.0
900	5.0	1.5	2.0
1200	4.0	1.0	1.5
1800	3.0	0.5	1.0
3600	1.5	0.4	0.5
7200	1.0	0.3	0.4

Perform motor/load alignment under the direction of the manufacturer's representative.

Provide written final alignment settings as part of the final test data.

3.3 ELECTRICAL TESTS

Perform continuity test on all phases.

Perform insulation resistance and polarization index test on each phase of motor. Conduct insulation tests on 480-volt and 600-volt motors using a 1000-volt insulation test set. For insulation tests on motors rated less than 480-volts, use a 500-volt insulation test set.

Include in test data the location and identification of motors and megohm readings versus time. Record test data at 15, 30, 45 seconds, and in 1 minute increments thereafter up to 10 minutes. Ensure Megohm readings are not be less than 25 megohms for each phase; and each phase reading is within 10 percent of the other two.

Perform inspections and test procedures on all motors in accordance with NETA ATS and NETA MAINT 7.15.1 for rotating machinery, AC motors.

Calculate the polarization index of each phase by dividing the 10 minute reading by the 1 minute reading. Verify that the polarization index is than 1.25. Reject any lower values and return the motor to the factory.

3.4 OPERATION AND MAINTENANCE DATA

No later than 10 days prior to final acceptance, submit manufacturer's operating and maintenance manual to the Contracting Officer.

3.5 WARRANTY

No later than 10 days prior to final acceptance, submit manufacturer's warranty to the Contracting Officer.

-- End of Section --

SECTION 27 05 28.36 40

CABLE TRAYS FOR COMMUNICATIONS SYSTEMS
08/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2012a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA VE 2	(2006) Cable Tray Installation Guidelines

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

1.2 ADMINISTRATIVE REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.2.1 Pre-Installation Meetings

The Contracting Officer will schedule a pre-installation meeting within 30 days of Contract Award. Submit the following for review and approval:

a. Fabrication Drawings

b. Installation Drawings

Submit manufacturer's product data for the following items:

a. Cable Trays

b. Supports

1.2.1.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G

Installation Drawings; G

SD-03 Product Data

Cable Trays; G

Supports; G

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G

1.4 QUALITY ASSURANCE

Comply with NEMA Standards Publication Number VE1, "Cable Tray Systems."

Comply with NEC, as applicable to construction and installation of cable tray and cable channel systems (Article 392 NEC).

Provide products that are UL-classified and labeled.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide ladder cable trays consisting of two longitudinal side members connected by individual transverse members.

Provide trough cable trays consisting of continuous one-piece ventilated-bottom sections contained within longitudinal side members.

Provide channel cable trays consisting of one-piece ventilated channel sections.

Provide solid bottom trays consisting of two longitudinal side members connected by one-piece bottom section.

2.2 MATERIAL

Provide cable trays constructed of steel in accordance with ASTM A1008/A1008M with a zinc coating applied after fabrication. Aluminum cable tray is acceptable.

2.3 FABRICATION

Submit fabrication drawings for cable trays consisting of fabrication and assembly details to be performed in the factory.

Prior to assembly, coat contact surfaces of trays with an antioxidant compound. Finish edges, fittings, and hardware free from burrs and sharp edges. Include splice and end plates, dropouts, and miscellaneous hardware.

2.4 COMPONENTS

2.4.1 Supports

Permit both vertical and horizontal adjustment, where possible on supports and hangers. Provide an adequate bearing surface for the tray on the horizontal and vertical tray supports and have provisions for holddown clamps or fasteners. Provide a secure means other than friction for fastening cable trays to supports.

Support cable trays at not more than 6 -foot intervals. Place supports for horizontal-elbow tray fittings within 2 feet of each fitting extremity and as recommended by the cable-tray manufacturer. Center spline cable trays are not acceptable.

When supported at 6 -foot intervals, the cable trays shall be capable of carrying not less than 150 pounds per linear foot. Tray fittings shall have not less than the load-carrying ability of straight tray sections and have the manufacturer's minimum standard radius.

PART 3 EXECUTION

Comply with NEMA VE 2 for cable tray installation.

3.1 INSTALLATION

3.1.1 Manufacturer's Instructions

Submit manufacturer's instructions for cable trays including special provisions required to install equipment components and system packages. Detail impedances, hazards and safety precautions.

3.1.2 Installation Drawings

Thirty calendar days prior to shipment, submit installation drawings to the Contracting Officer for approval. Coordinate drawings with all other work in the immediate area that could come in conflict with the installation. Include layout of cable tray work and details of both horizontal and vertical supports as specified in paragraph entitled, "Supports," of this section.

3.1.3 Grounding

Properly grounded cable trays by means of a low-resistance conductor of sufficient capacity, but in no case smaller than No. 1/0 AWG copper. Bond grounding conductor to cable-tray sections and fittings by compatible bolted connections. Consider cable tray sections in tandem assembly as having electrical continuity when these sections are bonded with appropriate high-strength bolts. Provide permanent and continuous effective grounding with an impedance sufficiently low to limit the

potential above ground and to facilitate operation of overcurrent devices in the circuit. Provide grounding and bonding of cable trays in accordance with NFPA 70.

-- End of Section --

SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM
08/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2001; R 2007) Laminated Thermosetting Materials

ELECTRONIC COMPONENTS ASSOCIATION (ECA)

ECA EIA/ECA 310	(2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-90-661	(2008) Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables for Use in General Purpose and LAN Communications Wiring Systems Technical Requirements

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA/BICSI 568	(2006) Standard for Installing Building Telecommunications Cabling

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 66	(2001; Errata 2003) Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pairs

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/TIA-607-B	(2011) Generic Telecommunications Bonding and Grounding (Earthing)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-1152	(2009) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
TIA-568-C.0	(2009; Add 1 2010) Generic Telecommunications Cabling for Customer Premises
TIA-568-C.1	(2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard
TIA-568-C.2	(2009; Errata 2010) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568-C.3	(2008; Add 1 2011) Optical Fiber Cabling Components Standard
TIA-569	(2012c; Addendum 1 2013; Errata 2013) Commercial Building Standard for Telecommunications Pathways and Spaces
TIA/EIA-606	(2002a; Errata 2007; R 2007; Adm 1 2008) Administration Standard for the Telecommunications Infrastructure

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 68	Connection of Terminal Equipment to the Telephone Network (47 CFR 68)

UNDERWRITERS LABORATORIES (UL)

UL 1286	(2008; Reprint Sep 2011) Office Furnishings
UL 1863	(2004; Reprint Aug 2008) Communication Circuit Accessories
UL 444	(2008; Reprint Apr 2010) Communications Cables
UL 467	(2007) Grounding and Bonding Equipment
UL 50	(2007; Reprint Apr 2012) Enclosures for Electrical Equipment, Non-environmental Considerations
UL 514C	(1996; Reprint Novy 2011) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 723	(2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials
UL 969	(1995; Reprint Nov 2008) Standard for

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, OUTSIDE PLANT (OSP), apply to this section with additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569, TIA/EIA-606 and IEEE 100 and herein.

1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect (MC).)

1.3.2 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

1.3.3 Floor Distributor (FD)

A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).)

1.3.4 Telecommunications Room (TR)

An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

1.3.5 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including wireless) including the entrance point at the building wall and continuing to the equipment room.

1.3.6 Equipment Room (ER) (Telecommunications)

An environmentally controlled centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.7 Open Cable

Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

1.3.8 Open Office

A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

1.3.9 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

The building telecommunications cabling and pathway system shall include permanently installed horizontal cabling, horizontal and backbone pathways, service entrance facilities, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building. The horizontal system shall be wired in a star topology from the telecommunications work area to the floor distributor or campus distributor at the center or hub of the star. The backbone pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware. The intrabuilding backbone provides connectivity from the floor distributors to the building distributors or to the campus distributor and from the building distributors to the campus distributor as required. The backbone system shall be wired in a star topology with the campus distributor at the center or hub of the star. Provide telecommunications pathway systems referenced herein as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.4.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications drawings; G

Telecommunications Space Drawings; G

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Telecommunications cabling (horizontal); G

Patch panels; G

Telecommunications outlet/connector assemblies; G

Equipment support frame; G

Connector blocks; G

Spare Parts; G

Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Telecommunications cabling testing; G

SD-07 Certificates

Telecommunications Contractor Qualifications; G

Key Personnel Qualifications; G

Manufacturer Qualifications; G

Test plan; G

SD-09 Manufacturer's Field Reports

Factory reel tests; G

SD-10 Operation and Maintenance Data

Telecommunications cabling and pathway system Data Package 5; G

SD-11 Closeout Submittals

Record Documentation; G

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

In exception to Section 01 33 00 SUBMITTAL PROCEDURES, submitted plan drawings shall be a minimum of 11 by 17 inches in size using a minimum scale of 1/8 inch per foot, except as specified otherwise. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Drawings

Provide registered communications distribution designer (RCDD) approved, drawings in accordance with TIA/EIA-606. The identifier for each termination and cable shall appear on the drawings. Drawings shall depict final telecommunications installed wiring system infrastructure in accordance with TIA/EIA-606. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the EF telecommunications and ER telecommunications, CD's, BD's, and FD's to the telecommunications work area outlets. Provide a plastic laminated schematic of the as-installed telecommunications cable system showing cabling, CD's, BD's, FD's, and the EF and ER for telecommunications keyed to floor plans by room number. Mount the laminated schematic in the EF telecommunications space as directed by the Contracting Officer. The following drawings shall be provided as a minimum:

a. T1 - Layout of complete building per floor - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.

b. T2 - Serving Zones/Building Area Drawings - Drop Locations and Cable Identification (ID'S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.

c. T4 - Typical Detail Drawings - Faceplate Labeling, Firestopping, Americans with Disabilities Act (ADA), Safety, Department of Transportation (DOT). Detailed drawings of symbols and typicals such as faceplate labeling, faceplate types, faceplate population installation procedures, detail racking, and raceways.

1.6.1.2 Telecommunications Space Drawings

Provide T3 drawings in accordance with TIA/EIA-606 that include telecommunications rooms plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and cabinet, backboard and wall elevations. Drawings shall show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 or T2 drawings.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to

installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years of similar scope and size. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

1.6.2.2 Key Personnel

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.

In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the

telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

1.6.2.3 Minimum Manufacturer Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3.

1.6.3 Test Plan

Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the components and accessories for each cable type specified, 60 days prior to the proposed test date. Include procedures for certification, validation, and testing.

1.6.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.5.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.5.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 DELIVERY AND STORAGE

Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.

1.8 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.10 MAINTENANCE

1.10.1 Operation and Maintenance Manuals

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system, Data Package 5. Submit operations and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data Package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION. Ensure that these drawings and documents depict the as-built configuration.

1.10.2 Record Documentation

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA/EIA-606. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. T5 drawings shall be provided in hard copy format and on electronic media using Windows based computer cable management software. A licensed copy of the cable management software including documentation, shall be provided. Provide the following T5 drawing documentation as a minimum:

a. Cables - A record of installed cable shall be provided in accordance with TIA/EIA-606. The cable records shall include only the required data fieldsin accordance with TIA/EIA-606. Include manufacture date of cable with submittal.

b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance

with TIA/EIA-606. Documentation shall include the required data fields as a minimum in accordance with TIA/EIA-606.

1.10.3 Spare Parts

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

PART 2 PRODUCTS

2.1 COMPONENTS

Components shall be UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

2.2 TELECOMMUNICATIONS PATHWAY

Provide telecommunications pathways in accordance with TIA-569 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide system furniture pathways in accordance with UL 1286.

2.3 TELECOMMUNICATIONS CABLING

Cabling shall be UL listed for the application and shall comply with TIA-568-C.0, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3 and NFPA 70. Provide a labeling system for cabling as required by TIA/EIA-606 and UL 969. Ship cable on reels or in boxes bearing manufacture date for for unshielded twisted pair (UTP) in accordance with ICEA S-90-661 for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

2.3.1 Horizontal Cabling

Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568-C.1.

2.3.1.1 Horizontal Copper

Provide horizontal copper cable, UTP, 100 ohm in accordance with TIA-568-C.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661. Provide four each individually twisted pair, minimum size 23 AWG conductors, Category 6A,

with a blue thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG) communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs shall be UL listed and labeled for wet locations in accordance with NFPA 70.

2.3.2 Work Area Cabling

2.3.2.1 Work Area Copper

Provide work area copper cable in accordance with TIA-568-C.2, with a blue, thermoplastic jacket.

2.3.2.2 Work Area Optical Fiber

Provide optical work area cable in accordance with TIA-568-C.3.

2.4 TELECOMMUNICATIONS SPACES

Provide connecting hardware and termination equipment in the telecommunications entrance facility and telecommunication equipment rooms to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with TIA/EIA-606.

2.4.1 Backboards

Provide void-free, interior gradeA-C plywood 3/4 inch thickas indicated. Backboards shall be fire rated by manufacturing process. Fire stamp shall be clearly visible. Paint applied over fire retardant backboard shall be UL 723 fire retardant paint. Provide label including paint manufacturer, date painted, UL listing and name of Installer. When painted, paint label and fire stamp shall be clearly visible. Backboards shall be provided on a minimum of two adjacent walls in the telecommunication spaces.

2.4.2 Equipment Support Frame

Provide in accordance with ECA EIA/ECA 310 and UL 50.

a. Cabinets, freestanding modular type, 16 gauge steel construction, minimum, treated to resist corrosion. Cabinet shall have removable and lockable side panels, front and rear doors, and have adjustable feet for leveling. Cabinet shall be vented in the roof and rear door. Cabinet shall have cable access in the roof and base and be compatible with 19 inches or panel mounting. Provide cabinet with grounding bar and a surge protected power strip with 6 duplex 20 amp receptacles. All cabinets shall be keyed alike.

2.4.3 Connector Blocks

Provide insulation displacement connector (IDC) Type 110 for Category 6A systems. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 25 percent spare.

2.4.4 Wire Managers

Provide horizontal and vertical wire managers of the same manufacturers as the equipment cabinets. Install them in accordance with manufacturer's specifications.

2.4.5 Patch Panels

Provide ports for the number of horizontal cables terminated on the panel plus 25 percent spare. Provide pre-connectorized copper patch cords for patch panels. Patch cords are not in contract and shall be provided by others.

2.4.5.1 Modular to 110 Block Patch Panel

Provide in accordance with TIA-568-C.1 and TIA-568-C.2. Panels shall be third party verified and shall comply with EIA/TIACategory 6A requirements. Panel shall be constructed of 0.09 inches minimum aluminum and shall be cabinet mounted and compatible with an ECA EIA/ECA 310 19 inches or 23 inches equipment cabinet. Panel shall provide 48 non-keyed, 8-pin modular ports, wired to T568B. Patch panels shall terminate the building cabling on Type 110 IDCs and shall utilize a printed circuit board interface. The rear of each panel shall have incoming cable strain-relief and routing guides. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

2.5.1 Outlet/Connector Copper

Outlet/connectors shall comply with FCC Part 68, TIA-568-C.1, and TIA-568-C.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and shall be third party verified and shall comply with TIA-568-C.2 Category 6A requirements. Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A and T568B wiring. Each outlet/connector shall be wired as indicated. UTP outlet/connectors shall comply with TIA-568-C.2 for 200 mating cycles.

2.5.2 Cover Plates

Telecommunications cover plates shall comply with UL 514C, and TIA-568-C.1, TIA-568-C.2, flush design constructed of high impact thermoplastic material to match color of receptacle/switch cover plates specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide labeling in accordance with the paragraph LABELING in this section.

2.6 MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

Provide MUTOA(s) in accordance with TIA-568-C.1.

2.7 TERMINAL CABINETS

Construct of zinc-coated sheet steel,as indicated. Trim shall be fitted with hinged door and locking latch. Doors shall be maximum size openings to box interiors. Boxes shall be provided with 5/8 inch backboard with two-coat varnish finish. Match trim, hardware, doors, and finishes with

panelboards. Provide label and identification systems for telecommunications wiring and components consistent with TIA/EIA-606.

2.8 GROUNDING AND BONDING PRODUCTS

Provide in accordance with UL 467, ANSI/TIA-607-B, and NFPA 70. Components shall be identified as required by TIA/EIA-606. Provide ground rods, bonding conductors, and grounding busbars as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.9 FIRESTOPPING MATERIAL

Provide as specified in Section 07 84 00 FIRESTOPPING.

2.10 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.11 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inches thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inches high normal block style.

2.12 TESTS, INSPECTIONS, AND VERIFICATIONS

2.12.1 Factory Reel Tests

Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3.

PART 3 EXECUTION

3.1 INSTALLATION

Install telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with NECA/BICSI 568, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569, NFPA 70, and UL standards as applicable. Provide cabling in a star topology network. Pathways and outlet boxes shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling. Cabling shall be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

3.1.1 Cabling

Install UTP, telecommunications cabling system as detailed in TIA-568-C.1, TIA-568-C.2. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain unterminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

3.1.1.1 Open Cable

Use only where specifically indicated on plans for use in cable trays, or below raised floors. Install in accordance with TIA-568-C.1, TIA-568-C.2. Do not exceed cable pull tensions recommended by the manufacturer.

Plenum cable shall be used where open cables are routed through plenum areas. Cable routed exposed under raised floors shall be plenum rated. Plenum cables shall comply with flammability plenum requirements of NFPA 70. Install cabling after the flooring system has been installed in raised floor areas. Cable 6 feet long shall be neatly coiled not less than 12 inches in diameter below each feed point in raised floor areas.

3.1.1.2 Horizontal Cabling

Install horizontal cabling as indicated on drawings Do not untwist Category 6A UTP cables more than one half inch from the point of termination to maintain cable geometry. Provide slack cable in the form of a figure eight (not a service loop) on each end of the cable, 10 feet in the telecommunications room, and 12 inches in the work area outlet.

3.1.2 Pathway Installations

Provide in accordance with TIA-569 and NFPA 70. Provide building pathway as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.3 Service Entrance Conduit, Underground

Provide service entrance underground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.4 Cable Tray Installation

Install cable tray as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Only CMP type cable shall be installed in a plenum.

3.1.5 Work Area Outlets

3.1.5.1 Terminations

Terminate UTP cable in accordance with TIA-568-C.1, TIA-568-C.2 and wiring configuration as specified.

3.1.5.2 Cover Plates

As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

3.1.5.3 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

3.1.5.4 Pull Cords

Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed.

3.1.5.5 Multi-User Telecommunications Outlet Assembly (MUTOA)

Run horizontal cable in the ceiling or underneath the floor and terminate each cable on a MUTOA in each individual zone. MUTOAs shall not be located in ceiling spaces, or any obstructed area. MUTOAs shall not be installed in furniture unless that unit of furniture is permanently secured to the building structure. MUTOAs shall be located in an open work area so that each furniture cluster is served by at least one MUTOA. The MUTOA shall be limited to serving a maximum of twelve work areas. Maximum work area cable length requirements shall also be taken into account. MUTOAs must be labeled to include the maximum length of work area cables. MUTOA labeling is in addition to the labeling described in TIA/EIA-606, or other applicable cabling administration standards. Work area cables extending from the MUTOA to the work area device must also be uniquely identified and labeled.

3.1.6 Telecommunications Space Termination

Install termination hardware required for Category 6A system. An insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.

3.1.6.1 Connector Blocks

Connector blocks shall be cabinet mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Install in accordance with industry standard wire routing guides in accordance with TIA-569.

3.1.6.2 Patch Panels

Patch panels shall be mounted in equipment cabinets with sufficient ports to accommodate the installed cable plant plus 25 percent spares.

a. Copper Patch Panel. Copper cable entering a patch panel shall be secured to the panel as recommended by the manufacturer to prevent movement of the cable.

3.1.6.3 Equipment Support Frames

Install in accordance with TIA-569:

a. Cabinets, freestanding modular type. When cabinets are connected together, remove adjoining side panels for cable routing between cabinets. Mount rack mounted fan in base of cabinet.

3.1.7 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00 FIRESTOPPING.

3.1.8 Grounding and Bonding

Provide in accordance with ANSI/TIA-607-B, NFPA 70 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2 LABELING

3.2.1 Labels

Provide labeling in accordance with TIA/EIA-606. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using laser printer.

3.2.2 Cable

Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA/EIA-606.

3.2.3 Termination Hardware

Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with TIA/EIA-606.

3.3 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3.1 Painting Backboards

Backboards are required to be fire-retardant and painted with two coats of white, fire retardant paint.

3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 TESTING

3.5.1 Telecommunications Cabling Testing

Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568-C.1 and TIA-568-C.2. Test equipment shall conform to TIA-1152. Perform optical fiber field

inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.

3.5.1.1 Inspection

Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1, TIA-568-C.2. Visually confirm Category 6A, marking of outlets, cover plates, outlet/connectors, and patch panels.

3.5.1.2 Verification Tests

UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but prior to being cross-connected.

3.5.1.3 Performance Tests

Perform testing for each outlet and MUTOA as follows:

a. Perform Category 6A link tests in accordance with TIA-568-C.1 and TIA-568-C.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.

3.5.1.4 Final Verification Tests

Perform verification tests for UTP systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

a. Voice Tests. These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and DSN telephone call.

b. Data Tests. These tests assume the Information Technology Staff has a network installed and are available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

-- End of Section --

SECTION 27 11 00.00 98

COMMUNICATIONS EQUIPMENT ROOM FITTINGS
09/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60603-7	(1997) Connectors for Frequencies Below 3 MHz For Use With Printed Boards - Part 7: Detail Specification for Connectors, 8-Way, Including Fixed and Free Connectors With Common Mating Features, With Assessed Quality

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

KSC-SPEC-E-0012	(1968, R2007) Specification for Heat and Blast Protection coating Materials for Electrical Cables

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 780	(2011) Standard for the Installation of Lightning Protection Systems

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA/EIA-568-B.1	(2001 Addendums 2001, 2003, 2003, 2003, 2004, 2007) Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements
TIA/EIA-606	(2002a; Errata 2007; R 2007; Adm 1 2008) Administration Standard for the Telecommunications Infrastructure

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 68	Connection of Terminal Equipment to the Telephone Network (47 CFR 68)

1.2 GENERAL REQUIREMENTS

1.2.1 Scope

This section includes the minimum requirements for entrance equipment, termination hardware, and cable installations in main communication equipment rooms and communication rooms/closets.

Equip said spaces to contain the following:

a. Entrance Facility (EF) Terminals

b. Surge Protection Modules

c. Wall Mounted Distribution Frames

d. Ladder Racking/Cable Tray

e. Grounding and Bonding Provisions

f. Backboards

g. Frame Mounted Termination Blocks and Rings

h. Cross Connects

1.2.2 Quality Assurance

Build-out all spaces in a neat and workmanlike manner. Match quality indicated of equipment and materials. Meet specified separation from sources of EMI.

Provide the communication grounding/earthing and bonding in accordance with applicable Codes and regulations, conforming to KSC-SPEC-E-0012 and NFPA 780. Meet the requirements of 27 05 26.00 98 for grounding throughout the entire cabling system.

1.2.3 Environmental Requirements

Rate connecting hardware for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, non condensing.

1.2.3.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Floor Plans; G

Front Elevations; G

SD-03 Product Data

Provide manufacturer's catalog data for the following items:

Floor Mounted Equipment Racks and Cabinets; G

Cable Management; G Hardware

Patch Panels; G

110 System Blocks; G

Patch Cords; G

Backboards; G

Cable Tray; G

Recycled Material Content; G

Communications Equipment Room Fittings; G

SD-11 Closeout Submittals

Floor Plans; G

Front Elevations; G

CAD Generated Drawings; G

Hard Copies; G

1.3.1 Preliminary Drawings

Prior to the start of work, submit preliminary drawings of the following: (Obtain electronic files of the building floor plans from the Contracting Officer.)

a. Scaled 1/4 inch by 1 foot by 0 inch Communication Room floor plans showing the planned location of all installed components.

b. Front elevations of a typical patch panel for each system.

1.3.2 Record Drawings

At the completion of the project, submit final record "As-Built" drawings of the following:

a. Scaled 1/4 inch by 1 foot by 0 inch Communication Room floor plans showing all installed components.

b. Front elevations of all systems patch panels.

c. CAD generated drawings on size "F" sheets. Submit reproducible hard copies and electronic copies in ".DXF" or ".DWG" format.

PART 2 PRODUCTS

Submit Manufacturer's data indicating the percentage of recycled material content in communications equipment room fittings verifying affirmative procurement compliance.

2.1 COMMUNICATIONS/EQUIPMENT ROOMS

2.1.1 Floor Mounted Cabinet

Provide floor mounted cabinets that meet the following specifications:

a. 16 gauge steel construction.

b. Nominal 77 inch by 19 inch by 30 inch.

c. Lockable Plexiglas hinged door on front and steel hinged door in rear.

d. Vented roof.

e. Removable side panels.

f. Leveling feet.

2.1.2 Cable Management for Equipment Racks

Provide black metal cable management with integral wire retaining fingers. Provide vertical cable management panels with have front and rear channels. Provide vertical cable management panels that have removable front and back covers, made of black metal. Provide a horizontal crossover cable manager at the top of each relay rack, with a minimum height of 2 rack units each. Provide a horizontal crossover cable manager near the center and at the bottom of each relay rack, with a minimum height of 4 rack units. Horizontal and vertical wire managers shall match the cabinet manufacturer.

2.1.3 Steel Ladder Racking/Cable Tray

Provide ladder rack/cable tray in equipment room, as shown on drawings for backbone cable support. Include connecting and support hardware to suit installation, including but not limited to, racks, runway mount plates, wall angle support brackets, butt splice swivels, connect junctions and grounding kit.

2.1.4 Patch Panels - Category 6A

Provide termination panels that support the appropriate Category 6A applications and facilitate cross-connection and inter-connection using modular Patch Cords. Patch cords are not in contract and provided by others. Size patch panels to fit an EIA standard 19 inch rack, or be capable of mounting to a wall.

Provide patch panels that accommodate at least 48 ports for each rack mount space, and have circuit boards tested in both directions as required by TIA/EIA-568-C.2. Provide patch panels that have angle left/angle right modules to provide optimum cable management, and that have removable six port modules to allow replacement in the field. Provide patch panels that have Category 6A jacks available in both T568A and T568B wiring schemes, with 110-style termination.

Provide patch panels that allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit, and modular ports compliant with FCC Part 68, subpart F and IEC 60603-7 with gold plating over nickel contacts or equivalent. Provide patch panels that allow the use of a 4-pair 110-style impact termination tool. Provide

patch panels having a plastic strip for physical protection of printed circuit board, with port identification numbers on both the front and rear of the panel, and provide clear label holders and white designation labels with the panel, with optional color labels available. Provide patch panels that are TIA/EIA-568-C.2 proposed Category 6A compliant.

Meet the following performance requirements (NEXT Loss and FEXT tested in both Differential and Common Mode):

PARAMETERS	PERFORMANCE AT 100 MHz
NEXT Loss	43.0 dB
FEXT	35.1 dB
Insertion Loss (Attenuation)	.4 dB
Return Loss	20 dB

Provide patch panels that are UL verified for TIA/EIA Category 6A electrical performance, made of a steel frame with black powder coat finish, 48 configurations.

Provide paired punch down sequence to allow pair twist within 1/2-inchof the termination. Provide port configurations and densities as called for on drawings, rear cable management bar(s) as recommended by the manufacturer, and insulation displacement connector 110-style terminations. Provide TIA/EIA-606 compliant color-coded icons or color-coded designation label strips for all patch panels. Identify voice or data functionality as required.

2.1.5 Backboards

Provide backboards that are 4 by 8 by 3/4 inch ACX, exterior grade, fire rated plywood, painted with two coats of white, acrylic, interior fire retardant paint. Ensure backboards provide adequate support and dress horizontal cabling between ladder rack and 110 wiring blocks as necessary or as shown on the drawings. Review cable routing plan for the Telecommunications Rooms, in the field, before installation of cabling commences.

2.1.6 110 System Blocks

Provide connecting hardware block that supports the appropriate Category 3 or Category 5E applications and facilitate cross-connection and/or inter-connection using either approved cross-connect wire or patch cords. Provide system blocks that are 110 System IDC style blocks, UL verified or equivalent for TIA/EIA Category electrical performance, and TIA/EIA-568-B.1 Category 3 or Category 5E compliant.

Meet the following criteria (NEXT Loss and FEXT tested in both Differential and Common Mode):

PARAMETERS	PERFORMANCE AT 100 MHz
NEXT Loss	43.0 dB
FEXT	35.1 dB
Insertion Loss (Attenuation)	.4 dB
Return Loss	20 dB

Provide system blocks made of flame retardant thermoplastic, in 50-, 100-, and 300-pair sizes, with 50-, 100-, and 300-pair blocks available without

legs, while the 100, and 300 pair blocks are available with legs. Provide blocks that include means to identify cables/services per TIA/EIA-606, with clear label holders with the appropriate colored inserts available for the wiring blocks. Provide insert labels with the product that contain vertical lines spaces on the basis of circuit size (3-, 4-, or 5-pair) and that do not interfere with running, tracing or removing jumper wire/patch cords. Provide label holders capable of mounting in the under portion of the wiring block. Provide system blocks with connecting blocks used for either the termination of cross-connect (jumper) wire or patch cords. Provide connecting blocks that are available in 3-, 4-, and 5-pair sizes.

Provide all connecting blocks with color-coded tip and ring designation markers, and of single piece construction. Provide system blocks with connecting blocks with a minimum of 200 re-termination without signal degradation below standard compliance limit. Provide blocks that support wire sizes: Solid 22 to 26 AWG, and 7-strand wires. Provide 300 pair blocks made by an ISO 9001 Certified Manufacturer, typical for feed and station cable, unless otherwise noted. Provide keep-off indicator buttons on all active cross-connected pairs used for alarm and security purposes. Coordinate the color and use with the Contracting Officer. Provide connecting block designation label strips of the colors conforming to TIA/EIA-606.

2.1.7 Cross Connect

Provide modular 110 cross connect blocks for all backbone terminations. Make cross connects with wire of equal gauge and performance category to that of the feed cable, which it is being connected to. Provide UL listed cross connect, and with one (1) roll of 1-pair and one (1) roll of 2-pair per Telecommunications Room (TR). Coordinate color code of one and two pair with Contracting Officer.

2.1.8 Labeling at Telecommunications Grounding Busbars

Telecommuncations grounding busbars (TGB) are provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING. Label grounding and bonding hardware and connections per TIA/EIA-606.

2.1.9 Category 6A Patch Cords

Patch cords are not in contract and shall be provided by others.

PART 3 EXECUTION

3.1 ENTRANCE FACILITY TERMINALS

Provide terminals that are frame mounted. Field verify actual length required for the input and output stubs. If the scope of work does not include splicing of the tip cable to the feed cable, provide clear labeling at the splice end of the tip cable referencing rack, row, and block information. Coordinate with Owner. Terminate output stub to appropriate block on distribution frame. Coordinate with Owner. Install No. 4 grounding conductor as straight as possible from terminal to ground bar.

3.2 SURGE PROTECTION MODULES

Fully protect all pairs entering a building, either with active pair surge

protection modules or surge protection modules specified of inactive pairs. Provide cost allowance in base bid for 80 percent active modules and 20 percent shunt modules.

3.3 FLOOR MOUNTED DISTRIBUTION FRAMES

Install frames as per drawings, in accordance with manufacturer instructions. Provide frames that are securely fastened to the floor using expansion anchors, and are plumb and square with the room.

3.4 STEEL LADDER RACKING/CABLE TRAY

Install all ladder rack/cable tray and associated mounting hardware in a manner that allows it to support its maximum rated load. Locate ladder rack/cable tray a minimum of 18 inch above top of floor mounted rack or wall mounted cross-connect fields. Ensure installation complies with manufacturer's instructions.

3.5 TERMINATION BLOCKS ON FRAME

Install color designation strips as follows:

DESCRIPTION	COLOR
C.O. Circuits	Orange
Common Equipment - PBX, Lan's, Muxes	Purple
First Level Backbone Cable	White
Second Level Backbone Cable	Gray
Horizontal Wiring	Blue
Auxiliary Circuits - Alarm, Security	Yellow
Future use and Key Systems	Red
Inter-building Campus Backbone	Brown

Install red insulator clips on all special circuits in the Main Equipment Room termination hardware and cross-connect facilities (ER). Confirm with the Contracting Officer which circuits to designate as special.

3.6 FLOOR MOUNTED EQUIPMENT RACKS AND CABINETS

Provide all floor mounted equipment racks that anchor to the floor and are plumb, provide vertical and horizontal cable and terminations as shown on the drawing, and mount with a minimum of 36 inches clear access behind and front of rack from the wall to a rack. Provide floor mounted equipment racks that ground the rack to the equipment ground bar. Adjacent racks can be bonded together. Provide communication grounding/earthing and bonding that is in accordance with applicable Codes and regulations. Install floor mounted equipment cabinets in a location which allows both the front and rear door to open a full 90 degrees. Install cabinets employing cooling fans such that there is at least 6 inch of clear space above the top of the fan casing.

3.7 WALL MOUNTED EQUIPMENT RACKS AND CABINETS

Secure wall mounted equipment racks to building structure with approved anchoring means, verify all existing wall construction and submit proposed anchoring methods for approval, and provide vertical and horizontal cable management both front and rear wherever available. Install wall mounted equipment cabinets in such a way as to not interfere with the use of the front door or hinged body section.

3.8 CABLE MANAGEMENT

Provide a horizontal crossover cable manager at the top and bottom of each rack, with a minimum height of 2 rack units each. Provide a horizontal crossover cable manager near the center of each relay rack, with a minimum height of 4 rack units. Provide two rear cable management bars and reusable Velcro-type hook and loop straps in each rear vertical channel. Provide reusable straps of varying sizes (each allowing 50 percent spare future expansion) and of adequate quantity to secure cable bundles at least every 4 rack units. Secure cable managers, slack managers, support bars, hook and loop straps per manufacturer recommendations.

3.8.1 Cable Supports

Provide "D" rings on 24 inch center for all exposed, wall mounted vertical Category 6A cable runs. Make all horizontal cable runs within room on cable tray.

3.9 CATEGORY 6A PATCH PANELS

Install and label Category 5E patch panels as recommended by manufacturer, per all TIA/EIA-606. Install rear cable management bar(s) as recommended by manufacturer, and install TIA/EIA-606 compliant color-coded icons or color-coded designation label strips for all patch panels. Identify voice or data functionality.

Install panels to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the patch panel can be no greater than 0.5 inches.

Install panels according to manufacturer's instructions and properly mounted to a rack, cabinet, bracket, or other appropriate mounting device.

Install panels such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Terminate cables on the panels to ensure there is no tension on the conductors in the termination contacts.

Properly label panels on front and back with the cable number and port connections for each port.

3.10 BACKBOARDS

Per the drawings, line the linear wall space used for anchoring equipment for the full room width with plywood. Install plywood for mounting termination equipment vertically, side by each, a minimum of 6 inchesabove finished floor. Install mounting that is sufficient enough to support the equipment. Install plywood for supporting backbone riser cables vertically, resting directly on the finished floor.

Provide anchoring and mounting techniques of plywood used to support backbone riser cables sufficient to support a minimum of 1000 pounds of weight. Provide heads of mounting screws that in no case protrude past the face of any plywood. Install distribution rings for the cross-connect fields above all wall mounted blocks. Two rings per vertical row of blocks. Mount rings with two hex head screws per ring.

3.11 110 SYSTEM BLOCKS

Install 110 system blocks on plywood backboard so that top of 300 pair block is 5 foot to 6 inch above finished floor, or as noted on the drawing. Mount blocks with steel, zinc plated 5/16-inch slotted hex head No. 10 by 3/4 inch drill screws, minimum four screws per block. Install designation strips color-coded in conformance with TIA/EIA-606 standard, generally as follows:

DESCRIPTION	COLOR
C.O. Circuits	Orange
Common Equipment - PBX, :LAN's, Muxes	Purple
First Level Backbone Cable	White
Second Level Backbone Cable	Gray
Horizontal Wiring	Blue
Auxiliary Circuits - Alarms, Security	Yellow
Future Use and Key Systems	Red
Inter-building Campus Backbone	Brown

3.12 GROUNDING AND BONDING

Bond all metallic equipment racks, conduits, cable tray, ladder racks, etc. to the telecommunications grounding busbar(s), using No. 6 AWG (minimum) equipment grounding conductor. Provide all connectors and clamps that are mechanical type made of silicon bronze, and terminals are solderless compression type, copper long-barrel NEMA two bolt. Bond the shield of shielded cable to the ground bar in communications rooms and spaces, per applicable code and manufacturer's recommended practices. Provide communication grounding/earthing and bonding that is in accordance with applicable codes and regulations.

3.13 MISCELLANEOUS REQUIREMENTS

Neatly dress, rack, label,and terminate all cables in communication rooms. Provide a minimum of 24 inches service loop on each terminated conductor, unless otherwise specified.

Provide room support services including HVAC, lighting, power, and fire protection as indicated on the drawings.

Firestop all sleeves and conduit openings after the cable installation is complete.

-- End of Section --

SECTION 28 31 00.00 98

FIRE DETECTION AND ALARM
09/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S1.4a	(2006) American National Standard Specification for Sound Level Meters
ANSI S3.41	(2008) American National Standard Audible Emergency Evacuation Signal

ASME INTERNATIONAL (ASME)

ASME A17.1	(2007; Addenda 2008) Safety Code for Elevators and Escalators

FM GLOBAL (FM)

FM P7825	(2009) Approval Guide

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code
NFPA 70	(2014) National Electrical Code
NFPA 72	(2013) National Fire Alarm and Signaling Code
NFPA 75	(2013) Standard for the Protection of Information Technology Equipment
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1016-2	(2007) Program Detail Manual Fire Alarm Systems, 8th Edition

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2006; Reprint Feb 2011) Surge Protective Devices
UL 1480	(2003; Rev thru Dec 2006); Standard for Safety Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
UL 1971	(2002; Rev thru Oct 2008) Signaling Devices for the Hearing Impaired
UL 268	(2009) Standard for Smoke Detectors for Fire Alarm Signaling Systems
UL 268A	(2008; Rev thru Sep 2009) Smoke Detectors for Duct Application
UL 346	(2005) Waterflow Indicators for Fire Protective Signaling Systems
UL 38	(2008; Rev thru Dec 2008) Standard for Signaling Boxes for Fire Alarm Systems
UL 497B	(2004; Reprint Oct 2008) Protectors for Data Communication Circuits
UL 521	(1999; Rev thru Jul 2005) Heat Detectors for Fire Protective Signaling Systems
UL 1711	(2006) UL Standard for Amplifiers for Fire Protective Signaling Systems, 4th Edition
UL 2196	(2006) UL Standard for Tests for Fire Resistive Cables, 1st Edition
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Evidence of the Contractor's State Certification G to the Contracting Officer for approval, prior to any work being started on the Fire Alarm System, in accordance with paragraph entitled "Services of a Certified Fire Alarm Specialist".

SD-02 Shop Drawings

Submit the following in accordance with the paragraph entitled, "General Requirements," of this section:

Connection Drawings G

Module Schematic Drawings G

Software Programs G

Fire Service Floor Plans G

Record Drawings G (As-Built Drawings after completion of the final acceptance test)

SD-03 Product Data

Where multiple types of the same item are required (Example: indoor, weatherproof, and explosion-proof types) provide separate Catalog Data for each type of device. Submit Manufacturer's Catalog Data for the following items:

Fire Alarm Control Panel G

CFMS Reporting Equipment G

Addressable Modules/Devices G

Annunciator Panels G

Heat-Actuated Detectors G

Smoke Detectors G

Duct Smoke Detectors G

Manual Alarm Stations G

Strobe Units G

Speakers G

Fire Resistive Cables G

Water Flow Alarm Devices G

Valve Tamper Switches G

Remote Auxiliary Control Relays G

Power Source G

Line Voltage Surge Suppressors G

Low Voltage Surge Suppressors G

Wiring (Wire and Multi-Conductor Cable) G

SD-05 Design Data

Design Analysis and Battery Calculations G

Voice Evacuation System G

Submit list of parts and components G for the installed system by manufacturer's name, part number, and nomenclature, and recommended stock level required for normal maintenance and unscheduled repairs.

SD-06 Test Reports

Fire Alarm System Acceptance Test Procedures (For Both Preliminary and Final Tests) G

SD-07 Certificates

Submit Quality Assurance Plan G consisting of the following in accordance with the paragraph entitled, "Quality Assurance Plan," of this section:

Submit listing and/or approval documentation G that all components are Underwriter Laboratory (UL) UL Fire Prot Dir listed or Factory Mutual (FM) FM P7825 approved for their intended use and function.

Submit Contractor Readiness Affirmation - For Preliminary Fire Alarm Testing G in accordance with the paragraph entitled, "Field Testing" of this section.

Submit KSC Transfer of Responsibility G for the designated portion of the Fire Alarm System; in accordance with the paragraph entitled, "Installation," of this section.

Submit NFPA 72 Fire Alarm System Record of Completion G in accordance with paragraph entitled, "Field Testing" of this section.

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals G bound in manual format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to acceptance tests being performed. Provide one single .pdf format of the O&M Manual on a single CD.

1.3 GENERAL REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING and Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS apply to work specified in this section.

Submit submittals for approval in the following sequence with each approved prior to the next submittal:

a. Sign and submit the KSC Transfer of Responsibility form no later than 30 days after notice to proceed.

b. Submit Product Data (Catalog Data), Contractor's Certifications, and Quality Assurance Plan, within 30 days after notice to proceed.

c. Submit Connection Drawings, Module Schematic Drawings, Design Analysis and Battery Calculations within 30 days after notice to proceed.

d. Submit new and revised Fire Alarm Control Panel (FACP) and Network Software Program information no later than 60 days prior to the scheduled preliminary test. Provide two completed sets minimum of the Record Drawings and documentation and make available for reference at the preliminary test.

e. Submit Acceptance Test Procedures no later than 60 days prior to the scheduled preliminary test.

f. Sign and submit the Contractor Readiness Affirmation form no later than 5 days prior to the scheduled preliminary test.

g. Submit Record Shop Drawings, Panel and Network software programs, and Battery Calculations for approval no later than 30 days prior to the scheduled final acceptance test. Provide two completed sets minimum of the Record drawings (As-built condition) and documentation and the NFPA 72 Fire Alarm System Record of Completion Form and make available for reference at the final test. Include submittal of listing and/or approval documentation

h. Submit Operation and Maintenance Manuals 14 days after the final test has been complete and approved.

i. Include in the Record drawing submittal all Shop Drawings, Panel and Network software programs, Battery Calculations, Completed Final Test Procedures, NFPA 72 Fire Alarm System Record of Completion Form and submit within 14 days after completion of the final acceptance test. Include in this submittal two (2) sets of CD ROM digital media of all the record drawings, Design Analysis, Battery Calculations and Program software information.

Prepare and submit all drawings generated by computer aided design (CAD). Include in digital media compact disc (CD) submittals .DWG or .DXF format files for all drawings: Connection Diagrams, Module Schematics, Battery Calculations, Floor plans and Fire Service Floor Plans. Also on this CD provide a complete copy of the aforementioned drawings in PDF format.

Provide Connection drawings consisting of point-to-point wiring diagrams of internal and external wiring including, but not limited to, all fire alarm field devices, panel wiring, and interconnection between other building systems and components and the fire alarm system. Indicate wire label designations matching the field installation on these drawings.

Include in Connection drawings Floor Plan Drawings that indicate equipment locations, device locations with address designation, and conduit/wiring routing from the FACP(s) to all field devices including looped Class A circuit routing requirements. Also include typical mounting requirements for each type of initiation, signaling, notification and control device. Show on Record drawings (as-built) for installations with flame detectors horizontal and vertical field of views for each detector and aiming point of detector with clear dimensions from fixed and readily identifiable structural references. Include riser diagram and sequence of operations in an input/output matrix format that clearly shows interaction of system components.

Provide Module schematic drawings (minimum size 8-1/2 by 11 inch) prior to system acceptance testing.

Include in Record Drawings connection drawings, floor plan drawings, module schematics, software programs, fire service floor plans, design and battery calculations, and all other data required to fully document the completed system. After final testing is complete, submit Record Drawings including digital media and hard copies of all new and revised software, drawings, and analysis/calculations incorporating approved comments and any changes. Document final system configuration in Record Drawings including, but not limited to, geographic monitor zone boundaries, location of the FACP, all initiating and auxiliary control devices, signaling line devices, notification appliances, additional cabinets, wet and dry pipe sprinkler risers, dry pipe control panel, smoke and fire dampers, magnetic door holders, and all other equipment associated with the fire alarm system(s). Also, annotate the location and address setting for each multiplexed addressable device (when used), deviations from and amendments to the record drawings, and field installation changes, concealed and visible.

Provide software programs, both hard copy and compact disc, for all new and/or existing programmable FACP(s) affected by the project. Provide system executable file and report file on the compact disc. Program information for FACP including program listings, system point summary, and addressable device switch settings. Include in corrected program information panel and network programs and sequence of operations in matrix format that clearly shows interaction of system components.

Conduct tests in accordance with approved Fire Alarm System Acceptance Test Procedures, and in accordance with the paragraph entitled "Field Testing" in this specification. Prepare a test procedure and test record form for conducting complete tests on control panels, reporting systems, wiring systems, and field devices installed in accordance with the manufacturer's requirements and these specifications. Identify each device and circuit to be tested in the test procedure, describe the initial condition, each step or function in the test, required test result, and equipment to be employed. Test procedures are to be written to minimally disrupt facility operations (minimize activation of evacuation notification appliances, AHU shutdown, etc.) in support of testing requirements. Ensure test forms have suitable space for recording test results on all equipment, devices, and wiring to be tested. Provide test record forms with identified spaces for verification signatures of official witnesses and dates of the test.

Clearly indicate on Fire Service Floor Plans the location of the FACP, all initiating and auxiliary control devices, signaling line devices, notification appliances, additional cabinets, detection systems, wet and dry pipe sprinkler risers, dry pipe control panel, smoke and fire dampers, magnetic door holders and all other equipment associated with the fire alarm system(s). Also, annotate the location and address setting for each multiplexed addressable device (when used). Do not place borders or title blocks on the Fire Service Floor Plan. Provide a symbol legend, which clearly identifies each device shown on the Fire Service Floor Plan. Install a copy of the Fire Service Floor Plan, minimum size18 by 24 inch in a painted metal frame with a Plexiglas cover. Submit the floor plan and it's location for approval, to the Contracting Officer, prior to installation.

Submit Design Analysis and Battery Calculations for approval for the Fire

Alarm and Detection Systems consisting of the battery capacity and loading calculations in accordance with the subpart entitled, "Fire Alarm Control Panel," of this section.

Submit list of parts and components in accordance with the subpart entitled "System Requirements," of this section.

1.4 SYSTEM REQUIREMENTS

Provide a fully addressable, modular type, microprocessor based, supervised, non-coded electrical fire alarm system. Provide Class A wiring for addressable device loop and notification appliance speaker loop between the fire alarm control panel (FACP) and fire alarm terminal cabinets (FATCs) positioned in the same location on each floor, meeting NFPA 72 Class A wiring requirements. Provide NFPA 72 Class A signaling line circuits, Style 6. Ensure all styles of Class A initiating device, signaling line, network, notification appliance, and control circuits use diverse routing in accordance with NFPA 72. Do not run the outgoing and return redundant circuit conductors in the same cable assembly, enclosure or raceway. Provide Class B wiring for addressable device and notification appliance circuits from a FATC located on a particular floor for the devices on that circuit located on that same floor, meeting NFPA 72 Class B requirements. Thematically, the intent for the fire alarm system is for the backbone from FACP to FATC and FATC to FATC to have all circuit types wired Class A and for the individual circuits with devices on a particular floor to be wired Class B.

Electrically connect the fire alarm system to report alarm, trouble, and supervisory signals to the Central Radio Monitoring System (CRMS) via radio transceiver; to sound the general alarm continuously; and to control auxiliary equipment such as dampers, air handling units, magnetic door latches, elevator recall, etc., upon operation of one or more initiating devices. For initiating, notification, signal, and auxiliary control circuits, use 24 V(DC). Ensure duct smoke detectors transmit to the CFMS as a silent alarm unless otherwise directed by the Authority Having Jurisdiction (AHJ).

Ensure the system conforms to all the applicable requirements of NFPA 70, NFPA 72, NFPA 75, NFPA 90A, and NFPA 101.

Ensure fire alarm systems contain all of the equipment, devices, programming and circuits required for system operation in accordance with NFPA Codes and KSC requirements, including remote reporting to and remote control from existing equipment.

Provide all additional equipment, cabinets, conduit, and labor to meet the requirements and intent of this specification. Provide power supplies, amplifiers, strobe synchronization devices, battery backup, etc, for the devices on a particular floor in the FATCs located on that particular floor. Power requirements should be coordinated with the electrical design for emergency power circuits.

Components installed under this contract can not be more than one (1) year older than the date of installation.

1.5 QUALITY ASSURANCE PLAN

Provide manufactured fire-alarm equipment which meets the requirements of the paragraph entitled, "System Requirements," of the latest standard

design, and listed by Underwriters' Laboratories or approved by Factory Mutual and be suitable for its intended service. Ensure all devices installed function with the control panel without interference of the operation of the control panel.

1.6 SERVICES OF A CERTIFIED FIRE ALARM SPECIALIST

Provide Services of a Certified Specialist thoroughly experienced in fire detection and alarm work on site, to perform or directly supervise the installation, make all necessary adjustments, and perform all tests on the fire alarm system at the site.

A Fire Alarm specialist is considered certified when the specialist holds a valid Fire Alarm System, Level III Certification from the National Institute for Certification in Engineering Technologies NICET 1016-2; or a valid Level III Fire Alarm Engineering Technician Certification from the International Municipal Signal Association (IMSA); or is licensed by the State of Florida as a Fire Alarm Contractor I in accordance with Florida State Statute, Chapter 489, Part II.

Certification of other recognized agencies with equivalent requirements will be considered. Provide Evidence of the Contractor's State Certification and the basis of certification to the Contracting Officer and secure Contracting Officer approval prior to any work being performed at Kennedy Space Center.

PART 2 PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

Provide fully addressable Fire Alarm Control Panel (FACP), of modular construction with solid state, microprocessor based electronics. Include non-volatile programmable operating system memory for all operating requirements in the panel. Addressable components are to include, but not be limited to, addressable monitor modules, control modules, signal modules, addressable notification appliance power supplies and addressable input/output relays. Equip modules with transient surge suppression.

Ensure FACP contains power-on, alarm, supervisory, and trouble indicating lights plainly visible when the cabinet is closed; and also contains the following functions accessible only by unlocking and opening the unit:

Alarm Silence
Trouble Silence
Supervisory Silence
Power On-Off (If standard by the manufacturer)
Alarm/Trouble Acknowledge
Auxiliary Devices (AHU shutdown relay) Maintenance By-pass Switches
System Reset

Ensure FACP contains all components necessary to monitor and supervise all initiating device circuits, and when any detector, manual alarm station (pull box), water flow switch, pressure switch, etc., connected to the fire alarm control panel is activated, the control panel's visual alarm, alarm indicator and audible signal are activated. This causes all notification appliances to be activated, including all associated auxiliary control functions. Verify that the control panel visually indicates the addressable device or zone in alarm and transmits an alarm

condition to the remote Central Fire Monitoring System. Provide separate audible and visual notification appliance circuits, with sufficient capacity to operate all devices connected, plus 25 percent minimum spare capacity.

Verify that the FACP includes all components and modules required for installation of a multiple addressable device network. Utilize network polling methods and provide two-way Class B supervised communications between the FATC for a particular floor and addressable devices and monitor, signal, or control addressable modules on that same floor. Provide Class A, Style 6, supervised communications for the addressable device loop circuit from FATC to FATC and FATC to FACP. Ensure that the FACP contains all components necessary to monitor and supervise all supervisory device circuits. Verify that when any valve tamper switch, low air pressure switch, water level indicator, or other supervisory device connected to the control panel is activated, the control panel supervisory visual indication and supervisory audible device is activated; and that control panel visually indicates the addressable device or zone in supervisory alarm and transmit a supervisory condition to the remote Central Fire Monitoring System.

Provide FACP with all components necessary to operate and supervise the circuits for annunciator panels indicated, auxiliary power supplies indicated, and auxiliary devices controlling equipment such as ventilating fans, air handling units, fan coil units, damper motors, magnetic door holders, elevator recall, etc. Ensure circuits for auxiliary control relays are supervised to within 3 feet of the device to be controlled in accordance with NFPA 101. Include maintenance bypass switches for all auxiliary control devices in the FACP. Ensure bypass switches are supervised to report supervisory signal when in the maintenance (bypass) position. Provide switches used for bypass functions which are either toggle or soft key type, and listed for use with the control panel. In addition, provide each switch with a positive visual indication to show the function is ON.

Provide panel which monitors and reports any trouble open supervised circuits, ground faulted supervised circuits, removal of detector or device, removal or failure of control panel module, maintenance by-pass switch activated, loss of primary power, power supply trouble, low battery voltage, loss of battery voltage, and activation of the alarm silence switch. Ensure all trouble signals are identified by initiating, notification appliance, auxiliary control, or signaling line circuit; and that trouble signals activate the control panel trouble visual indication and trouble audible devices, and send a trouble signal to the remote Central Fire Monitoring System.

Provide alarm, supervisory, and trouble reset switches which reset a cleared device in alarm, supervisory, or trouble condition. Ensure alarm and supervisory signals do not self-restore without activating the switch. Certain trouble signals may self-restore when the condition is resolved depending upon the limitations of the fire alarm system installed. Clearly identify any normally self-restoring troubles to the Contracting Officer for decision of the AHJ.

Ensure that alarm, supervisory, and trouble silence switches silence the alarm, supervisory, and trouble audibles, and that either switch placed in other than the normal position provides the following:

a. Report as an alarm, supervisory, or a trouble to the Central Fire

Monitoring System.

b. Transfer audible signal to a panel lamp visual indication.

c. Re-ring the trouble audible if the problem has been cleared, but the switch has been left in the silence position.

When the alarm silencing switches are in the silence position, ensure subsequent alarms reactivate the notification appliances, and the strobes remain operational until the FACP is reset.

Provide FACP suitable for use with UL listed or FM approved detectors and manual alarm stations and other fire alarm devices specified in this section.

Provide FACP with an individual set of Form C dry contacts which activate for alarm, trouble and supervisory conditions for connection to the Central Fire Monitoring System. Provide additional other fire monitoring or special function relay contacts as indicated.

Ensure all relays are continuous duty and have self-cleaning contacts of silver or an alloy of equivalent performance, and supervisory relays are suitably protected against dust by individual covers. Provide all relays with external functions, such as remote reporting, control device activation, and notification appliance activation, with at least one set of spare contacts. Permanently mark relays with the coil resistance, operating-current range, and internal pin connections using standard pin numbers.

Install a separate terminal cabinet adjacent to the FACP for interfacing device field wiring to the control panel. Provide outdoor cabinets of stainless steel construction rated NEMA 4X. Install terminal strips for all field wiring circuits plus 25 percent spare. Where a terminal cabinet is installed, install terminal strips to accommodate remote reporting circuits and associated surge suppressors. Provide copper ground bus within this terminal cabinet for termination of equipment ground conductors.

Provide steel FACP, terminal cabinets, surge suppression cabinets and battery cabinets, with a hinged cover and an integral pin-tumbler cylinder lock (mortise or standard rim cylinder from Best Access Systems) with removable core that accepts the key presently in use with other control units existing in the area. Lock core will be provided by the government. Paint cabinets with a prime coat and one or more finish coats of scratch-resistant baked enamel red finish coat unless otherwise indicated.

Include in FACP a voice evacuation system with all components and modules required for a multiple channel audio signaling system distributed over the required number of audio signaling device circuits, capable of accurately reproducing bell tones and pre-programmed and live voice messages for building evacuation. Include audio amplifier input with a dedicated power supply, with a primary power input of 120 V(AC) and a battery backup input of 24 V(DC). Ensure audio amplifier output is a minimum of 100 watts at 24 VRMS, with a minimum of 25 percent spare capacity provided. Locate a microphone and 4 inch speaker at the control panel for fire fighter paging and monitoring. Include in audio system controls switching with visual indication for localized facility-wide paging announcements. Provide voice messages English, followed by

temporal three (3) bell tone until silenced.

Provide system which operates from a power supply with 120 grounded V(AC) input and 24 V(DC) output, and functions satisfactorily with power input voltage varying from 85 to 110 percent of nominal value. Ensure power supply output is capable of powering all initiation, signaling, annunciation, and control devices during alarm condition with 25 percent minimum spare capacity.

Provide all FACPs and auxiliary power supplies with a DC power input and with a DC disconnect switch integral with the equipment provided (2P 30A switch), or provide a separate safety switch. If supplied within the cabinet, ensure the power on-off switch disconnects all power sources to the control panel. Provide the on-off switch with DC rated contacts.

Provide the means of automatically supplying the entire fire alarm system with backup power with batteries, charger, and power transfer equipment alarm system with battery backup power in event of a primary power system failure. Ensure system switches to battery power in event of AC power failure, and switches back to AC power upon return of primary power. Ensure control panel(s) and auxiliary power supplies are able to operate when the backup batteries are disconnected for any reason. Also ensure system controls charging currents and floating voltage levels to maintain batteries in optimum condition. Provide capability to recharge batteries in event of discharge. Fuse wiring to protect against battery over-current and polarity reversal. Confirm primary power, battery, or charging equipment failure results in a FACP trouble signal and visual indication.

Use sealed, spill-proof battery modules to prevent any corrosive fumes. Provide batteries listed for fire alarm service and suitable for high discharge currents required under alarm conditions. Size batteries to operate the fire alarm and detection system (including voice evacuation system), in normal supervisory condition for 24 hours, minimum, then operate the system in the alarm mode for 10 minutes, minimum. Locate batteries and battery cabinets as necessary for remotely located power supplies (i.e. those power supplies not at the primary FACP cabinets).

2.1.1 Large Capacity Fire Alarm Control Panel (With Voice)

Provide an FACP with initiation, notification appliance, auxiliary control, and local auxiliary relay circuits necessary for system requirements indicated. Include a minimum of 25-percent spare circuit capacity, rounded up based on circuits provided at each location (FACP, auxiliary power supply), for the following circuit types: initiation zones, addressable device zones, notification appliance circuits, auxiliary control circuits and local auxiliary relays. Ensure unit is expandable to 2000 addressable devices. Use modular construction with solid-state, microprocessor based electronics. Provide modules equipped with transient suppression. Include in system non-volatile programmable operating system memory for all operating requirements.

Include in FACP all components and modules required for installation of a multiple addressable device network. Utilize Network polling methods.

2.2 CFMS REPORTING EQUIPMENT

2.2.1 Radio Based FACP Reporting

Provide AES/Intellinet Corporation Model 7788F transceiver with minimum eight (8) zone relays. Multiple radio transceivers will be required and the zone relay required reporting shall be provided as indicated.

Provide optional reporting alarm connections to the spare transceiver zones where indicated. Provide separate enclosure(s) as required for 120 V(AC) power supply components (receptacle and plug-in step-down power transformer), AC power surge suppression, and 24 hour standby battery back-up power. Provide red finish coat on all enclosures unless otherwise indicated.

Provide the required number ofrelays in FACP or use addressable control relay modules grouped in a cabinet as indicated for all remote reporting signals required (i.e. equivalent number of relays or modules for all radio zones). Each relay is to include an end-of-line resistor for Class B wiring to the radio transceiver zone per the radio transceiver manufacturer's requirements.

Provide 3 db antenna and outdoor mounting provisions. Separation of antennas must be per transceiver manufacturer's instructions. Use manufacturer provided interconnecting cables and surge suppressors for such antennas.

2.3 ADDRESSABLE MODULES/DEVICES

Provide solid-state addressable modules compatible with the FACP. Provide modules which are suitable for individual outlet box mounting or group mounting within a control enclosure. Install outdoor modules in weatherproof enclosures with a neoprene gasket protected from corrosion.

Provide field addressable modules to individually communicate with the FACP using multiplexed communication techniques. Provide communication circuit wiring connections suitable for supervised Class B operation for device circuits on a particular floor from the FATC(s) for that floor. Provide communication circuit wiring connections suitable for supervised Class A, Style 6 operation for addressable circuits from FATC to FATC and FATC to FACP. Derive module power from the communication circuit or 24 V(DC) power supply supervised by the FACP. Power supplies should be located in the FATC(s) for a particular floor for those devices, as necessary. Ensure invalid address setting, component failure, or power failure initiates a trouble signal at the FACP.

Provide manufacturer's standard outlet box for enclosure housing a single isolated module (not grouped with other modules or no other modules nearby).

Provide enclosures housing more than one addressable module with hinged door type with back panel for module mounting. Provide hinged cover(s) with an integral pin-tumbler cylinder lock (Mortise or Standard Rim Cylinder from Best Access Systems) with removable core that accepts the key presently in use with other fire alarm control units at KSC; lock core will be provided by the government. Provide adequately sized enclosure to allow a minimum of 2-inch wiring space around the cabinet perimeter to include all module termination points. Provide additional spare space for 2 future modules. Provide terminal strips with 25-percent spare capacity

for interfacing all module connections to field wiring. Paint enclosures with a prime coat and one or more finish coats of red enamel to provide a smooth, hard, and durable finish. Provide enclosures with an engraved phenolic nameplate labeled, "FIRE ALARM MODULE TYPE, Address."

Provide supervised addressable modules for initiation device circuits back to FATC(s) on a particular floor, Class B type, unless otherwise indicated. Provide initiation device circuits from FATC to FATC and FATC to FACP suitable for supervised Class A, Style 6 operation.

Provide supervised addressable modules for notification appliance circuits back to FATC(s) on a particular floor, Class B type, unless otherwise indicated. Ensure module is suitable for use with bells, strobes, and relays. Provide notification appliance circuits from FATC to FATC and FATC to FACP suitable for supervised Class A, Style 6 operation.

Provide addressable relay modules for control and/or remote reporting circuits (addressable relays), including 2 separate fused Form-C contacts rated at 2 Amperes for 28 V(DC) or 120 V(AC).

Provide addressable modules for suppression system releasing service, if used, which are UL listed for use with the fire alarm control panel and the suppression system releasing device. Include in module all necessary circuitry to supervise the suppression system release device coil.

2.4 ANNUNCIATOR PANELS

Provide LCD alphanumeric type annunciator panels compatible with and supervised from the FACP, with an operating power supply of 24 V(DC). Provide yellow lamp color for trouble/supervisory and red for alarm; also provide a test switch for testing all lamps. Provide each lamp with a nameplate, with zone and function identified for all lamps. Provide engraved phenolic tag nameplates.

Program annunciator panels to annunciate only alarm and supervisory signals; annunciate trouble signals only at the main FACP.

Provide terminal strips suitable for No. 18 through No. 14 AWG diameter solid copper conductors for all annunciator panel wiring connections.

Mount annunciator panels in manufacturer required enclosures. Where hinged enclosures are used, provide a lock set matching that of the FACP. Paint all exposed metal parts of annunciator panels with a prime coat and one or more finish coats of scratch-resistant baked enamel. Provide red finish coat unless otherwise indicated.

2.5 HEAT-ACTUATED DETECTORS

Provide heat-actuated detectors with alarm-initiating devices designed for use with automatic/manual fire alarm systems in accordance with UL 521.

Provide heat-actuated detectors rated at 136 degrees F fixed temperature with 15 degree F per minute rate-of-rise feature unless otherwise indicated. Provide only fixed temperature type detectors at the top of elevator shafts.

Provide self-restorable detectors for the rate-of-rise feature and non-restorable for the fixed temperature feature. Ensure detectors have a rate-of-rise principle of operation, which uses an air chamber, a vent and

a flexible metal diaphragm, and a fixed temperature principle of operation using a fusible solder joint. Provide heat detectors which are individually addressable by connection to addressable modules. Provide addressable modules in accordance with the paragraph entitled, "Addressable Modules/Devices," of this section.

Provide electronic addressable type heat detectors where indicated, each listed for use with the FACP, which are only to be used in air conditioned spaces. Ensure electronic type heat detector spacing from lighting fixtures complies with manufacturer's installation requirements.

Provide addressable detector or base including circuitry and user selectable switching required for assigning each detector a unique address on the FACP communication bus. Verify invalid address switch settings or component failure initiates a trouble signal at the FACP. Provide detector head which plugs into a separate receptacle type base wired to the FACP signaling line circuit which powers and monitors the detector. Provide supervised base which initiates a trouble signal at the FACP if the detector is removed. Provide a light emitting diode indicator which gives a visual indication when the detector initiates an alarm.

Provide detectors with a set of normally open contacts that close to initiate an alarm, with wiring connections which are for supervised Class A operation, and made with terminal blocks capable of accepting No. 18 through No. 14 AWG diameter solid copper conductors. Ensure all components of the detectors are rust and corrosion resistant.

In areas subject to moisture or exterior atmospheric conditions, provide only detectors that are UL listed or FM approved for use in those locations.

Ensure enclosures and detectors mounted in hazardous locations conform to the requirements of Underwriter's Laboratory (UL) or Factory Mutual (FM) for the hazardous location classification indicated. Provide conduit seal-off fittings suitable for the hazardous location classification at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.6 SMOKE DETECTORS

Provide alarm initiating smoke detectors designed for use with automatic/manual fire alarm systems in accordance with UL 268.

Provide 2.5 percent per foot nominal obscuration (photo-electric) type smoke detectors, listed for use with FACP installed, including all required accessories, rust and corrosion resistant. Ensure detector head is a plug-in unit, that detector contains no moving parts, nor requires read justment or removal to resume normal operation after an alarm. Provide all detector openings with screen to prevent the entry of insects and debris.

Provide detector head that plugs into a separate receptacle type base, with base screw terminals suitable for No. 18 through No. 14 AWG diameter solid copper conductors for all wiring connections required. Ensure base is supervised to initiate a trouble signal at the fire alarm control panel if the detector is removed, and a light emitting diode indicator to provide a visual indication when the detector initiates an alarm.

Provide detectors in areas subject to moisture or exterior atmospheric

conditions that are UL listed or FM approved for such locations.

Provide remote annunciation in a centralized location for devices that are not readily visible or accessible such as detectors installed under raised floors, or other locations where the detector is concealed or not readily visible; or provide an addressable type detector. Ensure annunciator panels are in accordance with paragraph entitled, "Annunciator Panels," of this section.

Provide addressable detector(s) bases where indicated or used in lieu of remote annunciator panels, with detector or base which includes circuitry and user selectable switching required for assigning each detector a unique address on the FACP communication bus. Ensure invalid address switch settings or component failure initiates a trouble signal at the FACP.

Provide detectors with terminals suitable for Class B wiring powered from the panel alarm initiation or communication bus circuit; separate power sources are not acceptable. Power supplies can be located in a FATC on the same floor as the detector.

2.6.1 Duct Smoke Detectors

Provide alarm-initiating smoke detector devices designed for use with automatic/manual fire alarm systems in accordance with UL 268A.

Provide addressable type duct smoke detectors connected to an addressable FACP, unless otherwise indicated, with the ability to perform sensitivity testing from the FACP in accordance with NFPA 72.

Provide photoelectric type duct smoke detectors listed by UL Fire Prot Dir or FM approval guide, including duct housings, mounted exterior to the duct, and perforated sampling tubes extending across the width of the duct. Ensure activation of duct smoke detectors causes shutdown of the associated air-handling unit, annunciation at the FACP, and transmits a silent alarm to the Central Fire Monitoring Station, but does not activate the building evacuation notification appliances. Provide a single maintenance by-pass switch to isolate each air handling unit's duct smoke detectors. Ensure activation of any maintenance by-pass switch inhibits reporting and causes a supervisory condition at the FACP, and when the maintenance by-pass switch is restored to it's normal configuration, the supervisory signal at the FACP self restores. Where duct smoke detectors are installed outdoors, in unconditioned mechanical or electrical rooms, or in areas with high ambient temperatures and humidity, or in high ambient temperature areas, install the detector housing in an additional PVC enclosure with an additional set of supply and exhaust sampling tubes to prevent condensation from forming within the detector housing.

Provide duct smoke detectors with terminals suitable for Class B wiring powered from the panel alarm initiation or communication bus circuit; separate power sources are not acceptable. Power supplies can be located in a FATC on the same floor as the detector.

Install a separate remote test/light assembly for each duct smoke detector. Where multiple duct smoke detectors are installed, group the remote test switches together at a common location.

2.7 MANUAL ALARM STATIONS

Provide non-coded, manual alarm stations designed for use with automatic/manual fire alarm systems in accordance with UL 38.

Ensure wiring terminals are suitable for Class B wiring and capable of accepting No. 18 through No. 14 AWG diameter solid copper conductors. Make manual alarm stations individually addressable by connection to addressable modules, provided in accordance with the paragraph entitled, "Addressable Modules/Devices," of this section.

Ensure manual alarm station door has a protected, pull-down operating lever with recessed finger grip. When operated, ensure the station mechanically latches, breaks a glass or plastic rod, closes one or more sets of contacts, and locks the contacts in the operated position until reset. Stations with a pushbutton which depends upon a spring-loaded device to close the contacts when the handle is pulled are not acceptable, nor are stations which are resettable without the use of a key or tool.

Paint all exposed metal surfaces of enclosing cases with a prime coat and one or more finish coats of red enamel to produce a smooth, hard, durable finish. Provide identification and directions for operating fire-alarm stations on the cover in raised or depressed white-enameled letters. Manual alarm stations constructed of plastics or composite material are not acceptable.

Furnish surface-mounted stations with matching cast-iron or cast-aluminum back boxes with top and bottom threaded-conduit connections. For stations mounted outdoors, provide weatherproof type, with a neoprene gasket, and protect against corrosion. Provide a molded polycarbonate clear protective cover with the provision for a lead seal or plastic supervisory seal in all areas open to the general public. Ensure the protective cover does not have an integral warning horn.

For hazardous locations, provide manual pull stations that are UL listed, FM approved, or approved by a recognized testing laboratory for the hazardous location classification indicated. Ensure unit consists of a complete manufactured explosion-proof manual pull station assembly. Provide conduit seal-off fittings suitable for the hazard classification at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.8 STROBE UNITS

Provide strobe units designed for use with automatic/manual fire alarm systems, in accordance with UL 1971

Provide UL listed or FM approved strobe units including red cast metal housing, dome polycarbonate white lens with white "FIRE" lettering on two sides , and a zenon flash tube with solid state circuitry. Ensure unit brightness is 15, 30, 75, or 110 candela in accordance with NFPA 72, producing a minimum flashing frequency of 1 Hz and a maximum of 3 Hz. Synchronize all strobes. Ensure strobes remain flashing until the FACP is reset. Ensure visual notification appliance circuits have sufficient capacity to operate all devices connected, plus 25 percent minimum spare capacity per circuit.

Provide units which operate from polarized 24 V(DC), Class B wired supervised notification appliance circuits, with an operating current not

exceeding 0.1 amperes and capability of operating over a 20 percent variation in nominal input voltage. Ensure wiring connection terminal blocks are suitable for No. 16 through No. 12 AWG diameter solid copper conductors.

Provide flush mounted interior units using standard electrical back boxes, and surface mounted units in cast iron or cast aluminum boxes with threaded conduit hubs. Provide weatherproof units with a neoprene gasket, protected from corrosion, in exterior or wet locations. Paint all metal exposed surfaces with a prime coat and one or more finish coats of red enamel paint to provide a smooth, hard durable finish.

If mounted in hazardous locations, provide strobes UL listed or FM approved for the hazardous location classification indicated. When the unit is not factory sealed, provide conduit seal-off fittings suitable for the hazardous location classification indicated at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.9 SPEAKERS

Provide speakers UL listed or FM approved for audible signal use, designed for use with automatic/manual fire alarm systems in accordance with UL 1480 and UL 1711, capable of clearly reproducing voice messages and bell tones in a three-pulse temporal pattern over a 400 to 4000 Hz range. Ensure speaker output at 1000 Hz for 1 watt input power is no less than 87 dB at 10 feet.

Provide Notification Appliance mechanism consisting of sealed speaker and multiple-tap impedance matching transformer suitable for 24 V(DC), Class B, supervised audio signaling systems. Include with transformer settings 0.25, 0.5, 1.0, and 2.0 watt taps unless otherwise indicated. Ensure Wiring connections for 4 wire operation are screw terminals suitable for No. 16 through No. 12 AWGdiameter conductors.

Provide speaker housings made of red impact resistant polycarbonate or cast metal construction. Mount flush mounted interior speakers using standard electrical back boxes. Mount surface mounted speakers using red cast iron or cast aluminum boxes with threaded conduit hubs. If mounted in exterior or wet locations, provide weather-proof type with a neoprene gasket, protected from corrosion. Paint all metal exposed surfaces with a prime coat and one or more finish coats of red enamel paint to provide a smooth, hard, durable finish.

Ensure strobe portion of a combination audible/visual notification appliance is in accordance with the applicable provisions of the paragraph entitled, "Strobe Units," of this section.

If mounted in hazardous locations, provide speakers UL listed or FM approved for the hazardous location classification indicated. When the unit is not factory sealed, provide conduit seal-off fittings suitable for the hazardous location classification indicated at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.10 WATER FLOW ALARM DEVICES

Provide alarm-initiating water flow devices designed for use with automatic/manual fire alarm systems, in accordance with UL 346, conforming to UL or FM requirements for the particular type of sprinkler system being specified.

Ensure contact have a minimum of 2 single pole, double throw contacts rated 5 amps at 28 V(DC) or 250 V(AC). Make water flow devices individually addressable by connection to addressable modules, and provide in accordance with the paragraph entitled, "Addressable Modules/Devices," of this section. Provide weatherproof and corrosion protected flow devices for outdoor installations.

If installed in hazardous locations, provide water flow devices UL listed or FM approved for the hazardous location classification indicated. When the switch is not factory sealed, provide conduit seal-off fittings suitable for the hazardous location classification indicated at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.10.1 Pressure Switch

Wire alarm pressure switch to make or break an alarm circuit depending on rise or fall of water pressure. Provide an alarm pressure switch with an instant-recycle pneumatic-retard, or electronic adjustable setting time delay, settable from 45 to 90 seconds.

2.10.2 Vane-Type Flow Switch

Provide vane-type alarm flow switch which makes or breaks an alarm circuit upon deflection by a volume of flowing water that equals or exceeds the capacity of a single sprinkler. Ensure alarm flow switch has an instant-recycle pneumatic-retard, or electronic adjustable setting time delay, settable from 45 to 90 seconds.

2.11 VALVE TAMPER SWITCHES

Provide supervisory initiating valve tamper switches designed for use with automatic/manual fire alarm systems, in accordance with UL 346, conforming to UL or FM requirements of use on the specified valve.

Provide contacts with a minimum of 2 single pole, double throw contacts rated 5 amps at 28 V(DC) or 250 V(AC). Ensure valve tamper switches are individually addressable by connection to addressable modules, in accordance with the paragraph entitled, "Addressable Modules/Devices," of this section. Provide weatherproof, corrosion-protected switches for outdoor installations. In hazardous locations, provide valve tamper switches UL listed or FM approved for the hazardous location classification indicated. If the tamper switch is not factory sealed, provide conduit seal-off fittings suitable for the hazardous location classification indicated, at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.12 REMOTE AUXILIARY CONTROL RELAYS

Provide remote control relays with continuous duty coils rated 24 V(DC). Where relays are used on Class B supervised circuits, ensure coils incorporate supervisory current blocking diode. Provide relays with a minimum of 2 single pole, double throw contacts rated 5 amps at 28 V(DC) or 250 V(AC). Where auxiliary control circuits connected to the relay are protected at a higher ampacity than the relay contacts are rated, provide fusing rated to protect the relay contacts in the relay enclosure.

Provide addressable type relays, where indicated, in accordance with the

paragraph entitled, "Addressable Modules/Devices," of this section.

Mount remote auxiliary control relays in enclosures indicated, or if not indicated, in manufacturer's required enclosure. Install outdoor relays in a weatherproof enclosure with a neoprene gasket and protection against corrosion.

In hazardous locations, install relays with enclosures UL listed or FM approved for the hazardous location classification indicated. Provide seal-off conduit fittings at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

Paint enclosures with a prime coat and one or more finish coats of red enamel to provide a smooth, hard, and durable finish. Label enclosure with an engraved phenolic nameplate stating, "F/A RELAY."

Mount remote auxiliary control relays and supervise within 3 feetof the controlled device in accordance with NFPA 101.

2.13 POWER SOURCE

Ensure normal power to the local systems for all purposes, including separately powered notification appliances and initiating devices, is 120 volts 60 hertz. Ensure system operates satisfactorily between 85 and 110 percent of normal voltage. Provide fire-alarm-system disconnect/protective device as a fused switch with a red factory finish as specified herein for manual alarm stations. Mount this disconnect switch adjacent to the FACP. Mark as FIRE-ALARM DISCONNECT FED FROM (indicate supply circuit) with 1/2-inch high letters in white paint or engraved phenolic identification plates fastened with sheetmetal screws. Ensure switch is capable of being locked in the "on" or "off" position, a feature which can not interfere with the circuit protection capability of the device. Equip switch with surge suppression for all phase and neutral conductors. Install current limiting Class RK1 fuses properly sized to protect the fire alarm equipment.

When power is supplied from a single 20 amp circuit breaker, provide an adjustable set screw type clamping device over the circuit breaker handle to prevent handle operation. Paint only the locking device red.

2.14 WIRING

Provide copper conductor wiring in accordance with NFPA 70 and NFPA 72. Connect all devices to Class B circuits, per NFPA 72, with the wire types specified in this section, unless specifically noted otherwise in the paragraph entitled, "Wiring (Wire and MultiConductor Cable). Connect wiring between FATC to FATC and FATC to FACP Class A per NFPA 72 for all circuit types. For 120 V(AC) circuits, use No. 12 AWG minimum.

Ensure all conductors installed on fire alarm systems are solid copper with an insulation rating of not less than 300 volts, permanently marked with the size, voltage rating and manufacturer's name on the conductor jacket at no less than 2 feet intervals. Conductor sizes are listed below.

Conductor AWG diameter and Insulation Type are listed below. Required wire colors are listed in the paragraph entitled, "Wiring (Wire and Multi-Conductor Cable)," of this section.

Provide solid copper, shielded, twisted pairs, meeting UL 2196

requirements, for conductors in multiplexed communication circuits, signaling line circuits, speaker audio circuits, remote phone circuits, and remote reporting circuits. Ensure cable is listed as Type FPL, Power-Limited Fire Protective Signaling Cable, with conductor size less than No. 16 AWG diameter for data circuits and No. 14 AWG diameter for audio circuits.

Provide direct current initiating device (manual pull station) circuit conductor size of not less than No. 16 AWG diameter, with insulation Type TFN for No. 16 AWG diameter, and Type THHN/THWN for No. 14 AWG diameter and larger.

Size power leads from the control panel for product-of-combustion detectors accordingly, but not less than No. 14 AWG diameter, with insulation Type THHN/THWN for No. 14 AWG diameter and larger.

Provide direct current notification appliance circuit (strobes) conductor size of not less than No. 14 AWG diameter, with insulation Type THHN/THWN for No. 14 AWG diameter and larger.

Provide direct current auxiliary control device (AHU shut down relay) circuit conductor size of not less than No. 14 AWG diameter, with insulation Type THHN/THWN for No. 14 AWG diameter and larger.

Ensure all underground circuit wiring meet UL Standards 444 and 13, and TIA 455-82B water infiltration tests; equal to West Penn Aqua Seal.

2.14.1 Fire Resistive Cables

Provide fire resistive cables for notification appliance circuits designed for use with automatic/manual fire alarm systems in accordance with UL 2196.

Provide UL Fire Prot Dir listed Type FPL-CI fire alarm cable for use with power limited fire alarm notification appliance circuits. Ensure the CI cable has a minimum 2 hour fire resistance rating by having passed the applicable testing requirements of UL 2196. Install this cable in locations required to meet NFPA 72 survivability requirements.

2.15 SURGE SUPPRESSORS

Provide line voltage and low voltage surge suppression devices to suppress all voltage transients which might damage the control panel components.

Install surge suppression in accordance with UL 497B on each conductor of fire alarm circuits which extend beyond a building. Locate protection as close as practical to the point where the circuits leave the building. Install protectors in surge suppression cabinets of adequate size with terminal strips for all wiring connections plus 25 percent spare. Paint enclosures with a prime coat and one or more coats of red baked enamel finish to provide a smooth, hard, and durable finish. Where installed outdoors, provide stainless steel NEMA 4X rated cabinets. Provide a copper ground bus inside the cabinet and connect protectors to an earth ground electrode system in accordance with the manufacturer's requirements and NFPA 70. Ensure an etched metal or engraved laminated plastic identification plate labeled, "Fire Alarm Cabinet," is affixed to the cabinet door of the alarm control unit to identify the cabinet as a fire alarm cabinet. For cabinets painted black, ensure the identification plate has white letters on a black background, and for cabinets not painted red, the identification plate has white letters on a red

background.

2.15.1 Line Voltage Surge Suppressors

Provide suppressor UL 1449 listed with a maximum 330 volt clamping level and a maximum response time of 5 nanoseconds, and also meets IEEE C62.41, category B tests for surge capacity. Ensure suppressor is a multi-stage construction type which includes inductors and silicon avalanche zener diodes. Provide suppressor which has a long-life indicating lamp (light emitting diode or neon lamp) which extinguishes upon failure of protection components, with externally accessible fuses. Wire in series with the incoming power source to the protected equipment using screw terminations.

2.15.2 Low Voltage Surge Suppressors

Provide for all circuits which leave the building shell and as shown on the contract drawings. When circuits interconnect two (2) or more buildings, provide an arrestor at the circuit entrance to each building. Ensure suppressor is UL 497B listed, with a maximum 30 volt clamping level and a maximum response time of 5 nanoseconds, with multi-stage construction and both differential/common mode protection.

PART 3 EXECUTION

3.1 SYSTEM SEQUENCE OF OPERATION

3.1.1 Normal Operation

Ensure all switches are in the normal position; available power lamp is on, the trouble and detector identification lamps are off, and all circuits are electrically supervised.

3.1.2 Supervisory Condition

Per system conditions identified in the paragraph entitled, "Fire Alarm Control Panel," of this section, ensure that a supervisory signal is transmitted to the Central Fire Monitoring System, device indication is provided, a supervisory signal is activated in the FACP, and input is provided to remote annunciators (when used). Ensure supervisory signal in the alarm control unit is comprised of visual and audible indications and is self-restoring.

3.1.3 Trouble Condition

Per system conditions identified in the paragraph entitled, "Fire Alarm Control Panel," of this section, ensure that a trouble signal is transmitted to the remote reporting device of the Central Fire Monitoring System, providing zone indication, activating a trouble signal in the FACP, and providing input to remote annunciators (when used). Ensure trouble signal in the alarm-control unit provides visual and audible indications.

3.1.4 Alarm Condition

Ensure activation of any detectors, manual alarm stations, water flow switches, or other initiating devices closes a contact that activates the appropriate FACP. FACP transmits a signal to the remote reporting device of the Central Fire Monitor System, activates the facility indicating appliances, provides zone identification, controls air handling and

ventilating units, provides an input to remote annunciators (when used), and provides indication or control to devices or other systems.

3.2 INSTALLATION

Install all equipment in accordance with manufacturer's recommendations and requirements of this Section.

3.2.1 Fire Alarm Control Panel(s) and Reporting Equipment

Install equipment in each protected building, located where indicated, and complete with all indicated accessories and devices. Install equipment in accessible locations in such a manner as to prevent damage from vibration or jarring. Equipment requires a minimum of 3 feet clearance directly in front of the panel for maintenance per NFPA 70. With multiple equipment, the 3 feet clearance is required directly in front of the complete configuration. In addition, provide a 28 inch clear aisle way for access to the equipment.

Ensure wiring within FACP(s) and reporting equipment is in accordance with the paragraph entitled, "Installation in Cabinets and Boxes," of this section.

When FACP(s) and reporting equipment are installed flush or semi-flush, provide three spare 1-inch conduits in accordance with the paragraph entitled, "Conduit and Raceways," of this section, from the FACP wiring termination cabinet to an accessible location.

3.2.2 Addressable Modules and/or Devices

Install zone addressable modules at accessible locations indicated. Configure module address switches to settings indicated on approved shop submittals. Individually identify modules adjacent to their mounting.

Mount control zone addressable modules used for smoke control, AHU shutdown, etc. in accessible locations within 3 feet of the device to be controlled. Do not install control modules connected to separately energized control wiring from auxiliary systems in the same enclosure with initiation and signal zone addressable modules.

Where zone addressable modules are grouped within an enclosure, wire in accordance with the paragraph entitled, "Installation in Cabinets and Boxes," of this section.

3.2.3 Annunciator Panels

Install panels in accessible locations in such a manner as to prevent damage from vibration or jarring.

Install annunciator panels in each protected building, at locations indicated, complete with all accessories and devices. Annunciator panels require a minimum of 3 feet clearance directly in front of the panel for maintenance, per NFPA 70. With multiple panels, the 3 feet clearance is required directly in front of the complete configuration. In addition, provide a 28 inch clear aisle way for access to the annunciator panels.

Provide wiring within annunciator panels in accordance with the paragraph entitled, "Installation in Cabinets and Boxes," of this section.

3.2.4 Heat-Actuated Detectors

Ceiling mount detectors unless otherwise indicated. Location, number, and general arrangement to be as indicated. Provide field installation locations complying with NFPA 72.

Configure addressable electronic heat detector address switch settings as approved on shop drawings and submittals. Do not install detectors until work by other trades is completed.

Locate electronic, addressable detectors no closer than 1 foot from any part of lighting fixtures. Space separation from lighting fixture in accordance with the manufacturer's requirements, but no closer than 1 foot. Mount detectors no closer than 3 feet from any supply or return diffuser.

Make provisions for devices mounted in acoustical, lay-in type ceilings to utilize 'T' bar corner plate/bracket. Cut ceiling tile as required to accommodate mounting plate and device wiring.

3.2.5 Smoke Detectors

Provide smoke detector location, number, and general arrangement as indicated. Ensure field installation in accordance with NFPA 72. Do not install detectors until the work of other trades is complete.

Utilize 'T' bar corner plate bracket for devices mounted in acoustical, lay-in type ceilings. Cut ceiling tile as required to accommodate mounting plate and device wiring.

Install duct smoke detectors in accordance with the manufacturer's requirements and NFPA 90A. Seal all duct penetrations air and water-tight.

Configure addressable smoke detector address switch settings as approved on shop drawings and submittals.

Locate detectors no closer than 6 feet from a fluorescent light fixture. Locate detectors no closer than 3 feet from any return air diffuser and no closer than 6 feet from any supply diffuser. Ensure detectors installed in areas subject to moisture or exterior atmospheric conditions are UL listed or FM approved for such locations.

3.2.6 Manual Pull Stations (Fire Alarm Boxes)

Mount manual pull stations at locations indicated within 18-inch of the latch side of the door. Ensure mounting height is 48-inch above the finished floor measured from the top of the device.

Where manual pull stations are installed outdoors, arrange conduit systems to drain away from the manual pull stations.

3.2.7 Speakers

Mount audio speaker notification appliances at the approximate locations indicated. Ensure mounting height is 90-inch above the finished floor measured from the top of the speaker, but no less than 6-inch below the ceiling.

Where speakers are installed outdoors, arrange conduit systems to drain away from speakers.

3.2.8 Strobe Units/Combination Audio Visual

Mount strobe notification appliances at the approximate locations indicated. Ensure locations are unobstructed and allow viewing by area occupants in accordance with NFPA 70. Ensure mounting height is 80-inch above the finished floor measured from the bottom of the strobe, but no less than 6-inch below the ceiling.

Where strobes are installed outdoors, arrange conduit systems to drain away from strobes. Ensure visual and audible appliances are capable of operating independently via separate and independent circuits for both the audible and strobe portions.

3.2.9 Auxiliary Control Relays

Install and supervise remote control relays in accessible locations within 3 feet of the device to be controlled.

3.2.10 Wiring (Wire and Multi-Conductor Cable)

Provide wiring conforming to the requirements of NFPA 70 and the following special requirements:

Install fire alarm system circuits in a separate raceway system. Route each circuit type (Initiating, Notification, Signaling, and Control) through a dedicated separate conduit or raceway system configured to comply with NFPA 72 Class "A" or Class "B" conduit system requirements depending on requirements for the circuit established in this specification. Do not allow 60-Hertz power circuits to enter enclosures containing fire alarm circuits except where required to connect to the fire alarm system.

Provide continuous conductors from a terminal point at one device to a terminal point at the next device and from a device to the FACP. Break wires at each terminal; do not loop wires over a terminal. Terminate approved explosion proof devices, provided with pigtail wiring connection leads, on a field installed terminal strip installed in the box on which the device is mounted. Install solderless ring tongue terminal lugs with manufacturer's required tooling on the device wiring connection leads. Use this ring type lug on stranded wire only. Terminate solid wire on compression or screw type terminals. When screw type terminals are used, capture the conductor under 80 percent of the screw head surface. Identify all circuit conductors within each enclosure where a tap, splice, or termination is made. Provide conductor identification by heat-shrink-type sleeves or other approved method. Use point destination type conductor labels to indicate cabinet, circuit board, terminal block and screw terminal location for each individual conductor.

Provide conductor colors as listed below and in accordance with FED-STD-595. Where modifications are made to existing systems, match the new or added conductors to the size and color-coding of the existing system.

Mark conductors for multiplexed communication circuits, speaker audio circuits, remote phone circuits, and remote station signaling circuits with circuit designation, and maintain consistent color-coding for the positive and negative loops throughout the cable system.

The Class B requirements below are for circuits from a FATC on a particular floor to devices on that particular floor. For circuits from FATC to FATC and FATC to FACP, Class A wiring is required and color coding should be the same as required below for the circuit types.

Install direct current initiating device circuits (heat detectors, smoke detectors, manual pull station) as Class B circuits per NFPA 72. Ensure the positive loop conductor is colored blue, Color No. 15102, and the negative loop conductor is colored black, Color No. 17038.

Install power leads from the control panel for product-of-combustion detectors as Class B circuits per NFPA 72. Ensure the positive conductor is be colored white, Color No. 17877, and the negative conductor is colored black, Color No. 17038.

Install direct current notification appliance (strobes) circuits as Class B circuits per NFPA 72. Ensure the positive conductor is colored red, Color No. 11105, and the negative conductor is colored orange, Color No. 12473.

Install direct current auxiliary device control device circuits (AHU shutdown relay) as Class B circuits per NFPA 72. Ensure the positive conductor is colored yellow, Color No. 13591, and the negative conductor is colored brown, Color No. 10055.

Install solenoid valve control circuits as Class B circuits per NFPA 72. Ensure the positive conductor is colored yellow, Color No. 13591, and the negative conductor is colored violet, Color No. 37100.

3.2.10.1 60-Hertz Power

Provide 60-hertz power to FACP(s) or separately powered devices of 120 volts. Provide one black phase conductor, one white or gray solidly grounded neutral conductor, and one green equipment grounding conductor. Size conductor as shown on the drawing with the minimum size No. 12 AWG copper. Install surge arrestors in accordance with NFPA 72 and NFPA 70.

Clearly identify Circuit Breakers used to supply AC power to the FACP. Provide a permanent label with white background and red lettering adjacent to the circuit breaker.

3.2.10.2 Installation in Cabinets and Boxes

Install wiring in control cabinets and boxes in a neat and orderly manner with wire properly grouped, tie-wrapped, or laced parallel and perpendicular to the major axis, supported and identified. Provide continuous control wiring from device to device with no splices unless otherwise indicated. Permanently mark all wires entering or leaving control cabinets, boxes, and devices and terminate on screw terminals. Ensure marking is consistent throughout the fire alarm system and is the same as the identification shown on the connection drawings.

Ensure wire labels correspond to the approved connection drawings and use a method indicating the destination of the other end of the wire. Provide labels in control panel equipment or between fire alarm terminal cabinets which indicate the destination of the other end by cabinet designation-terminal strip designation-terminal number. Provide labels in

fire alarm terminal cabinets indicating connection in control panel equipment by fire alarm cabinet designation-module identifier-module terminal strip identifier-terminal number. Provide conductor labels with legible machine-printed black lettering on white background using indelible ink. Ensure labels are heat shrink or wrap around type.

3.2.11 Conduit and Raceways

Minimum size for fire alarm system initiating, notification, signaling line and control circuit conduits and raceways is 3/4-inch. Install in accordance with NFPA 70. Ensure all Class A circuits use diverse routing in accordance with NFPA 72. Do not run outgoing and return redundant circuit conductors in the same cable assembly, enclosure or raceway. The outgoing and return circuit conductors are only permitted to be run in a single conduit or raceway for drops that enter or exit an initiating device, notification appliance, or control unit enclosure.

Install rigid galvanized steel conduit in all hazardous (classified) locations, exterior locations where the conduit is exposed above grade, interior exposed locations from finished floor to 1 foot above finished ceiling unless otherwise shown on the drawings. EMT with hexnut expansion gland-type fittings can be installed in all other locations. Use flexible metal conduit, maximum length 6 feet, as the final connecting raceway to a fire alarm device mounted on vibrating equipment or on a suspended ceiling.

Where devices, junction boxes, and cabinets are installed outdoors, arrange conduit systems to drain away from the box; ensure conduit enters the box side or bottom only and drain type fittings are installed.

Use schedule 80 PVC for conduit direct buried in earth. Ensure that portions of underground raceway systems that penetrate above finished grade are rigid, galvanized, heavy-wall steel conduit with a 40-mil PVC coating or painted with a bitumastic compound.

Conceal all conduit in interior finished areas. Fire-stop all conduit passing through fire-resistant rated walls, floors, ceilings, in a manner that maintains the fire-resistant rating of the wall, floor or ceiling.

Ensure conduit installed in a vertical position is parallel with walls and perpendicular with the floor and ceiling, and that conduit installed in a horizontal position is parallel with the floor and ceiling and perpendicular to the walls. Make changes in direction of runs with symmetrical bends. For bends of over 1-inch in diameter, provide factory made elbows.

3.2.12 Water Flow Alarm and Valve Tamper Switches

Install switches in accordance with the manufacturer's requirements and make final connections using liquid-tight flexible metallic conduit. Adjust time delays on water flow/pressure switches to between 45 and 90 seconds to prevent false alarms due to momentary water movement.

3.2.13 Elevators

Ensure initiating devices to effect control of the elevator(s) in an alarm condition report through the facility fire alarm system and initiate the following actions in the elevator controls in accordance with ASME A17.1 and NFPA 72:

a. Primary Fire Fighter Recall.

b. Secondary Fire Fighter Recall.

c. Power Feed Shunt-Trip.

d. "Do Not Use Elevator" Warning.

3.3 FIELD TESTING

After complete installation of the equipment and at such time as directed by the Contracting Officer, conduct tests to demonstrate that the installation requirements of this specification have been met and that the sequential functions of the system comply with the requirements specified herein. Perform the Tests covered in the following paragraphs in two parts:

a. Contractor Checkout - Perform this test to remove all troubles, ground faults, ensure all devices are fully functional and operational, and test the programming to ensure the installation meets the contract drawings and specifications.

b. Preliminary - Perform this test using the approved test procedure and witnessed by the Government construction inspectors. Verify Record (as-built) fire alarm system drawings against the system installed, annotate all red-lines, and summarize on a single set of record (as-built) drawings. Follow the test procedures as written and annotate all red-lines on a single Test Procedure. Secure the initials and date on the summarized set of drawings and test procedures from the construction inspector and the fire alarm vendor. The Preliminary test is not considered complete until all steps in the test procedure have been satisfactorily completed. This includes any additional steps required to complete 100 percent testing of the fire alarm system and its associated functionality.

c. Final Acceptance - After the successful completion of the preliminary test, schedule a Final Acceptance test. Incorporate the final acceptance test procedure and record (as-built) drawings including all red lines from the preliminary test. Provide a copy of the consolidated redlines for the record (as-built) drawings and preliminary test procedures from the preliminary test. Ensure the Contracting Officer and the Authority Having Jurisdiction or their designee(s) witness the final acceptance test for the fire alarm system. During the Final Acceptance Test, provide two corrected as-built drawings and Final Acceptance Test Procedures for use in conducting the final acceptance test. Upon completion of the Final Acceptance Test, provide the following documentation to the Contracting Officer; a copy of the Final Acceptance Test procedure (with all steps annotated as complete), a corrected set of as-built drawings and a signed and completed NFPA 72 Fire Alarm System Record of Completion form.

On both preliminary and final tests, follow the approved testing procedures.

3.3.1 External System Wiring

Perform the following tests on the external system wiring before connection to the control panel:

Check continuity of circuits with an ohmmeter. Insert temporary jumpers in appropriate sockets of missing detectors and install the end-of line resistor when this test is performed. Verify resistance reading for each circuit is the value of the end-of-line resistor, plus or minus 10 percent.

Check each wire for grounds with 300-volt and 500-volt insulation resistance test set. Ensure resistance to ground is not less than 20 megohms. Isolate each wire tested from ground, with all other wires within the same conduit grounded. Verify that the conduit system is grounded prior to insulation resistance testing by verifying a short circuit between the conduit and earth ground.

3.3.2 Fire Alarm System Acceptance Test Procedures (For Both Preliminary and Final Tests)

After completion of the above tests, connect the external system wires to the appropriate terminals in the control panel and perform the following tests:

With the control panel energized, demonstrate the proper operation of all indicating lights and alarms.

Demonstrate each annunciator panel lamp to operate when its associated device or zone is activated.

Activate each manual pull station to demonstrate proper operation.

Activate each smoke detector in accordance with the manufacturer's instructions, to demonstrate proper operation; both alarm and trouble.

Perform a static pressure differential test on each duct smoke detector to verify the pressure differential between the inlet and outlet tubes is within the manufacturer's specifications for acceptable operation. For air handling units with variable speed drives, test at both the minimum and maximum operating speeds.

Activate each optical integrity test switch and verify that each flame detector on this circuit went into alarm and that all the addressable interface modules latched in the alarm condition. Restore the test switch and visually verify the flame detectors returned to normal operation.

Each time an initiating or supervisory circuit is activated, verify that the associated device address, notification appliances circuits, auxiliary control circuits, and alarm reporting to the Central Fire Monitoring System is activated and the correct information is displayed by the color graphics units.

Remove and ground one lead at each alarm initiating device, (manual pull station, smoke detector, heat actuated detector etc.), to demonstrate circuit trouble, ground fault, and then alarm over ground fault with an open circuit. Alternate between positive (plus) and negative (minus) leads during the device testing process.

Turn off power to each separately powered panel or device to simulate loss of power and to demonstrate operation of the trouble alarm.

Test the rate-of-rise function on each heat-actuated detector in each zone by application of heat from a heat lamp or hand held hot air blower. Ensure detectors initiate an alarm to the system, sustain repeated tests of the rate-of-rise function without damage to the fixed temperature function. Replace heat-actuated detectors (HADS) subject to operation from body temperature.

Open and close water suppression system valves requiring tamper switches, to demonstrate proper operation.

Activate water flow/pressure switches by water flow at the inspector's test valve to demonstrate proper operation. Set water flow time delay between 45 and 90 seconds.

Verify discharge of electrically activated suppression systems. Verify each initiation device that activates the suppression system to activate the solenoid valve. Fully discharge the overall system at least once.

Demonstrate each alarm initiating circuit to operate its associated alarm-control and auxiliary control units and remote reporting.

Remove and ground one lead at each notification appliance and auxiliary control device to demonstrate open circuit trouble, ground fault trouble, and then operation over ground fault with an open circuit. Alternate between positive (plus) and negative (minus) leads during the device testing process.

Measure and record sound pressure level with a sound level meter meeting ANSI S1.4a, Specifications for Sound Level Meters, Type 2 requirements. Measure and record sound pressure Levels and ambient background levels throughout the protected area. Set the sound level meter in accordance with ANSI S3.41, American National Standard Audible Evacuation Signal, using the time-weighted characteristic F (FAST). Record the maximum output when the audible emergency evacuation signal is on. Verify audible information to be distinguishable and understandable. In locations where voice intelligibility is required, verify by one of the NFPA 72 approved methods. Ensure Acceptable Sound pressure level differentials comply with NFPA 72.

Demonstrate each alarm control unit to operate in all modes.

Demonstrate capacity and the operation of the battery backup system to operate as required by these specifications by disconnecting the 120 volt, 60 Hz power from the fire alarm (control) panel and operating the system as specified for backup operation.

Demonstrate all circuits interconnecting with other systems fire protection, smoke control (including smoke control panel and pressurization fans), HVAC, security and safety, elevators, etc., to operate as specified on alarm from the associated zone or zones.

Verify all maintenance bypass functions operate as specified. Independently verify each device or circuit controlled by the bypass function.

Test multiplex equipment, devices, and wiring in accordance with NFPA 70and manufacturer's requirements. Remove and ground one lead at

each addressable device to demonstrate open circuit trouble, ground fault trouble, and then operation over ground fault with an open circuit. Alternate between positive (plus) and negative (minus) leads during the device testing process.

Test Style 7 network wiring configuration and fault tolerance to verify proper operation.

3.3.3 Reacceptance System Tests

Perform reacceptance testing after system components are added or deleted; after any modification, repair, or adjustment to system hardware or wiring; or after any change to software. Test all components, circuits, systems operations, or site specific software functions known to be affected by the change or identified by a means that indicates the system operational changes are 100 percent tested. In addition, also test 10 percent of the initiating devices that are not directly affected by the change and verify proper system operation.

Changes to all control units connected or controlled by the system executive software require a 10 percent functional test of the system, including a test of at least one device on each input and output circuit to verify proper system operation.

Upon completion of the modification, functionally test the existing devices that were reinstalled and test the devices that are on both sides of the point of connection of the new devices. Test all newly installed devices in accordance with the paragraph entitled, "Fire Alarm System Acceptance Test Procedures (For Both Preliminary and Final Tests)," of this section.

After final acceptance testing has been successfully completed, submit test data under the terms of the "GENERAL REQUIREMENTS" clause of this contract.

3.4 OPERATION AND MAINTENANCE MANUALS

Submit Operation and Maintenance Manuals. Bind information in manual format and group by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to acceptance tests being performed.

3.5 PAINTING

Bring all manufacturer's standard finish equipment surfaces, damaged during construction, to as-new condition by touchup or repainting to the satisfaction of the Contracting Officer, or replace with new undamaged equipment at no additional cost to the Government.

Paint all fire alarm conduit fittings, junction boxes, and junction box covers red, Color No. 11105 in accordance with FED-STD-595. Mark conduit with a minimum 1-inch wide band every 20 feet. Alternative compliant

method is to use red-colored EMT conduit that is hot-galvanized for durability with a red top coat. If the alternative method is selected, none of the conduit fittings, junction boxes, or junction box covers are required to be painted.

-- End of Section --

SECTION 31 00 00

EARTHWORK
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 145	(1991; R 2000) Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T 2	(2006) Standard Method of Test for Sampling of Aggregates (same as ASTM D 75)
AASHTO T 87	(2004) Standard Method of Test for Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 2216	(2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	(2006) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937	(2004) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3282	(2004) Standard Practice for

	Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D 3740	(2004) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.2 DEFINITIONS

1.2.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by ASTM D 2487 as SP, SM,SP-SM, and ASTM D 3282, Soil Classification Group A-1, A-2-4, and A-3.

1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory soil materials shall mean ASTM D 2487, GW, GP, GM, GP-GM, CW-GM, GC, GP-GC, GM-GC, SW, SW-SM, SC, SW-SC, SP-SC, CL, ML, CL-ML, CH, MH, and AASHTO M 145, Soil Classification Groups A-2-5, A-2-6, A-2-7, A-4, A-5, A-6, And A-7, peat, muck, and other highly organic soil, and other highly organic material, buried vegetation, roots, and post consumer materials such as trash, refuse, or other debris and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test. Notify the Contracting Officer when encountering any contaminated materials.

1.2.3 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

1.2.4 Unstable Material

Unstable materials that are are too wet to properly support the utility pipe, conduit, or appurtenant structure.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Dewatering Work Plan; G

Submit 15 days prior to starting work.

Contractor shall record Existing Conditions prior to starting work in accordance with the paragraph entitled, "Existing Conditions," of this section.

Excavation Plan; G

SD-06 Test Reports

Contractor shall submit written Test Reports of Soil Test results within 5 calendar days. Submit test reports in accordance with paragraph entitled, "Quality Control Testing During Construction," of this section.

SD-07 Certificates

Certificates for Proposed Soil Materials shall be submitted to the Contracting Officer in accordance with paragraph entitled, " Backfill and Fill Materials," of this section.

1.4 SUBSURFACE DATA

Subsurface soil boring logs are included as part of the Ardaman & Associates geotechnical investigation, dated January 25, 2013.

1.5 QUALITY CONTROL TESTING DURING CONSTRUCTION

Retain a Florida-registered professional geotechnical engineer to supervise all testing and perform inspections during all earthwork activities to verify compliance with this section. The Florida-registered professional geotechnical engineer shall also inspect all subgrades and observe and inspect all proof-rolling operations to verify the removal of unsatisfactory materials and compliance with the subgrade compaction requirements of this Specification.

Furnish the soil survey for satisfactory soil materials and samples of soil materials. Provide a certified soil-testing service approved by the Contracting Officer. Testing shall include soil survey for satisfactory soil materials, sampling and testing soil materials proposed for use in the work, and field-testing facilities for quality control during the construction period.

Testing agencies shall conform to the requirements of ASTM D 3740.

Soil materials shall be tested by the Contractor during construction as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
Satisfactory	Sieve analysis	ASTM C 136	One daily for

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
soil materials	of fine and coarse aggregates		each soil material from each source; additional test whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregates	ASTM C 136	
	Amount of material passing No. 200 sieve	ASTM C 117	
	Moisture content of subbase material	ASTM D 2216	
Soil materials prior to compaction	Moisture-density relations of soil	ASTM D 1557	One of each type of subgrade soil; one for each backfill and fill material from each source
Soil material-in-place after compaction	Density of soil-in-place	ASTM D 6938 Nuclear Methods	According to the paragraph entitled "TESTING."

Inspection of Subgrade and Fill: The Testing Laboratory shall inspect and approve the following subgrades and fill layers before further construction work is performed thereon:

a. During backfill operations determine that the material being used and the maximum lift thickness comply with the specifications.

b. Paved Areas and Building Slab Subgrade: Make at least one field density test of the natural subgrade for every 2,500 square feet of paved area or building slab but in no case less than three tests. In each compacted fill layer or lift, make one field density test for every 2,500 square feet of building slab or paved area but in no case less than three tests.

c. Foundation Wall Backfill: Make at least one field density test for each 200 lineal feet of wall with a minimum of four tests for the basement walls around the perimeter of each building and a minimum of one test for every other type of foundation wall on the site. Tests shall be at random locations and elevations for each wall.

d. Subgrade Beneath Column and Wall Footings: Make at least one field density test for each column footing and one for each 25 lineal feet of wall or fraction thereof.

Field Density Tests: Field Density Tests shall be run according to ASTM D 2937, or ASTM D 2922 as applicable.

Acceptance Criteria: The results of field density tests by the Laboratory will be considered satisfactory if the average of any three consecutive tests has a value not less than the required density with no single test falling more than 2 percent below the required density and the moisture content conforms to the requirements of the specification.

Report Copies: Moisture-density curves and results of field density tests shall be submitted to the parties specified earlier in this section.

Additional Testing: If reports by the Laboratory indicate field densities lower than specified, additional tests will be run by the Laboratory with at least the frequencies scheduled above on recompacted fill and/or natural subgrade. The Testing Laboratory shall notify the Contractor on a timely basis for any required retesting so as not to delay the work. The costs of such tests shall be liable to the Owner for repayment by the Contractor.

1.6 FOUNDATION INSPECTION

Spread (Dug) Footing

Subgrade: Verify that foundation bearing conditions are consistent with soil report tests and that the footing is being installed in the proper soil strata at the proper elevation. Make recommendations regarding adjustment to subgrade or bearing elevation if subgrade is not adequate to support footing.

Mat Footing

Subgrade: Verify that foundation bearing conditions are consistent with soil report tests and that the footing is being installed in the proper soil strata at the proper elevation. Make recommendations regarding adjustment to subgrade or bearing elevation if subgrade is not adequate to support footing.

1.7 TEST REPORTS

No soil material shall be used until a written report of Soil Test results has been reviewed and approved by the Contracting Officer.

1.8 EXISTING CONDITIONS

Existing conditions shall be recorded, in the presence of the Contracting Officer, and shall include all structures and other facilities adjacent to areas of alteration or removal. Such records shall contain the location

of existing utilities, the elevation of the top of foundation walls, the location and extent of cracks and other damage, and a description of surface conditions that exist prior to the start of work. Copies of the record shall be submitted and the conditions prior to starting work shall be verified.

1.9 DEWATERING WORK PLAN

Submit procedures for accomplishing dewatering work in accordance with paragraph entitled "Dewatering" in this specification section.

1.10 EXCAVATION PLAN

Submit an Excavation Plan for review and approval at least 15 days before starting work. The Plan shall be in accordance with the Section titled "Shoring and Bracing."

PART 2 PRODUCTS

2.1 BACKFILL AND FILL MATERIALS

Backfill and fill material shall consist of sandy clay, sand, gravel, shale, or other satisfactory soil materials as defined in Subpart 1.2.1 Satisfactory Materials.

Materials for backfill and fill shall be satisfactory soil materials, free of clay clods, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials and other deleterious matter, and shall be satisfactory soil material as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
Satisfactory soil materials	Sampling	AASHTO T 2	One for each source of material to determine conformance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregate	ASTM C 136	
	Mechanical analysis of soils	ASTM D 422	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
	Liquid limit of soils	ASTM D 4318	
	Plastic limit and plasticity index of soils	ASTM D 4318	
	Moisture-density relations of soil	In accordance with paragraph entitled "TESTING," ASTM D 1557	

2.2 ONSITE ORGANIC SOILS

Onsite organic soils may be used as fill outside of the 5-foot building excavation envelope, paving, sidewalk, structures, and utility trenches. Use of these materials must be reviewed and approved by the Contracting Officer.

2.3 COMPACTION EQUIPMENT

Compaction equipment shall consist of sheepsfoot rollers, pneumatic-tired rollers, tamper rollers, vibrating tampers, or other compaction equipment capable of obtaining the required density throughout the entire layer. If hand-held compaction equipment is used, the maximum lift thickness shall not exceed 6 inches.

2.4 BURIED WARNING AND IDENTIFICATION TAPE

Provide polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes

Red:	Electric
Yellow:	Gas, Oil; Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air

2.4.1 Warning Tape for Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a

minimum thickness of 0.003 inch and a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2.4.2 Detectable Warning Tape for Non-Metallic Piping

Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch, and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.5 DETECTION WIRE FOR NON-METALLIC PIPING

Insulate a single strand, solid copper detection wire with a minimum of 12 AWG.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Before starting earthwork, the location of underground utilities shall be carefully verified by hand methods. Utilities to be left in place shall be protected from damage.

Excavation, filling, backfilling, and grading shall be to subgrade elevations specified.

Excavated materials suitable for backfill shall be piled in an orderly manner sufficiently distant from excavations to prevent overloading, slides, and cave-ins.

Excavations shall be done in ways that will prevent surface water and subsurface water from flowing into excavations and will also prevent flooding of the site and surrounding area.

3.2 UNAUTHORIZED EXCAVATION

Unauthorized excavation shall consist of removal of materials beyond indicated subgrade elevations or side dimensions specified without specific direction and shall be replaced as specified at no additional cost to the Government.

Unauthorized excavation under foundations or retaining walls shall be filled by lowering the bottom elevation of the footing or base to the excavation bottom without altering the approved top elevation.

Elsewhere unauthorized excavations shall be backfilled and compacted as specified for authorized excavations of the same classification.

3.3 SURFACE PREPARATION

Grass and other vegetation, roots, debris, stones, objects larger than 2 inches in any dimension, and other materials undesirable to the subsurface construction shall be removed by mowing, grubbing, raking, or other methods from the surface of areas to be stripped.

3.3.1 Stripping Of Topsoil

Where indicated or directed, strip topsoil to a depth of 4 inch. Spread topsoil on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inch in diameter, and other materials that would interfere with planting and maintenance operations. Excavated topsoil shall be transported to, and stockpiled in, designated topsoil storage areas.

3.3.2 Grubbing Operations

Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas. Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated as areas to be paved.

3.3.3 Proof-Rolling

In cleared areas, outside of the 5-foot building excavation envelope, prior to placement of fill material, the soils shall be proof-rolled. Proof-rolling shall consist of at least three passes of a compactor capable of achieving the compaction requirements as defined in Area Classifications in the paragraph entitled "Percentage of Maximum Density Requirements." Each pass shall overlap the preceding pass by 30 percent to complete coverage. Areas that yield shall have all deleterious material removed and replaced with clean, compacted satisfactory material.

3.3.4 Filling Depressions

Depressions resulting from grubbing operations shall be completely filled with acceptable backfilling material, unless further excavation or earthwork is required.

Prior to filling, subgrade surfaces of depressions shall be free of standing water, frost, or frozen material. Unsatisfactory soil materials shall be removed.

Contractor shall place fill material in horizontal layers not to exceed 6 inches in loose depth. Each layer shall be compacted at the optimum moisture content to a density equal to the original adjacent ground. Surface of filled depressions shall be graded to meet adjacent contours and to provide surface water drainage.

3.4 GENERAL EXCAVATION

3.4.1 Removal of Unsatisfactory Materials

Excavate all soils and any other material within the 10-foot building excavation envelope to a vertical depth of no less than 9 feet below the original surface level of the ground. Retain a Florida-registered professional geotechnical engineer to inspect the completed excavation to verify that all unsatisfactory materials have been removed and compliance with subgrade compaction requirements. Excavate and remove all unsatisfactory materials encountered below the minimum specified

excavation depth to a depth directed by the Contracting Officer.

3.4.2 Ditches, Gutters, and Channel Changes

Excavation shall be accomplished by cutting accurately to the cross sections, grades, and elevations indicated. Excessive open-ditch or gutter excavation shall be backfilled with suitable materials to grade at no additional cost.

3.4.3 Structures

Excavation for manholes and similar structures shall be sufficient to leave at least 12 inches in the clear between the outer surfaces and the embankment or timber used to hold and protect the walls. Any overdepth excavation below such appurtenances that has not been directed will be considered unauthorized and shall be refilled with select bedding material or concrete, as directed by the Contracting Officer, at no additional cost to the Government.

Excavation shall be made accurately to the lines, grades, and elevations indicated. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as indicated. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before concrete or masonry is to be placed.

3.4.4 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.4.5 Dewatering

3.4.5.1 Dewatering System

The dewatering system shall be adequate to pre-drain the soils to be excavated. At the building this shall be to the extent that the piezometric water level in the construction area is a minimum of 2 feet below the bottom of the excavation, side slopes of excavations, or bottom of the footings at all times, or as otherwise required to obtain the specified compaction and installation conditions. Pipeline trenches must be dewatered at least 6 inches below the trench bottom.

Groundwater was encountered at depths that ranged from 3.6 to 6 feet below the existing ground surface at the time of soil borings in December 2012. Seasonal high groundwater level is estimated to be approximately 2 feet

above those levels. The Contractor must use his experience and judgment to evaluate the groundwater levels to be encountered during construction.

In the event of layered soils, the hydrostatic head in the zone below the subgrade elevation shall be relieved to prevent uplift.

Unless otherwise noted and prior to any excavating below or within 2 feet above the groundwater level, a dewatering system shall be placed into operation to lower water levels to the extent specified previously, and then shall be operated continuously 24 hours per day, 7 days a week, until work has been completed to the satisfaction of the Contracting Officer.

Where used, well points shall be installed in an approved manner and in sufficient numbers to provide the necessary removal of water as stated previously. Well points and header piping shall be installed in such a manner that traffic on public thoroughfares and site access roads will not be impeded.

The Contractor shall be solely responsible for the arrangements, locations, and depths of the dewatering system necessary to accomplish the specified work.

To prevent excessive noise, exhaust from all pumps and engines shall be silenced and muffled.

Wellpoint pump discharge shall be controlled to prevent erosion, undermining, and all other damage, and be piped to approved locations.

The Contractor shall comply with any and all applicable regulations and permitting requirements concerning groundwater and discharge.

Excavations shall be kept free from water during the placing of concrete structures and utilities.

3.4.5.2 Observation Wells

The Contractor shall install observation wells as may be required to record the piezometric water level at dewatering locations.

The Contractor shall be responsible for maintaining wells and observing and recording the elevation of the piezometric water levels daily.

3.4.5.3 Discharge

Water from dewatering shall be discharged into a settlement basin.

3.4.6 Trench Excavation Requirements

Trenches shall be of adequate width and depth for the specified purpose. Side slopes of the trenches shall be as nearly vertical as practicable. Care shall be taken not to overexcavate. Bottoms of the trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on undisturbed soil at every point along its entire length except where it is necessary to excavate for bell holes and for proper sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded to ensure that the pipe rests on the prepared bottom for as much of its full length as practicable. Bell holes and depressions shall be only of such length, depth, and width as required to make the joint. Stones shall be removed, as necessary, to avoid point

bearing. Where rock excavation is required in trenches for pipe, the rock shall be excavated to a minimum overdepth of 6-inches below the trench depth specified. Except as specified for wet or otherwise unstable material, overdepths shall be backfilled with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe, as determined by the Contracting Officer, is encountered in the bottom of the trench, it shall be removed and the trench shall be backfilled to the proper grade with coarse sand, fine gravel, or other suitable, approved material.

Trench excavations in surfaced areas shall be by open cut, unless otherwise shown. The pavement shall be cut by concrete saw or other approved method. Cuts shall be in straight lines parallel to the utility line location and shall be to a depth of at least one quarter of the pavement thickness. The remainder of the pavement shall be broken out. Pavement shall be removed a minimum of 12 inches on each side of the trench and 6 inches beyond where the base course is to be removed.

3.4.6.1 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Government.

3.4.6.2 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures sufficient to leave at least 12 inch clear between the outer structure surfaces and the face of the excavation or support members. Clean rock of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Remove loose disintegrated rock and thin strata. Specify removal of unstable material. When concrete or masonry is to be placed in an excavated area, take special care not to disturb the bottom of the excavation. Do not excavate to the final grade level until just before the concrete or masonry is to be placed.

3.4.6.3 Excavation For Sanitary Sewers And Storm Sewers

The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall not exceed 8 inches or be less than 5 inches on either side of the pipe. The width of the trench above that level shall be as wide as necessary for sheeting and bracing and for the proper performance of the work.

For pipe indicated resting on the trench bottom, the bottom of the trench shall be rounded so that the pipe shall nest firmly on undisturbed soil for as nearly the full length of the barrel (as proper jointing operations will permit). This part of the excavation shall be done manually only a few feet in advance of the pipe being laid.

Depth of excavation for gravity sewer lines shall permit the installation of the pipe at the flow line elevations shown on the plans.

3.4.6.4 Excavation For Water Distribution System

Trenches shall be graded to avoid high points that necessitate placing vacuum and relief valves in the waterlines. If a profile of the pipes is not provided, trenches shall be of a depth to provide a minimum cover over the top of the pipe of 2-112 feet from the existing ground surface or the indicated finished grade (whichever is lower) and at additional depth if necessary to avoid interference of the waterlines with other utilities.

3.4.6.5 Excavation For Electrical Utilities

Excavation of trenches for electrical cables and duct lines shall provide vertical walls, unless otherwise approved by the Contracting Officer, and the trench shall be only as wide as necessary for workers to install the cables or ducts. Abrupt changes in grade of the trench bottom shall be avoided. Trenches shall be of a depth to provide a minimum cover over the top of the cables or ducts of 2-feet below finished grade, and at additional depth if necessary to avoid interference of the electrical cables or ducts with other utilities.

3.4.6.6 Jacking, Boring, and Tunneling

Unless otherwise indicated, provide excavation by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections.

3.4.7 Structural Excavation

Excavation for structures shall conform to the dimensions and elevations indicated in the Construction Documents within a tolerance of plus or minus 0.10 foot and shall extend a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services and other construction indicated, and for inspection.

In excavating for footings and foundations, care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall be done just before concrete is placed. Bottoms shall be trimmed to the required lines and grades to leave a solid bed to receive concrete.

3.4.8 Stability of Sides

Sides of excavations over 5 feet in depth shall be sloped not steeper than 34 degrees from the horizontal of the material excavated or shall be shored and braced where sloping is not possible because of space restrictions, stability of material excavated, or where excavations are subjected to vibrations from vehicular traffic, the operation of machinery, or any other source.

Sides and slopes of excavations shall be maintained in a safe condition by scaling, benching, shelving, or bracing until completion of backfill placement.

3.4.9 Shoring and Bracing

Any shoring and bracing in excavations shall be maintained for the entire length of time excavations will be open. Shoring and bracing shall be

carried down with the excavation.

Sheeting used to prevent lateral movement of soil shall be removed in accordance with the requirements.

Untreated sheeting shall not be left in place beneath structures or pavements.

Submit an Excavation Plan that indicates how existing infrastructure, utilities, and buildings will be protected during earthwork and dewatering operations. The Plan shall be prepared, signed, and sealed by a Professional Engineer licensed in Florida.

3.5 SELECTION OF BORROW MATERIAL

Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used.

3.6 GRADING AREAS

Areas within the limits of grading under this section, including adjacent transition areas, shall be uniformly graded. Finished surface shall be smooth within the specified tolerances, compacted, and with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

3.6.1 Grading Outside Building Lines

Areas outside the building lines for each structure shall be graded to drain away from the structure and to prevent ponding of water after rains. Finished surface shall be within the tolerance specified below for each area classification, compacted as specified, and free from irregular surface changes.

Grassed or planted areas:

Finished surface of areas to receive topsoil shall be not more than 0.10 foot above or below the indicated finish elevations.

Walks:

Surface of areas under walks shall be shaped to line, grade, and cross section; finished surface shall be not more than 0.0 foot above or 0.10 foot below the indicated finish elevation.

Pavements:

Surface of areas under pavements shall be shaped to line, grade, and cross section; the finished surface shall be not more than 1-inch above or below the indicated finish elevation when tested with a 10-foot straightedge applied both parallel with and at right angles to the centerline of the area. Finished surface shall vary no more than 1 inch.

3.6.2 Grading Surface of Fill Under Structures

Surface of fill under building slabs shall be smooth and even, free of voids, compacted as specified and to indicated grade within the specified tolerances. When tested with a 10-foot straightedge, parallel with and at

right angles to the building lines, the finished surface shall not exceed plan grades nor be less than 1 inch of plan grades.

3.7 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Protect surfaces from erosion resulting from ponding or water flow.

3.8 GROUND SURFACE PREPARATION

3.8.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inches before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inches, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inches and compact it as specified for the adjacent fill.

3.8.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.9 UTILIZATION OF EXCAVATED MATERIALS

Dispose of unsatisfactory materials removed from excavations into designated waste disposal or spoil areas. Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. Do not waste any satisfactory excavated material without specific written authorization. Dispose of satisfactory material, authorized to be wasted, in designated areas approved for surplus material storage or designated waste areas as directed. Clear and grub newly designated waste areas on Government-controlled land before disposal of waste material thereon. Stockpile and use coarse rock from excavations for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. Do not dispose excavated material to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

3.10 BURIED TAPE AND DETECTION WIRE

3.10.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inch es below top of subgrade.

3.10.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over it's entire length. Install wires at manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.11 FILLING AND BACKFILLING

3.11.1 Preparations Prior to Backfill Placement

Excavations shall be backfilled as promptly as the work permits but not until completion of the following:

Approval of construction below finish grade

Inspection, testing, approval, and recording location of underground utilities

Removal of concrete formwork

Removal of shoring and bracing; backfilling of voids with satisfactory soil material; temporary sheet piling driven below bottom of structures; and cutting off and removing of utilities in a manner that prevents settlement of the structure or utilities

Removal of trash and debris

Completion of concrete waterproofing

3.11.2 Preparation of Ground Surface to Receive Fill

Vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials shall be removed from ground surface prior to the placement of fills. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stripped, or broken up in such manner that fill material will bond with the existing material.

When the ground surface has a density less than that specified for the particular area classification, the ground surface shall be broken up, pulverized, moisture-conditioned to near optimum moisture content of the soil material, and compacted to the required depth and percentage of maximum density.

3.11.3 Placement and Compaction

Any backfill or fill shall be placed in loose lifts not exceeding 6 inches in thickness. Before compaction, each layer of backfill or fill material shall be moistened or aerated as necessary to provide the optimum moisture content of the soil material and shall then be compacted to the percentage of maximum density for each area classification as specified. Backfill or fill material shall not be placed on surfaces that are muddy, frozen, icy, or contain frost.

Backfill and fill materials adjacent to structures shall be brought up evenly around structures and shall be carried up to the indicated elevations.

Compaction adjacent to structures, within a horizontal distance from the face of the structure equal to the depth of backfill or fill material (measured from the bottom of footing or bottom of foundation or retaining wall) to final grade, shall be done with power-driven hand tampers.

3.11.4 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding 6 inch loose thickness.

3.11.5 Compaction

3.11.5.1 Percentage of Maximum Density Requirements

Actual density of each layer of soil material-in-place shall be not less than the following percentages of the maximum density of the same soil material determined by the moisture-density test per ASTM D 1557.

AREA CLASSIFICATION	PERCENT MAXIMUM DENSITY
Grassed areas	92
Walks	95
Utility trenches	95
Structures	
Top 12 inches of subgrade	95
Each layer of back-fill material	95
Building slabs and steps	
Top 12 inches of subgrade and each layer of backfill material	95

3.11.5.2 Moisture Control

Moisture content in soil material at time of compaction shall be within specified limits.

Where the moisture content of a layer of soil material is below optimum before compaction, the required amount of water shall be uniformly applied to the surface of the layer of soil material and the layer of soil disked or otherwise mixed until a uniform moisture content is reached.

Where the moisture of a layer of soil material is above optimum, it shall be dried.

3.12 EMBANKMENTS

3.12.1 Earth Embankments

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. Place the material in successive horizontal layers of loose material not more than 6 inches in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise brake up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements are identical with those requirements specified in paragraph SUBGRADE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.13 SUBGRADE PREPARATION

3.13.1 Proof Rolling

All subgrade areas within the 10-foot building excavation envelope and beneath all structures and paved areas shall be proof rolled after excavation has been completed.

Proof-rolling of the building areas shall consist of at least 10 passes of a compactor capable of achieving the density requirements described in the next paragraph. Each pass shall overlap the preceding pass by 30 percent to achieve complete coverage. In areas that continue to "yield", remove all deleterious material and replace with clean, compacted suitable backfill. The proof-rolling shall occur after cutting and before filling. The number of passes can be reduced to three within the proposed parking/drive areas.

Care shall be exercised to avoid damaging any neighboring structures while the compaction operation is underway. Prior to commencing compaction, occupants of adjacent structures shall be notified and the existing condition (i.e. cracks) of the structures documented with photographs and survey (if deemed necessary). If requested, Ardaman & Associates could assist with pre- and post-construction surveys of existing structures and with vibration monitoring during construction. Compaction shall cease if deemed detrimental to adjacent structures, and Ardaman & Associates should be notified immediately.

3.13.2 Construction

Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 6 inches below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. After rolling, do not show

deviations for the surface of the subgrade for roadways greater than 1 inch when tested with a 10-foot straightedge applied both parallel and at right angles to the centerline of the area. Do not vary the elevation of the finish subgrade more than 0.05 foot from the established grade and cross section.

3.13.3 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas, compact each layer of the embankment in accordance with the Area Classifications in the paragraph entitled "Percentage of Maximum Density Requirements."

3.13.3.1 Subgrade for Pavements

Compact subgrade for pavements in accordance with the Area Classifications in the paragraph entitled "Percentage of Maximum Density Requirements for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top 12 inches of subgrade.

3.14 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.14.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do no disturb the finished subgrade by traffic or other operation. The Contractor is responsible for protecting and maintaining the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.

3.14.2 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.15 TESTING

Determine field in-place density of soils and the percentage of the maximum soil density. When test results indicate that compaction is not

as specified, remove the material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.15.1 In-Place Densities

a. Within 5 feet of the building, the minimum frequency of in-place density testing shall be one test for each 2,500 square feet of area in each 12 inches of depth of backfill or fill and in the top 12 inches of natural soil below the excavation. Two additional in-place density tests shall be performed under each spread footing to test the soil for a depth of 2 feet. Two additional in-place density tests shall be performed under continuous or wall footings for every 50 lineal feet of footing to test the soil for a depth of 2 feet.

b. Under parking, sidewalks, and paving, perform an in-place density test for every 5,000 square feet of area in the top 12 inches of natural soil and in every 12 inches of fill.

c. Utility trench backfill shall be tested once for every 200 linear feet of trench in each 12 inches of backfill.

3.15.2 Check Tests on In-Place Densities

If ASTM D 6938 is used, check in-place densities by ASTM D 1556 as follows:

a. One check test per lift for each 20,000 square feet, or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines.

b. One check test per lift for each 20,000 square feet, of fill or backfill areas compacted by hand-operated machines.

c. One check test per lift for each 2,500 linear feet, or fraction thereof, of embankment or backfill for roads.

3.15.3 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 75 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.15.4 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

3.16 MAINTENANCE

3.16.1 Protection of Graded Areas

Newly graded areas shall be protected from traffic and erosion and shall be maintained free of trash and debris.

3.16.2 Reconditioning Compacted Areas

Where approved compacted areas are disturbed by subsequent construction operations or adverse weather, the surface shall be scarified, reshaped, and compacted as specified to the required density prior to further construction.

3.17 DISPOSITION OF SURPLUS MATERIAL

Excess excavated satisfactory materials shall be removed from Government property.

Waste materials, including excavated material classified as unsatisfactory soil material, and debris, shall be removed from government property.

-- End of Section --

SECTION 31 31 16

SOIL TREATMENT FOR SUBTERRANEAN TERMITE CONTROL
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

7 USC Section 136	Federal Insecticide, Fungicide, and Rodenticide Act

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Termiticide Application Plan; G

Termiticide application plan with proposed sequence of treatment work with dates and times. The termiticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area/volume treated, amount applied; and the name and state license number of the state certified applicator shall be included.

Termiticides

Manufacturer's label and Material Safety Data Sheet (MSDS) for termiticides proposed for use.

Foundation Exterior

Written verification that other site work will not disturb the treatment.

Utilities and Vents

Written verification that utilities and vents have been located.

Crawl and Plenum Air Spaces

Written verification that crawl spaces and plenum air spaces have been located.

Verification of Measurement

Written verification that the volume of termiticide used meets the application rate.

Application Equipment

A listing of equipment to be used.

Warranty

Copy of Contractor's warrany.

SD-04 Samples

Termiticides

Submit on request samples of the pesticides used in this work or the Contracting Officer may draw, at any time and without prior notice, from stocks at the job site. Should analysis, performed by the Government, indicate such samples to contain less than the amount of active ingredient specified on the label, work performed with such products shall be repeated, with pesticides conforming to this specification, at no additional cost to the Government.

SD-06 Test Reports

Equipment Calibration and Tank Measurement

Certification of calibration tests conducted on the equipment used in the termiticide application.

Soil Moisture

Soil moisture test result.

Quality Assurance

Pest Management Report and copies of daily records signed by an officer of the Contractor.

SD-07 Certificates

Qualifications

Qualifications and state license number of the termiticide applicator.

1.3 QUALIFICATIONS

For the application of pesticides, the Contractor shall use the services of a subcontractor whose principal business is pest control. The subcontractor shall be licensed and certified in the state where the work is to be performed. Termiticide applicators shall also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control.

1.4 SAFETY REQUIREMENTS

Formulate, treat, and dispose of termiticides and their containers in accordance with label directions. Draw water for formulating only from sites designated by the Contracting Officer, and fit the filling hose with a backflow preventer meeting local plumbing codes or standards. The filling operation shall be under the direct and continuous observation of a contractor's representative to prevent overflow. Secure pesticides and related materials under lock and key when unattended. Ensure that proper protective clothing and equipment are worn and used during all phases of termiticide application. Dispose of used pesticide containers off Government property.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Termiticide material shall be delivered to the site in the original unopened containers bearing legible labels indicating the EPA registration number and manufacturer's registered uses. All other materials to be used on site for the purpose of termite control shall be delivered in new or otherwise good condition as supplied by the manufacturer or formulator.

1.5.2 Storage

Materials shall be stored in designated areas and in accordance with manufacturer's labels. Termiticides and related materials shall be kept under lock and key when unattended.

1.5.3 Handling

Termiticides shall be handled in accordance with manufacturer's labels. Manufacturer's warnings and precautions shall be observed. Materials shall be handled preventing contamination by dirt, water, and organic material. Protect termiticides from sunlight as recommended by the manufacturer.

1.6 INSPECTION

Termiticides shall be inspected upon arrival at the job site for conformity to type and quality in accordance with paragraph TERMITICIDES. Each label shall bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended or under appropriate regulations of the host county. Other materials shall be inspected for conformance with specified requirements. Unacceptable materials shall be removed from the job site.

1.7 WARRANTY

The Contractor shall provide a 5-year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions constructed under this contract. Warranty shall include annual inspections of the buildings or building additions. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim, the Contractor shall:

a. Retreat the soil and perform other treatment as may be necessary for elimination of subterranean termite infestation;

b. Repair damage caused by termite infestation; and

c. Reinspect the building approximately 180 days after the retreatment.

1.8 QUALITY ASSURANCE

The Contractor shall comply with 7 USC Section 136 for requirements on contractor's licensing, certification, and record keeping. The Contractor shall maintain daily records using Pest Management Maintenance Record, DD Form 1532-1 and submit copies of records when requested by the Contracting Officer. These forms may be obtained from the main web site:

http://www.dtic.mil/whs/directives/infomgt/forms/ddforms1500-1999.htm

Upon completion of this work, submit Pest Management Report. DD Form 1532 identifying target pest, type of operation, brand name and manufacturer of pesticide, formulation, concentration or rate of application used.

PART 2 PRODUCTS

2.1 TERMITICIDES

Termiticides shall be currently registered by the EPA or approved for such use by the appropriate agency of the host county. Non-repellant termiticide shall be selected for maximum effectiveness and duration after application. The selected termiticide shall be suitable for the soil and climatic conditions at the project site.

PART 3 EXECUTION

3.1 TECHNICAL REPRESENTATIVE

The certified installation pest management coordinator shall be the technical representative, shall be present at all meetings concerning treatment measures for subterranean termites, and may be present during treatment application. The command Pest Control Coordinator shall be contacted prior to starting work.

3.2 SITE PREPARATION

Site preparation shall be in accordance with Section 31 00 00 EARTHWORK. Work related to final grades, landscape plantings, foundations, or any other alterations to finished construction which might alter the condition of treated soils, shall be coordinated with this specification.

3.2.1 Ground Preparation

Food sources shall be eliminated by removing debris from clearing and grubbing and post construction wood scraps such as ground stakes, form boards, and scrap lumber from the site, before termiticide application begins.

3.2.2 Verification

Before work starts, the Contractor shall verify that final grades are as indicated and smooth grading has been completed in accordance with Section 31 00 00 EARTHWORK. Soil particles shall be finely graded with particles

no larger than 1 inch and compacted to eliminate soil movement to the greatest degree.

3.2.3 Foundation Exterior

The Contractor shall provide written verification that final grading and landscape planting operations will not disturb treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures.

3.2.4 Utilities and Vents

The Contractor shall provide written verification that the location and identity of HVAC ducts and vents, water and sewer lines, and plumbing have been accomplished prior to the termiticide application.

3.2.5 Crawl and Plenum Air Spaces

The Contractor shall provide written verification that the location and identity of crawl and plenum air spaces have been accomplished prior to the termiticide application.

3.3 SITE CONDITIONS

The following conditions shall determine the time of application.

3.3.1 Soil Moisture

Soils to be treated shall be tested immediately before application. Soil moisture content shall be tested to a minimum depth of 3 inches. The soil moisture shall be as recommended by the termiticide manufacturer. The termiticide will not be applied when soil moisture exceeds manufacturer's recommendations because termiticides do not adhere to the soil particles in saturated soils.

3.3.2 Runoff and Wind Drift

Termiticide shall not be applied during or immediately following heavy rains. Applications shall not be performed when conditions may cause runoff or create an environmental hazard. Applications shall not be performed when average wind speed exceeds 10 miles per hour. The termiticide shall not be allowed to enter water systems, aquifers, or endanger humans or animals.

3.3.2.1 Vapor Barriers and Waterproof Membranes

Termiticide shall be applied prior to placement of a vapor barrier or waterproof membrane.

3.3.2.2 Utilities and Vents

Prior to application, HVAC ducts and vents located in treatment area shall be turned off and blocked to protect people and animals from termiticide.

3.3.3 Placement of Concrete

Concrete covering treated soils shall be placed as soon as the termiticide has reached maximum penetration into the soil. Time for maximum penetration shall be as recommended by the manufacturer.

3.4 TERMITICIDE TREATMENT

The Contractor shall submit a Termiticide Application Plan for approval before starting the specified treatment.

3.4.1 Equipment Calibration and Tank Measurement

Immediately prior to commencement of termiticide application, calibration tests shall be conducted on the application equipment to be used and the application tank shall be measured to determine the volume and contents. These tests shall confirm that the application equipment is operating within the manufacturer's specifications and will meet the specified requirements. The Contractor shall provide written certification of the equipment calibration test results within 1 week of testing.

3.4.2 Mixing and Application

Formulating, mixing, and application shall be performed in the presence of the Contracting Officer or the technical representative. A closed system is recommended as it prevents the termiticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying termiticides shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

3.4.3 Treatment Method

For areas to be treated, the Contractor shall establish complete and unbroken vertical and/or horizontal soil poison barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Application shall not be made to areas which serve as crawl spaces or for use as a plenum air space.

3.4.3.1 Surface Application

Surface application shall be used for establishing horizontal barriers. Surface applicants shall be applied as a coarse spray and provide uniform distribution over the soil surface. Termiticide shall penetrate a minimum of 1 inch into the soil, or as recommended by the manufacturer.

3.4.3.2 Rodding and Trenching

Rodding and trenching shall be used for establishing vertical soil barriers. Trenching shall be to the depth of the foundation footing. Width of trench shall be as recommended by the manufacturer, or as indicated. Rodding or other approved method may be implemented for saturating the base of the trench with termiticide. Immediately after termiticide has reached maximum penetration as recommended by the manufacturer, backfilling of the trench shall commence. Backfilling shall be in 6 inch rises or layers. Each rise shall be treated with termiticide.

3.4.4 Sampling

The Contracting Officer may draw from stocks at the job site, at any time and without prior notice, samples of the termiticides used to determine if

the amount of active ingredient specified on the label is being applied.

3.5 VERIFICATION OF MEASUREMENT

Once termiticide application has been completed, tank contents shall be measured to determine the remaining volume. The total volume measurement of used contents for the application shall equal the established application rate for the project site conditions. The Contractor shall provide written verification of the measurements.

3.6 CLEAN UP, DISPOSAL, AND PROTECTION

Once application has been completed, the Contractor shall proceed with clean up and protection of the site without delay.

3.6.1 Clean Up

The site shall be cleaned of all material associated with the treatment measures, according to label instructions, and as indicated. Excess and waste material shall be removed and disposed off site.

3.6.2 Disposal of Termiticide

The Contractor shall dispose of residual termiticides and containers off Government property, and in accordance with label instructions and EPA criteria.

3.6.3 Protection of Treated Area

Immediately after the application, the area shall be protected from other use by erecting barricades and providing signage as required or directed.

3.7 CONDITIONS FOR SATISFACTORY TREATMENT

3.7.1 Equipment Calibrations and Measurements

Where results from the equipment calibration and tank measurements tests are unsatisfactory, re-treatment will be required.

3.7.2 Testing

Should an analysis, performed by a third party, indicate that the samples of the applied termiticide contain less than the amount of active ingredient specified on the label, and/or if soils are treated to a depth less than specified or approved, re-treatment will be required.

3.7.3 Disturbance of Treated Soils

Soil and fill material disturbed after treatment shall be re-treated before placement of slabs or other covering structures.

3.7.4 Termites Found Within the Warranty Period

If live subterranean termite infestation or termite damage is discovered during the warranty period, the Contractor shall re-treat the site.

3.8 RE-TREATMENT

Where re-treatment is required, the Contractor shall comply with the

requirements specified in paragraph WARRANTY.

-- End of Section --

SECTION 31 62 13.20

PRECAST/PRESTRESSED CONCRETE PILES
08/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 318	(2011; Errata 1 2011; Errata 2 2012; Errata 3-4 2013) Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2012) Standard Specification for Carbon Structural Steel
ASTM A416/A416M	(2012) Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM A615/A615M	(2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2009b) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A82/A82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C1202	(2012) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

ASTM C1218/C1218M	(1999; R 2008) Standard Specification for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2012) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2012) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C172/C172M	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C31/C31M	(2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2013) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2012) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C494/C494M	(2013) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2013) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2003; R 2008) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C989/C989M	(2012a) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load

ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966	(2007) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4945	(2012) High-Strain Dynamic Testing of Piles

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI JR-382	(1993) PCI Journal: Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling
PCI MNL-116	(1999) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 4th Edition
PCI STD-112	(1984) Standard Prestressed Concrete Piles Square, Octagonal and Cylinder

1.2 SUSTAINABILITY DESIGN REQUIREMENTS

See section 01 33 29 LEED DOCUMENTATION for all material requirements.

1.3 LUMP SUM PAYMENT

The contract price for piling shall include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off, dispose of any cut-offs, and meet the applicable contract requirements. The contract price also includes mobilization, pre-drilling, and redriving heaved piles. If, in redriving, it is found that any pile is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserve the right to increase or decrease the total length of piles to be furnished and installed, change the pile locations or elevations, require the installation of additional piles, or direct the omission of piles from the requirements shown and specified. Should total number of piles or individual length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; backdriving; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible. Refere to the instructions to bidders for unit pricing requirements.

1.3.1 Acceptance Criteria

Safe design capacity for piles is 90 tons. Piles shall be driven to a minimum depth of 90 feet below cut-off elevation, and to such additional depth as required to obtain a bearing capacity of not less than the

specified capacity.

1.4 PILE REQUIREMENTS

Provide square precast prestressed concrete piles, PCI JR-382. Production of piles shall be in accordance with PCI MNL-116. The Contractor's Geotechnical Consultant will determine and list "calculated" tip elevations or driving resistance for each pile from test pile data. This information will be given to the Contractor no later than 7 days from receipt of complete test data. Use this list as the basis for ordering the piles. Do not order piles until list is provided. Test piles shall be 15 feet longer than the bid length.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G

Geotechnical Consultant Documentation; G

Wave Equation Analysis; G

Order List; G

Precasting manufacturer's quality control procedures; G

Provide instructions and procedures on how the Contractor will assist the Government in the processes of Dynamic Pile Testing, Inspection and Monitoring of piles during installation and testing.

SD-02 Shop Drawings

Piles; G

SD-03 Product Data

Pile Driving Equipment; G

Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, cap blocks, pile cushions, leads, extractors and preboring equipment at least 30 days prior to commencement of work.

SD-05 Design Data

Concrete mix design; G

Submit a concrete mix design before concrete is placed, for each type of concrete used for the piles.

SD-06 Test Reports

Aggregates; G

Silica Fume; G

Concrete Compressive Strength;

Test piles; G

Load tests; G

Submit concrete cylinder compressive strength test results. Submit test pile recordsandload test data.

Dynamic Pile Analysis; G

Submit a summary report of dynamic test results for test piles within 7 calendar days of completing field work. For permanent piles, submit a field summary report within one (1) day of testing. Submit a typed report summarizing the results of dynamic testing of permanent piles on a monthly basis.

SD-07 Certificates

Aggregates; G

Admixtures; G

Silica fume manufacturer's representative; G

Prestressing steel; G

Cement; G

Fly ash and pozzolan; G

Ground Slag; G

Load Test Supporting Data

SD-11 Closeout Submittals

Pile records; G

Submit pile and test pile records. Submit load test data and results.

1.6 QUALITY ASSURANCE

1.6.1 Piles

Prepare in accordance with ACI SP-66. Indicate placement of reinforcement including tendons. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up. Provide certification of a Professional Engineer registered in any jurisdiction of the U. S. or its territories, that layout and details of reinforcement and tendons conform with that shown on the structural design drawings.

1.6.2 Quality Control Procedures

Submit the precasting manufacturer's quality control procedures and inspection records established in accordance with PCI MNL-116.

1.6.3 Installation Procedures

a. Submit information on the type of equipment proposed to be used, proposed methods of operation, pile driving plan including proposed sequence of driving, and details of all pile driving equipment and accessories.

b. Provide details of pile driving equipment and a Wave Equation Analysis of pile drivability for selection of the hammer along with a statement of driving procedures. The Wave Equation Analysis is to be completed by the Contractor's Geotechnical Consultant for each test pile location where different subsurface conditions exist and is to include the following information pertaining to the proposed pile driving equipment:

(1) Complete Pile and Driving Equipment Data Form, located at the end of this section, for each proposed pile hammer and pile type combination.

(2) Copies of computer input and output sheets and graphs showing soil resistance versus blow count as well as maximum tension and compression stresses versus blow count. Analysis shall be run at the estimated tip elevation as well as other required elevations to define maximum stress levels in the pile during driving.

c. Provide detailed procedures for conducting the dynamic pile load test and equipment to be used for conducting the load test. The detailed description shall explain how specific information of pile performance will be evaluated.

1.6.4 Geotechnical Consultant Documentation

The services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and Pile Dynamic Analysis, shall be hired by the Contractor to observe test pile installation and job pile installation as specified herein. The Geotechnical Consultant shall be independent of the Contractor and shall have no employee or employer relationship which could constitute a conflict of interest.

1.6.5 Concrete Mix Design

Certify, using a Government-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI 211.1 or ACI 318 for specified strength and is based on aggregate data which has been determined by laboratory tests during last twelve months. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolan, ground slag, and admixtures; and applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted.

1.6.6 Load Test Supporting Data

Submit Jack calibration records, a testing arrangement description and diagram, and the proposed loading sequence.

1.6.7 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be available, if needed, to visit the plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

1.7 DELIVERY, STORAGE, AND HANDLING

Piles shall be stored, handled, and transported in accordance with PCI MNL-116 except as follows. Methods used for handling and storage of piles shall be such that the piles are not subjected to excessive bending stress, cracking, spalling, or other damage.

1.7.1 Damaged Piles

The Contractor shall inspect each pile for sweep and structural damage such as cracking and spalling before transporting them to the project site and immediately prior to placement in the driving leads. Any unusual cracks (cracks other than crazing, surface drying, shrinkage cracks and end cracks) shall be brought to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, shall be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

1.7.1.1 Repairable Cracks

Piles with cracks equal to or greater than 0.006 inches but less than 0.06 inches shall be rejected or repaired. As an alternate to pile rejection, the Contractor may submit a proposal to repair deficient piles, which shall be restored prior to driving to provide its required design capacity, perform its intended function in the structure, and take into consideration long term durability in corrosive environment.

1.7.1.2 Non-Repairable Cracks

Piles with cracks equal to or greater than 0.06 inches shall be rejected.

1.7.2 Pile Sweep

Sweep shall be limited to 1/8 inch per 10 feet over the length of the pile. Piles having excessive sweep shall be rejected.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall be portland cement, blended cement or portland cement in combination with natural pozzolan or fly ash or ground granulated blast furnace slag and conforms to appropriate specifications listed below.

2.1.1.1 Cement

ASTM C150/C150M, Type II with a maximum alkali content of 0.40 percent; or ASTM C595/C595M, Type IP(MS) or IS(MS) blended cement except as modified herein. The blended cement shall consist of a mixture of ASTM C150/C150M cement (with alkali content not exceeding 0.40 percent and one of the following materials: ASTM C618 pozzolan or fly ash, or ASTM C989/C989M ground iron blast-furnace slag, or ASTM C1240 silica fume. If no satisfactory test results are available (made within the past six months) to prove that the cement alkali content is less than 0.40 percent, then cement with a maximum of 0.60 percent alkali shall be used. Cement certificates shall include test results in accordance with ASTM C150/C150M, including equivalent alkalies indicated in the optional chemical requirements. Use cement with a tricalcium aluminate (C3A) content of less than 8 percent.

2.1.1.2 Fly Ash and Pozzolan

ASTM C618, Class N, or F except that the maximum total alkalies shall be 3.0 percent, and the maximum allowable loss on ignition shall be 3 percent. If the aggregates are reactive, the maximum calcium oxide content shall be 13.0 percent. Class C shall not be used.

2.1.1.3 Ground Iron Blast-Furnace Slag

ASTM C989/C989M, Grade 120.

2.1.1.4 Silica-Fume

ASTM C1240, provide silica fume that is a by-product of silicon or ferrosilicon production. Provide percent by weight of the total cementitious materials as indicated in the table below.

2.1.1.5 Supplemental Cementitious Materials (SCM) Content

The concrete mix shall contain one of the SCMs listed below, or a linear combination thereof.

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT		
SCM	Minimum Content	Maximum Content
Class N Pozzolan or Class F Fly Ash with SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 70 percent	25 percent	35 percent
Class N Pozzolan or Class F Fly Ash with with SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 80 percent	20 percent	35 percent

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT		
SCM	Minimum Content	Maximum Content
Class N Pozzolan or Class F Fly Ash with with SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 90 percent	15 percent	35 percent
GGBF Slag	30 percent	50 percent
Silica Fume	5 percent	10 percent

2.1.2 Water

Water shall be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete or steel.

2.1.3 Aggregates

ASTM C33/C33M , except as modified herein. Provide aggregate free from any substance which may be deleteriously reactive with alkalies in cement in an amount sufficient to cause excessive expansion of concrete. Do not mix, store in same stockpile, or use fine aggregates from different sources of supply in same concrete mix or same structure without approval. The fineness modulus of fine aggregate shall be not less than 2.40 or greater than 3.0. If the selected aggregates fail the soundness test, the Contractor may use the aggregate source, provided concrete specimens made with the aggregates to be used for the piles shall have a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666/C666M. Prior to pile fabrication, submit certified test reports for the following tests specified in ASTM C33/C33M ,in addition, twice during each shift when the concrete plant is operating, the gradation of each size of aggregate shall be tested in accordance with ASTM C136:

a. Grading

Amount of material finer than No. 200 sieve

Organic impurities

Soundness

Clay lumps and friable particles

Coal and lignite

Weight of slag

Abrasion of coarse aggregate

Fineness modulus

Reactive aggregates

2.1.3.1 Alkali-Silica Reactivity (ASR)

Fine and coarse aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate activity.

The fine and coarse aggregates shall be evaluated separately, using ASTM C1260. Test results of the individual aggregates shall have a measured expansion equal to or less than 0.08 percent at 16 days after casting. Should the test data indicate an expansion of greater than 0.08 percent, the aggregates(s) shall be rejected or additional testing, using ASTM C1567, shall be performed as follows: utilize the Contractor's proposed low alkali portland cement and SCM in combination with the proposed aggregate for the test portioning. The SCM quantity shall be determined that will meet all the requirements of these specifications and that will lower the ASTM C1567 expansion to equal or less than 0.08 percent at 16 days after casting.

If the above option does not lower the expansion to less than 0.08 percent at 16 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.1.4 Admixtures

Chemical admixtures shall conform to ASTM C494/C494M, Type A. Air-entraining admixture shall conform to ASTM C260/C260M. Do not use admixtures containing chlorides.

2.1.5 Prestressing Steel

Use seven-wire stress-relieved or low-relaxation strand conforming to ASTM A416/A416M, Grade 270. Use prestressing steel free of grease, oil, wax, paint, soil, dirt, and loose rust. Do not use prestressing strands or wire having kinks, bends, or other defects.

2.1.6 Reinforcing Steel

ASTM A615/A615M, Grade 60; ASTM A706/A706M, Grade 60;where welding of reinforcing bars will be required .Weld reinforcing steel in accordance with AWS D1.4/D1.4M.

2.1.7 Ties and Spirals

Steel, ASTM A82/A82M for spirals and ASTM A615/A615M for ties.

2.1.8 Anchorages and End Fittings

ACI 318.

2.1.9 Grout

Provide cement grout for prestressed piles using materials conforming to requirements stipulated herein for concrete mixes. Use admixtures, if required, known to have no injurious effects on steel or concrete. Do not use calcium chloride.

2.1.10 Pile Driving Points

Pile driving points shall be of steel conforming to the requirements of

ASTM A36/A36M, of the type.

2.2 CONCRETE MIX DESIGN

ACI 211.1 or ACI 318, Chapter 4. Concrete shall have a minimum compressive strength of 5000 psi at 28 days and a maximum size aggregate of 3/4 inches. Concrete shall be air entrained with a minimum of 4.5 percent and a maximum of 7.5 percent. Mix shall contain fly ash, ground iron blast furnace slag or silica fume to meet the requirements specified herein to mitigate Alkali-Silica Reactivity (ASR). For marine exposure, ensure a dense concrete free of shrinkage cracks, with a minimum degree of permeability. The maximum water cement ratio shall be 0.40 .

2.3 FABRICATION

2.3.1 Formwork

Formwork and dimensional tolerances shall be in accordance with PCI MNL-116, and as specified herein. Provide forms of metal, braced and stiffened against deformation, accurately constructed, watertight, and supported on unyielding casting beds. Forms shall permit movement of pile without damage during release of prestressing force. Form precast dowel holes with galvanized flexible metal conduit. Inside forms or void tubes not to be grouted may be treated cardboard, plywood, or other material.

2.3.2 Pretensioning

Pretensioning shall be performed in accordance with PCI MNL-116, and as specified herein. Use gage calibrated within last 6 months by a laboratory approved by Contracting Officer. Provide means for measuring elongation of steel to nearest 1/8 inch. Give tensioning steel a uniform prestress prior to being brought to design prestress. Induce same initial prestress in each unit when several units of prestressing steel in a pile are stretched simultaneously.

2.3.3 Casting

2.3.3.1 Conveying

Convey concrete to formwork in accordance with PCI MNL-116, and as specified herein. Clean conveying equipment thoroughly before each run. During placing, make any free vertical drop of the concrete less than 3 feet. Remove concrete which has segregated in conveying or placing.

2.3.3.2 Placing and Casting

Perform concrete casting within 3 days after pretensioning steel; however, do not deposit concrete in forms until placement of reinforcement and anchorages has been inspected and approved by pile manufacturer's quality control representative. Produce each pile of dense concrete straight with smooth surfaces with reinforcement retained in its proper position during fabrication. Use vibrator with heads smaller than the minimum distance between steel for pretensioning. Make surface of pile ends perpendicular to axis of pile. Chamfer, 3/4 inch, ends of piles and corners of square piles.

2.3.4 Curing of Piles

Cure piles using moist or accelerated curing. Curing of piles shall be in accordance with the PCI MNL-116 except as follows.

2.3.4.1 Moist Curing

Moist cure using moist burlap coverings, plastic sheeting, or membrane curing compound until minimum strength to detension is achieved.

2.3.4.2 Accelerated Curing

After placement of concrete, moist cure for a period of 4 hours. Follow by accelerated curing until concrete has reached specified release strength. Enclose casting bed for accelerated curing with a suitable enclosure. During application of steam or heat, increase the air temperature at a rate not to exceed 40 degrees F per hour. Cure at a maximum temperature of 150 degrees F until concrete has reached specified release strength. Reduce temperature at a rate not to exceed 20 degrees F per hour until a temperature of 20 degrees F above ambient air temperature is reached. After accelerated curing, moist cure using either water or membrane curing until a total accelerated and moist curing time of 72 hours is achieved.

2.3.5 Detensioning

Detensioning shall be performed in accordance with PCI MNL-116, and as specified herein. Gradually release tension in strands from anchorage. Detension after approval by pile manufacturer's quality control representative. Perform transfer of prestressing force when concrete has reached a minimum compressive strength of 3000 psi.

2.4 PRODUCT QUALITY CONTROL

Where piling is manufactured in a plant with an established quality control program as attested to by a current certification in the PCI "Certification Program for Quality Control" perform product quality control in accordance with PCI MNL-116. Where piling is manufactured by specialists or in plants not currently enrolled in the PCI "Certification Program for Quality Control," set-up a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an independent commercial testing laboratory approved by the Contracting Officer in accordance with the following.

2.4.1 Aggregate Tests

Take samples of fine and coarse aggregate at concrete batch plant and test. Perform mechanical analysis (one test for each aggregate size) in accordance with ASTM C136. Tabulate results of tests in accordance with ASTM C33/C33M.

2.4.2 Slump and Strength Tests

Sample concrete in accordance with ASTM C172/C172M at time concrete is deposited for each production line. Perform slump tests in accordance with ASTM C143/C143M. Mold cylinders in accordance with ASTM C31/C31M. Mold at least six cylinders per day or one for every 50 cubic yards of concrete placed, whichever is greater. Cure cylinders in same manner as piles and for accelerated curing, place at coolest point in casting bed.

Perform strength tests in accordance with ASTM C39/C39M. Test two cylinders of each set at 7 days or 14 days, or at a time for establishing transfer of prestressing force (release strength) and removal of pile from forms. Test remaining cylinders of each set 28 days after molding.

2.4.3 Changes in Proportions

If, after evaluation of strength test results, compressive strength is less than specified compressive strength, make adjustments in proportions and water content and changes in temperature, moisture, and curing procedures as necessary to secure specified strength. Submit changes in mix design to Contracting Officer in writing.

2.4.4 Compressive Strength Test Results

Evaluate compressive strength test results at 28 days in accordance with ACI 214R using a coefficient of variation of 10 percent. Evaluate strength of concrete by averaging test results of each set of standard cylinders tested at 28 days. Not more than 10 percent of individual cylinders tested shall have a compressive strength less than specified design strength.

2.4.5 Chloride Ion Concentration

Sampling and determination of water soluble chloride ion content in accordance with ASTM C1218/C1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed 0.06 percent by weight of cement.

2.4.6 Chloride Ion Penetration

To ensure the durability of concrete in marine environment, concrete shall be proportioned to have the chloride ion penetration test in accordance with ASTM C1202, and be below 3000 coulombs for concrete specimens tested at 56 days.

PART 3 EXECUTION

3.1 PILE DRIVING EQUIPMENT

3.1.1 Pile Hammers

Furnish a hammer capable of developing the indicated ultimate pile capacity considering hammer impact velocity; ram weight; stiffness of hammer and pile cushions; cross section, length, and total weight of pile; and character of subsurface material to be encountered. Use the same pile hammer, operating at the same rate and in the same manner, as that used for driving test piles. Obtain required driving energy of hammer, except for diesel hammers, by use of a heavy ram and a short stroke with low impact velocity. At final driving, operate pile hammer in accordance with manufacturer's recommendation for driving either end bearing piles or friction piles. At final driving, operate diesel powered hammers at rate recommended by manufacturer for hard driving. Maintain pressure at steam or air hammer so that: (1) for double-acting hammer, the number of blows per minute during and at completion of driving of a pile is equal approximately to that at which hammer is rated; (2) for single-acting hammer, there is a full upward stroke of the ram; and (3) for differential type hammer, there is a slight rise of hammer base during each upward

stroke.

3.1.2 Driving Helmets and Cushion Blocks

3.1.2.1 Driving Helmets or Caps and Pile Cushions

Use a steel driving helmet or cap including a pile cushion between top of pile and driving helmet or cap to prevent impact damage to pile. Use a driving helmet or cap and pile cushion combination capable of protecting pile head, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over top of pile. Provide driving helmet or cap that fits sufficiently loose around top of pile so that pile may be free to rotate without binding within driving helmet. During test pile installation, demonstrate to satisfaction of Contracting Officer that equipment to be used on project performs specified function. Use pile cushion of solid wood or of laminated construction using plywood, softwood or hardwood boards with grain parallel to end of pile. Provide pile cushion with thickness of 3 inches minimum and the thickness shall be increased so as to be suitable for the size and length of pile, character of the sub-surface material to be encountered, hammer characteristics, and the required driving resistance. Replace pile cushion at the start of driving of each pile and when it becomes highly compressed, charred or burned, or has become spongy or deteriorated in any manner. Show details of driving helmets, capblocks, and pile cushions. Submit 2 weeks prior to test pile installation.

3.1.2.2 Hammer Cushion or Capblock

Use a hammer cushion or capblock between driving helmet or cap and hammer ram consisting of aluminum and micarta (or equal) discs stacked alternately in a steel housing or a suitable polymer designed for this specific purpose as indicated by the hammer manufacturer. Use steel plates at top and bottom of capblock. Replace aluminum, micarta or polymer discs that have become damaged, split or deteriorated in any manner.

3.2 PRELIMINARY WORK

3.2.1 Wave Equation Analysis of Pile Drivability

a. Prior to driving any pile, the Contractor shall submit a pile Wave Equation Analysis, performed by his Geotechnical Consultant, for each distinct subsurface profile condition. These analyses shall take into account the proposed hammer assembly, pile cap block and cushion characteristics, the pile properties and estimated lengths and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity.

b. The Wave Equation Analysis shall demonstrate that the piles will not be damaged during driving, shall indicate that the driving stresses will be maintained within the limits below and indicate the blow count necessary to achieve the required ultimate static pile capacities.

Allowable Driving Stresses

Concrete

Compression - 0.85f'c minus UPL
Tension - (3 times (the square root of f'c)) plus UPL

f'c is compressive strength of concrete
UPL = Unit Prestress after Losses
(Obtain values from pile manufacturer)

c. Upon completion of the dynamic and static testing programs outlined in this specification section, a refined Wave Equation Analysis shall be performed taking into consideration the evaluated capacities, gain/loss factors and recommended production pile lengths. Production pile driving criteria shall be developed based on the results of the refined Wave Equation Evaluations.

d. All pile driving equipment furnished by the Contractor shall be subject to the approval of the Contractor's Geotechnical Consultant. Complete the attached pile and driving equipment data form, including hammer information, in full as part of the submittal of the results of the Wave Equation Analyses.

e. The cost of performing the Wave Equation Analyses shall be paid for by the Contractor and included in the base bid.

3.2.2 Order List

The Contractor shall submit to the Contracting Officer for approval, an itemized list for piles prior to placing the order with the supplier. The list shall indicate the pile lengths required at each location as shown on the plans and the corresponding ordered length of each pile. Load testing and refined wave equation analysis shall be completed prior to submission of an order list.

3.2.3 Pile Length Markings

The Contractor shall mark each pile prior to driving with horizontal lines at one foot intervals, and the number of feet from pile tip at 5 foot intervals.

3.3 PILE DRIVING

3.3.1 Driving Piles

Notify Contracting Officer 10 days prior to driving of test piles and load test. Foundation excavation shall be stopped at 1 foot above foundation grade before piles are driven. When pile driving is completed, excavation shall be completed to bottom of pile cap elevation. Piles may be driven when their specified 28-day concrete strength has been achieved but not less than 7 days after casting. Drive piles to tip elevation andto reach a driving resistance established by the wave equation analyses (WEAP) in accordance with the schedule which the contractor's geotechnical consultant will prepare from the test-pile driving data. During initial driving and until pile tip has penetrated beyond layers of very soft soil or below bottom of predrilled , use a reduced driving energy of the hammer as required to prevent pile damage. Refusal criteria shall be established by the Contracting Officer and as specified in Revised FDOT Specification Section 455. If a pile fails to reach indicated tip elevation, or if a pile reaches indicated tip elevation without reaching required driving resistance, notify Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB.

Noise levels shall be monitored and reported to the Contracting Officer for review. If these are found to be excessive, the contractor shall be prepared to adjust or replace driving equipment to maintain noise level within acceptable limits Piles or pile sections shall not be handled or moved in any manner that would result in cracking or permanent damage to the concrete or to the grout surrounding the prestressing cables. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

Care shall be exercised to avoid damaging neighboring structures. A photographic survey shall be conducted to document all existing conditions prior to commencement of pile driving. Conditions shall be verified at regular intervals to verify that existing structures are not damaged during pile driving.

3.3.2 Protection of Piles

Take care to avoid damage to piles during handling, placing pile in leads, and during pile driving operations. Support piles laterally during driving, but allow rotation in leads. Where pile or projecting reinforcement orientation is essential, take precautionary measures to maintain the orientation during driving. Square top of pile to longitudinal axis of pile. Maintain axial alignment of pile hammer with that of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through the reinforcement, by using a special driving head.

3.3.3 Tolerances in Driving

Drive piles with a variation of not more than 3 inches from vertical for plumb piles . Additional costs for verifying design adequacy, re-engineering pile group design and additional time and materials required resulting from pile deviations shall be the responsibility of the contractor Maintain and check axial alignment of pile and leads at all times. If subsurface conditions cause pile drifting beyond allowable axial alignment tolerance, notify Contracting Officer and perform corrective measures as directed. Place butts within 4 inches of location indicated. Manipulation of piles within specified tolerances will not be permitted. In addition to specified tolerances, maintain a location to provide a clear distance of at least 5 inches from butt to edge of pile cap. If clear distance can not be maintained, then notify Contracting Officer. Check each pile for heave. Redrive heaved piles to required point elevation.

3.3.4 Rejected Piles

Piles damaged or impaired for use during handling or driving, mislocated, or driven out of alignment beyond the maximum tolerance shall be withdrawn and replaced by new piles or shall be cut-off and abandoned and new piles driven as directed. Excess cut-off from piles and unacceptable piles shall be removed from the work site. All work in connection with withdrawing and removing rejected piles from the site shall be done at no additional cost to the Government.

3.3.5 Predrilling of Piles

The soil profile encountered at the project site is generally loose to medium dense with the exception of some dense to very dense soils

encountered in the top 10 to 20 feet. Therefore, hard driving conditions are not anticipated, particularly once the top 10 to 20 feet of soil is penetrated. The contractor shall retain the services of a vibration specialist to monitor vibration during pile driving at the site. Vibration limits shall be established by the contractor's vibration specialist but shall not be greater than 0.5 inches per second

If vibration levels during pile driving are found to be excessive and if approved by the Geotechnical Consultant the contractor shall be prepared to preform/predrill. The diameter of the hole should not exceed two-thirds the width of the pile. Contractor shall be prepared to Predrill the top 10 to 20 feet below cut-off elevation prior to driving piles in order to reduce vibration levels. Drive pile the final 10 feet of penetration as continuous an operation as possible without stopping. Predrill holes for piles to be driven within 15 feet of existing structures or underground utilities

3.3.6 Splices

Make splices as indicated. Splices shall be capable of developing the full strength of the member in compression, tension, shear, and bending. Detail drawings of splices and design calculations demonstrating the strength of the splice shall be submitted for approval.

3.3.7 Build-Ups

Where required, pile section may be extended to cut-off elevation by means of a cast-in-place reinforced concrete build-up. Make build-up in accordance with PCI STD-112. Construct build-ups made after completion of driving in accordance with detail, "Build-Up Without Driving." Make build-ups to be driven in accordance with detail "Build-Up With Driving." Have details of means for protecting joints by a suitable mortar or epoxy approved by Contracting Officer. Where build-ups are exposed to water, protect cast-in-place section from water during curing period. Concrete in build-up shall have a minimum compressive strength of 5000 psi. Build-ups will not be permitted on more than 10 percent of total number of piles. If this percent figure is exceeded, or if in the judgment of the Contracting Officer, the clustered location of build-ups is undesirable, withdraw piles of insufficient length and replace with longer piles. Payment for such withdrawal and replacement will be made as an adjustment to the contract price.

3.3.8 Pile Cut-Off

Cut-off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods approved by Contracting Officer. Use of explosives for cutting is not permitted. Cut-off sections of piles shall be removed from the site upon completion of the work.

3.4 FIELD QUALITY CONTROL

3.4.1 Test Piles

Use test piles of type, and drive as specified for piling elsewhere in this section. Order test piles 15 feet longer in length than production piles. The additional test pile length shall be driven only at the direction of the Contracting Officer. TheContractor's Geotechnical Consultant will use test pile data to determine "calculated" pile tip elevation or necessary driving resistance. Drive test piles at the

locations indicated. Drive test piles to indicated tip elevation. Use test piles, if located properly and offering adequate driving resistance in finished work. Pre-drilling is permitted only when test piles clearly establish validity of its use, or as directed by the Contracting Officer. A pile dynamic analyzer shall be provided and operated as specified in paragraph DYNAMIC PILE ANALYSIS during the driving of each test pile. Modify driving as required based upon recommendation of Contractor's Geotechnical Consultant and approval of the Contracting Officer.

3.4.2 Dynamic Pile Analysis

The purpose of dynamic testing is to provide supplemental information for evaluating pile hammer performance, driving stresses, and bearing capacities. Dynamic testing shall be conducted during the entire time piles are initially driven or redriven and during pile restrike testing. Use test piles of type as specified elsewhere in this section. Equipment to obtain dynamic measurements, record, reduce and display its data shall be furnished and meet the requirement of ASTM D4945. The equipment shall have been calibrated within 12 months thereafter throughout the contract duration. Drive test piles at the locations indicated. The contractor shall employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile driving process, monitoring of test pile installation, and in the use of the Pile Driving Analyzer and its related equipment. Dynamic pile analysis shall be performed as follows:

a. Each dynamic pile analysis shall be performed in two steps. The first step is to check the hammer, pile and soil performance, and to determine the suitability of the proposed hammer for the size, length and type of pile being installed for the soil types encountered as the piles are driven. This initial monitoring shall determine whether pre-augering or jetting is appropriate, efficiency of the hammer relative to specified efficiency, effectiveness of cushion, level of compressive and tensile stress in pile and extent/location of any pile damage caused by the initial driving. With each blow of the pile the information listed below shall be electronically recorded and analyzed by the Pile Driving Analyzer:

(1) Blow number

(2) Blow rate per minute and/or stroke.

(3) Input and reflected values of force and velocity.

(4) Value of upward and downward traveling force wave with time.

(5) Maximum and final transferred energy to pile, hammer system efficiency.

(6) Maximum compressive stress, velocity, acceleration and displacement.

(7) Maximum tensile stress in pile.

(8) Pile structural integrity, damage detection, extent and location.

(9) Bearing capacity of pile by Case method.

If the pile, hammer and soil performance evaluation recommends changes to the hammer stroke, pile cushioning, augering or any other aspect for the pile driving operation these changes shall be incorporated into production pile driving in an effort to control excessive stresses and pile damage. Test piles damaged or broken during installation shall be replaced, incorporating driving modifications as determined by the Contractor's Geotechnical Consultant and reviewed and approved by the Contracting Officer. This procedure shall be repeated until allowable tensile and compressive stresses are achieved in the pile and/or pile damage is minimized. Selected initial driving records shall be subjected to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and estimation of anticipated gain/loss factors.

b. Upon completion of test pile driving the piles shall be allowed to set-up for at least 72 hours. After evaluation of pile, hammer and soil performance by the Contractor's Geotechnical Consultant, the second step of the dynamic pile analysis may proceed. This portion of the evaluation requires striking the set-up piles a minimum of 20-50 times, or as directed by the Contractor's Geotechnical Consultant using the same hammer which was used for the test pile driving and which will be used for production pile driving. The hammer shall be "warmed up" and in optimal readiness prior to restriking, in order to avoid capacity losses during evaluation of restrike data. Maximum hammer energy shall be applied during restrike in order to fully mobilize the soil resistance. However, care should be exercised as to not overstress the pile. In addition to those items listed above, selected restrike driving records (as directed by the Contractor's Geotechnical Consultant are to be subjected to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and plot of applied load vs. average pile displacement based on the calculated soil properties.

c. Performance Report:

(1) Upon satisfactory completion of each dynamic load test a minimum of three copies of a Pile Performance Report shall be submitted for the Contractor by the Contractor's Geotechnical Consultant. The submittal shall be prepared and sealed by a Professional Engineer registered in the State of Virginia and shall be made within three working days of the completion of the dynamic load test.

(2) The report for the Dynamic Pile Analysis shall contain the following information:

(a) Bearing capacity of pile from Case Pile Wave Analysis Program (CAPWAP). Information resulting from analysis of a selected restrike blow.

(b) Maximum and final transferred energy, hammer system efficiency during pile installation.

(c) Maximum compressive stress, velocity, acceleration and displacement.

(d) Maximum tensile stress in pile.

(e) Pile structural integrity, damage detection, extent and location.

(f) Blows per minute and blow number.

(g) Input and reflection values of force and velocity, upward and downward traveling force wave with time.

(h) Pile skin friction and toe resistance distribution.

(i) Maximum energy transferred to pile.

(3) The maximum allowable pile design load will be proposed by the Contractor's Geotechnical Consultant based upon the results of a satisfactory pile load test conducted on a pile driven as specified herein and shall include the effects of load transfer to the soil above the foundation stratum.

d. The equipment to be used for dynamic testing of the pile hammer and soil performance and for dynamic load testing of the test pile shall be either a model GCPC or a PAK Pile Driving Analyzer as manufactured by Pile Dynamics, Inc., of Cleveland Ohio or approved equivalent.

e. All services of the Contractor's Geotechnical Consultant shall be paid for by the Contractor. The Contractor's Geotechnical Consultant shall be available throughout the pile driving operation to consult with the Contracting Officer when required by the Contracting Officer. The cost of changes in the Contractor's procedure, as required by evaluation of the results of the Pile Driving Analysis, shall be at the Contractor's expense.

3.4.3 Static Load Tests

Perform compressive load tests on 2 single test piles in accordance with ASTM D1143/D1143M (standard loading procedure) as modified herein. Allow a minimum of 72 hours following final test pile driving for pile set-up prior to load testing. Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform or reaction frame attached to sufficient uplift piles to safely take required load applied to pile by hydraulic jack. Increase load in increments not exceeding 25% of allowable pile load until rapid progressive settlement takes place or until application of total compressive load of two times the pile allowable capacity for compressive load tests . Consider load test satisfactory when after one hour at full test load gross settlement of pile butt is not greater than gross elastic pile compression plus 0.15 inch plus one percent of pile tip or width in inches, slope of gross load-settlement curve under full test load does not exceed 0.05 inches per ton, net settlement after removal of test load does not exceed 3/4 inch. Perform load tests at locations as proposed by the Contractor's Geotechnical Consultant and as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Loading, testing, and recording and analysis of data shall be under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

3.4.3.1 Safe Design Capacity

The safe design capacity of a test pile as determined from the results of load tests shall be the lesser of the two values computed according to the following:

a. One-half of that load which causes a net settlement after rebound of not more than 0.01 inch per ton of total test load.

b. One-half of the load that causes a gross settlement of not more than 1 inch, provided the load settlement curve shows no sign of failure.

3.4.4 Tensile Load Test

Perform tensile load tests on two single test piles in accordance with ASTM D3689, as modified in paragraph LOAD TESTS. A tensile load of 70 tons shall be applied to each tensile load test pile. In performing the tension load test, the ultimate load to be applied shall be one and one-half times the safe tension capacity, and the Standard Loading Procedure shall be employed.

3.4.5 Lateral Load Test

Perform lateral load tests on two piles in accordance with ASTM D3966, as modified and in paragraph LOAD TESTS. Lateral load tests shall consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. A lateral load of 20 tons shall be applied to each pair of lateral load test piles. Required movement readings shall be made and recorded for each pile.

3.4.6 Pile Records

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations, number of blows required for each foot of penetration and number of blows for the last 6 inches penetration or fraction thereof for the "calculated" driving resistance. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, obstructions, and any driving interruptions. A preprinted pile driving log for recording pile driving data and pile driving equipment data form is included at the end of this section.

-- End of Section --

SECTION 32 10 00

BITUMINOUS CONCRETE PAVEMENT
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 166	(2007) Standard Method of Test for Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) using Saturated Surface-Dry Specimens
AASHTO T 176	(2002) Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by use of the Sand Equivalent Test
AASHTO T 2	(2006) Standard Method of Test for Sampling of Aggregates (same as ASTM D 75)
AASHTO T 30	(2007) Mechanical Analysis of Extracted Aggregate
AASHTO T 37	(2007) Standard Method of Test for Sieve Analysis of Mineral Filler for Hot-Mix Asphalt (ASTM D 546)

ASPHALT INSTITUTE (AI)

AI MS-02	(6th Edition; 1997) Mix Design Methods for Asphalt

ASTM INTERNATIONAL (ASTM)

ASTM C 127	(2004) Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C 128	(2004a) Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C 131	(2003) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 88	(2005) Soundness of Aggregates by Use of

	Sodium Sulfate or Magnesium Sulfate
ASTM D 1073	(2001) Fine Aggregate for Bituminous Paving Mixtures
ASTM D 113	(2007) Standard Test Method for Ductility of Bituminous Materials
ASTM D 1754	(2002) Standard Test Method for Effects of Heat and Air on Asphalt Materials (Thin-Film Oven Test)
ASTM D 1856	(1995a; R 2003) Recovery of Asphalt from Solution by Abson Method
ASTM D 2041	(2003a) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2170	(2001a) Kinematic Viscosity of Asphalts (Bitumens)
ASTM D 2172	(2005) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 242	(1995; R 2000e1) Mineral Filler for Bituminous Paving Mixtures
ASTM D 3176	(2002) Standard Practice for Ultimate Analysis of Cole and Coke
ASTM D 3180	(2007) Standard Practice for Calculating Coal and Coke Analyses from As-Determined to Different Bases
ASTM D 4	(1986; R 2004) Bitumen Content
ASTM D 5	(2005a) Penetration of Bituminous Materials
ASTM D 5581	(2007) Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus (6-inch diameter specimen)
ASTM D 692	(2000; R 2004) Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 70	(2003) Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method)
ASTM D 854	(2002) Specific Gravity of Soil Solids by Water Pycnometer
ASTM D 92	(2005a; R 2010) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D 979	(2001) Sampling Bituminous Paving Mixtures

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

Section 300	(2007) Prime and Tack Coats for Base Courses
Section 300-1	(2007) Prime and Tack Coats for Base Courses - Description
Section 300-2	(2007) Prime and Tack Coats for Base Courses - Materials
Section 330	(2007) Hot Bituminous Mixtures - General Construction Requirements
Section 330-13	(2007) Hot Bituminous Mixtures - General Construction Requirements - Protection of Finished Surface
Section 334	(2007) Superpave Asphalt Concrete
Section 710	(2007) Painting Traffic Stripes
Section 916-1	(2007) Bituminous Materials - Superpave PG Asphalt Binder

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED GBDC	(2009) LEED Reference Guide for Green Building Design and Construction
LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's catalog data for bituminous concrete shall be submitted showing description, mixing, and application instructions for the following items:

Bituminous Concrete; G (LEED NC)
Asphalt Cement; G (LEED NC)
Bituminous Prime Coat; G (LEED NC)
Bituminous Tack Coat; G (LEED NC)
Paint; G (LEED NC)

Submit documentation relative to each material credit in accordance with the LEED GBDC.

SD-05 Design Data

A Job-Mix Formula (G) for bituminous concrete shall be submitted in accordance with paragraph entitled, "Job-Mix Formulas," of this section.

SD-06 Test Reports

Test reports shall be submitted in accordance with the paragraph entitled, "Quality Control Testing During Construction," of this section.

1.3 ENVIRONMENTAL REQUIREMENTS

Do not produce or place bituminous concrete when the weather is rainy or foggy, when the base course is frozen or has excess moisture, or when the ambient temperature is less than 40 degrees F in the shade away from artificial heat.

1.4 PROTECTION OF PERSONS AND PROPERTY

Paving operations shall be conducted in a manner that will ensure the safety of persons and property.

1.5 SAMPLING AND TESTING

1.5.1 Testing and Inspection

A bituminous-concrete testing and inspection service shall be provided by the Contractor. Testing service shall be approved and shall include sampling and testing bituminous-concrete materials proposed for use in the work, tests and calculations for bituminous concrete mixture, and field-testing facilities for quality control during construction of bituminous-concrete courses.

1.5.2 Tests for Bituminous Concrete Materials

Bituminous-concrete materials proposed for use in the work shall be sampled and tested as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
Coarse and fine aggregates	Sampling	AASHTO T 2	One for each material
	Sieve analysis	ASTM C 136	
	Magnesium Sulfate Soundness Test	ASTM C 88	
	Sand Equivalent Test of fine aggregate	AASHTO T 176	
	Resistance to abrasion of small size	ASTM C 131	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
	coarse aggregate		
Mineral Filler	Sieve analysis	AASHTO T 37	One for each source of material
Asphalt cement	Penetration	ASTM D 5	One for each specified penetration grade
	Flash point	ASTM D 2170 ASTM D 92	
	Ductility	ASTM D 113	
	Loss on heating	ASTM D 1754	
	Solubility	ASTM D 4, Procedure No. 1	
	Ash	ASTM D 3176 ASTM D 3180	

1.5.3 Test for Bituminous Concrete Mixture

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
Compacted bituminous-concrete mix	Bulk density	AASHTO T 166	Four for each bituminous-concrete mixture
	Marshall Stability Test	ASTM D 5581	
Aggregate and asphalt cement	Specific gravity of coarse aggregate	ASTM C 127	One for each material
	Specific gravity of fine aggregate	ASTM C 128	
	Apparent specific gravity of mineral filler	ASTM D 854	
	Apparent specific gravity of asphalt cement	ASTM D 70	
Uncompacted bituminous-concrete	Maximum theoretical specific gravity	ASTM D 2041	Two for each bituminous-concrete mixture

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
mix			

A density and voids analysis shall be calculated for each series of bituminous-concrete mixture test specimens in conformance with AI MS-02 and shall include the quantity of absorbed asphalt cement in pounds of dry aggregate, percent of air voids, and percent of voids in mineral aggregate.

Report of each job-mix formula shall be submitted on the form entitled, "Hot-Mix Design Data by the Marshall Method" as shown in AI MS-02.

1.5.4 Quality Control Testing During Construction

Bituminous-concrete mixtures shall be sampled and tested for quality control during construction of the bituminous-concrete courses as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
Uncompacted bituminous-concrete mix	Sampling	ASTM D 979	One for each mixture or day of operation
	Asphalt cement content	ASTM D 2172	
	Mechanical analysis extracted aggregates	AASHTO T 30	
	Recovery of asphalt cement by Abson Method	ASTM D 1856	
	Penetration of recovered asphalt cement	ASTM D 5	
	Ductility of recovered asphalt cement	ASTM D 113	
Compacted bituminous-concrete Marshall samples	Bulk density	AASHTO T 166	Same as specified for uncompacted mix
	Marshall Stability and Flow Tests	ASTM D 5581	
In-place pavement	Density and thickness	As specified	One specimen for each 500 square yards of completed bituminous-concrete

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH REQUIREMENT FOR EACH MATERIAL
			course

Test reports results shall be reported in writing on the same day that tests are made.

A bituminous-concrete mixture that does not meet the requirements specified shall not be used in the specified work.

1.5.5 Field Testing Facilities at the Mixing Plant

Field-testing facilities for testing bituminous-concrete materials and mixes at the bituminous mixing plant shall be provided by the testing service.

1.6 CONSTRUCTION EQUIPMENT LIST

Construction equipment list for all major equipment used for transporting, spreading and finishing shall be submitted to the Contracting Officer prior to construction.

PART 2 PRODUCTS

2.1 BITUMINOUS CONCRETE

2.1.1 Aggregate for Bituminous-Concrete

Coarse aggregate shall conform to ASTM D 692.

Fine aggregate shall conform to ASTM D 1073. Sand equivalent value shall be not less than 30.

2.1.2 Mineral Filler

Mineral filler for bituminous paving mixtures shall conform to ASTM D 242.

2.2 ASPHALT CEMENT

Cement shall conform to Section 916-1 of the FDOT Standards Specifications.

2.3 BITUMINOUS PRIME COAT

Bituminous prime coat shall be emulsified asphalt conforming to the requirements of FDOT Standard Specification Section 300-2.

2.4 BITUMINOUS TACK COAT

Bituminous tack coat shall be emulsified asphalt conforming to the requirements of FDOT Standard Specification Section 300-2.

2.5 JOB-MIX FORMULAS

A job-mix formula for each bituminous-concrete mixture proposed for use in the work shall be submitted for approval prior to start of work.

Job-mix formula shall be in accordance with FDOT Standard Specification Section 334.

2.6 PERFORMANCE REQUIREMENTS

Bituminous concrete mixtures shall meet the performance requirements of FDOT Standard Specification Section 334 for Superpave Asphalt Sampling, test methods, and frequency shall be in conformance with FDOT Standard Specification Section 334.

2.7 PAVEMENT MARKING

2.7.1 Paint

Paint shall conform to the requirements of FDOT Standard Specifications Section 710.

2.8 CONCRETE WHEEL STOPS

Provide car stops to the profile and size indicated. Manufacture with air entrained concrete having a minimum compressive strength of 3,000 psi at 28 days, with two No. 4 reinforcing rods located at mid-point of its cross section and with two galvanized sleeves for anchoring.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Excavation and Filling

Excavation and filling to establish elevation of subgrade is specified in Section 31 00 00 EARTHWORK.

3.2 ASPHALT CONCRETE SURFACE COURSE

3.2.1 Weather Limitations

Weather limitations are stated in FDOT Standard Specifications Section 330 and as modified herein.

Bituminous prime and tack coats shall be applied only when the ambient temperature in the shade is above 50 degrees F or when the temperature has not been below 35 degrees F for 12 hours immediately prior to application. Application may commence when the aggregate base course is dry or contains moisture not in excess of the amount that will permit uniform distribution and the required penetration.

Bituminous-concrete courses shall be constructed only when the ambient temperature is above 40 degrees F and the underlying base course is dry.

3.2.2 Transportation of Mixtures

Bituminous-concrete mixtures shall be transported from the mixing plant to the project site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of a concentrated solution of hydrated lime and water to prevent adhesion of the mixture to the truck beds.

Each load of mixture shall be covered with canvas or similar material of

sufficient size and weight to retard heat loss and to protect the mixture from the weather.

In cool weather or for long hauls, the entire contact area of each truck bed shall be insulated. Covers shall be securely fastened.

Deliveries of the mixture shall be so scheduled that the placing and compaction can be completed during daylight unless satisfactory artificial light is provided.

Mixture shall be delivered in a such manner that the temperature of the mixture at the time of dumping into the paver will be not less than 230 degrees F.

Trucks shall not travel on the mixture until compaction is complete and the bituminous-concrete pavement surface will support traffic without measurable deformation.

3.3 PREPARATION OF AREA TO BE PAVED

3.3.1 Surface Preparation

Preparation shall be in accordance with Section 300 of the FDOT Standard Specifications.

3.3.2 Priming the Base Course Surface

Priming the base course surface shall be in accordance with Section 300 of the FDOT Standard Specifications.

3.3.3 Priming Other Contact Surfaces

Contact surfaces of curbs, gutters, manholes, and other structures projecting into or abutting the concrete pavement shall be coated with a thin, uniform coating of bituminous tack-coat material prior to the bituminous-concrete mixture being placed against such structures.

Application shall conform to FDOT Standard Specifications Section 300-1.

Excess tack-coat material shall be squeegeed from the surface.

3.4 PLACING BITUMINOUS-CONCRETE COURSES

Placement shall be in accordance with FDOT Standard Specification Section 330 and Section 334, except at modified herein.

3.4.1 General

Bituminous-concrete mixture shall be placed on the prepared surface, uniformly spread and struck off. Bituminous-concrete courses shall be placed in layers of approximately equal thickness except that no layer shall be more than 2-inches thick after compaction. Courses shall be so placed that, when compacted, they will conform to the indicated grade, cross-section, and thickness.

3.4.2 Pavement Placing

Each paver shall be adjusted and the speed regulated so that the surface of the bituminous-concrete mixture will be smooth and, when compacted,

will conform to the depths, cross sections, grades, and contours indicated.

Placing shall begin along the centerline of areas to be paved on a crowned section, at the high side of a section with a one-way slope and in the direction of the traffic flow. The mixture for each course shall be placed in strips not less than 10-feet wide. Progressive strip placement shall commence after rolling of the first strip. Rolling shall be extended to overlap the preceding strips. Placing the bituminous-concrete mixture shall be continuous.

Experienced shovelers and rakers shall follow each paver, adding hot bituminous-concrete mixture and raking the mixture as required to produce a course that, when completed, will conform to requirements specified.

3.4.3 Hand Placing

In areas where the use of machine spreading is not practicable, the mixture shall be spread and finished by the use of heated hand tools.

Mixture shall be dumped on approved dump boards and distributed into place from the dump boards in a uniformly loose layer of a thickness that will, when compacted, conform to required grade and thickness. Mixture shall be dumped no faster than it can be handled properly by the shovelers and rakers.

3.4.4 Joints

Joints shall have the same texture, density, and smoothness as other sections of the course. Joints between old and new pavements, or between successive days' work, shall be made to ensure a continuous bond between the old and new sections of the pavement.

Transverse joints in succeeding courses shall be offset at least 24 inches. The edge of the previously placed course shall be cut back to expose an even vertical surface over the full thickness of the course.

Longitudinal joints in succeeding courses shall be offset at least 6 inches. When the edges of longitudinal joints are irregular or do not conform to the specifications, the edge shall be cut back to expose an even vertical surface over the full thickness of the course.

3.5 COMPACTION

3.5.1 General

Compaction shall commence as soon after placing as the bituminous-concrete mixture will bear the weight of the roller without undue displacement.

Delays in compacting the freshly spread mixture will not be permitted.

During rolling, the wheels shall be kept moist with the minimum amount of water required to avoid picking up the bituminous-concrete mixture.

In places not accessible to the rollers, the mixture shall be compacted with hot hand tampers.

3.5.2 Rolling Procedure

Rolling shall commence longitudinally at the extreme sides of lanes and

proceed toward the center of the pavement, except on superelevated curves. Rolling on superelevated curves shall commence on the low side and progress to the high side, overlapping on successive trips by at least one-half the width of the rear wheel of the roller.

Alternate trips of the roller shall be of slightly different lengths.

Rollers shall move at a slow but uniform speed with the drive roll or wheel nearest the paver. Speed of the rollers shall not exceed 3 miles per hour for steel-wheeled rollers or 5 miles per hour for pneumatic-tired rollers.

Rollers shall not be parked on the pavement.

3.5.3 Initial Rolling

The initial rolling shall immediately follow the rolling of the longitudinal joint and edges. Rollers shall be operated as close to the paver as possible without causing undue displacement.

Preliminary tests of crown, grade and smoothness shall be made immediately after the initial rolling.

Before the rolling is continued, deficiencies shall be corrected by adding or removing material so that the finished course will conform to the specified requirements for grade and smoothness.

3.5.4 Second Rolling

Second rolling shall follow the initial rolling as closely as possible, while the mixture is hot and in condition suitable for proper compaction.

Rolling shall be continuous (at least 3 complete coverages) after the initial rolling until the mixture has been compacted.

Causing undue displacement will not be permitted.

3.5.5 Finish Rolling

Finish rolling shall be done while the mixture is warm enough for the removal of roller marks. Rolling shall continue until all roller marks are eliminated and the course has the specified density.

3.5.6 Patching Deficient Areas

Bituminous-concrete mixtures that become mixed with foreign material or that are defective, such as low areas or "bird-baths," shall be removed, replaced with fresh bituminous-concrete mixture to obtain the required grade and smoothness for the finished surface, and compacted to the specified density.

Pavement in deficient areas shall be removed to the full thickness of the bituminous-concrete course and so cut that the sides are perpendicular and parallel to the direction of traffic and the edges are vertical. Edges shall be sprayed with bituminous tack-coat material.

Skin patching an area that has been rolled will not be permitted.

3.5.7 Protection of Pavement

After final rolling, vehicular traffic shall not be permitted on the pavement until the pavement has cooled and hardened and in no case sooner than 6 hours.

3.6 ACCEPTANCE PROVISIONS

3.6.1 General

Density, surface smoothness, and thickness of completed bituminous-concrete base and surface courses shall be tested to verify compliance with the specified requirements.

3.6.2 Density and Thickness Requirements

Pavement specimens of each completed bituminous-concrete course shall be taken on the basis specified. Diameter of pavement core specimens shall be not less than 3 inches, and shall be through the entire base course and surface course. Locations for the removal of pavement specimens shall be directed by the Contract Officer. Test holes shall be repaired.

Perform testing in conformance with Section 334 of FDOT Standard Specifications.

Thickness shall not vary from the indicated thickness by more than 1/2 inch for the base course and 1/4 inch for the surface course.

3.6.3 Surface Requirements

Surface requirements shall be as provided in FDOT Standard Specifications Section 330-13, except as modified herein.

The finished surface of each bituminous-concrete course shall be tested for smoothness with a 10-foot straightedge applied parallel with, and at right angles to, the centerline of the paved area. The entire paved area shall be checked from one side to the other. Advancement along the pavement shall be in successive stages of not more than half the length of the straightedge.

Final surface shall have a uniform texture and shall conform to the required grade and cross section. Low or defective areas shall be immediately corrected by cutting out the faulty areas and replacing them.

3.7 PAVEMENT STRIPING

3.7.1 Surface Preparation

New pavement surfaces shall be cured for 14 days before application of marking materials. Where oil or grease are present on old pavements, the affected areas shall be scrubbed with approved detergent or degreaser, and rinsed thoroughly.

3.7.2 Traffic Control

Traffic control markers shall be placed along newly painted lines to prevent damage to newly painted surfaces.

3.7.3 Application

Paint shall be applied in accordance with FDOT Standard Specification Section 710.

Markings shall be sharply outlined, with uniform thickness, and stripe widths shall be as indicated.

If there is a deficiency in drying of the markings, painting operations shall be discontinued until the cause of the slow drying time is determined and corrected.

If discoloration of the paint occurs due to bleeding of bituminous materials, the paint shall be applied in 2 coats.

3.7.4 Concrete Wheel Stops

Provide concrete wheel stops where indicated. Install with an anchor rod driven through each sleeve.

3.8 WASTE MANAGEMENT

Protect excess material from contamination and return to manufacturer, or reuse on-site for walkways, patching, ditch beds, speed bumps, or curbs.

-- End of Section --

SECTION 32 11 24

GRADED CRUSHED AGGREGATE BASE COURSE
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	(2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1883	(2007e2) CBR (California Bearing Ratio) of Laboratory-Compacted Soils
ASTM D2217	(1985; R 1998) Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
ASTM D4318	(2010) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D75/D75M	(2009) Standard Practice for Sampling Aggregates

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED GBDC	(2009) LEED Reference Guide for Green Building Design and Construction
LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be

submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Aggregates; (LEED NC)

Submit documentation relative to each material credit in accordance with the LEED GBDC.

SD-06 Test Reports

Bearing ratio

Liquid limit

Plasticity index

Density

Gradation

Thickness

1.3 WEATHER LIMITATIONS

Do not construct base course when rainfall or other weather conditions detrimentally affect the quality of the finished course.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aggregates

Consist of durable and sound crushed concrete, crushed gravel, or crushed stone. Materials shall originate primarily from on-site construction waste, then from off-site construction waste, and finally from other nearby sources as needed. Material may contain post-consumer or post-industrial recycled content. Crushed stone and gravel shall be free from flat, elongated, soft, or disintegrated pieces. Crushed gravel retained on a No. 4 sieve shall have at least 90 percent by weight with at least two fractured faces and 100 percent by weight with at least one fractured face. Base course materials samples shall have a bearing ratio of at least 100 as determined by laboratory tests on a 4-day soaked specimen in accordance with ASTM D1883; compact specimen in accordance with ASTM D1557, Method D. Determine grain size in accordance with ASTM C136 and amount of material finer than 200 mesh sieve in accordance with ASTM C117. The base course shall be of such nature that it can be compacted readily with watering and rolling to a firm, stable base and shall conform to the following sizes:

Percentage by Weight Passing Square Mesh Laboratory Sieves			
Sieves	Size Numbers		
	1		
2 inch	100		
1 1/2 inch	95-100		
3/4	65-90		
3/8 inch	45-95		
No. 4	35-60		
No. 10	25-45		
No. 50	5-25		
No. 200	0-10		

That portion of the material passing the No. 40 sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 4 as determined by ASTM D4318. Prepare samples in accordance with ASTM D2217, Procedure A.

PART 3 EXECUTION

3.1 BASE COURSE

Construct the graded aggregate base course on a prepared subgrade. Place grade stakes in lanes parallel to the centerline of areas to be paved and space for string lining or other control methods. The base course shall consist of aggregate processed, deposited, spread, and compacted on a prepared surface. The Contractor shall be responsible for protection of completed areas against detrimental effects. Recondition, reshape, and recompact areas damaged by freezing, rainfall, or other weather conditions.

3.2 PLACING

Do not dump mixed materials in piles, but place on prepared subgrade or subbase in layers of uniform thickness with a spreader. When a compacted course 6 inches in thickness is required, place material in a single layer. When a compacted course in excess of 6 inches is required, place material in layers of equal thickness. Do not exceed 6 inches or have less than 3 inches in thickness for any compacted layer. Place layers so that when compacted, they will be true to grades or levels required with the least possible surface disturbance. Where the base course is constructed in more than one layer, clean previously constructed layers of loose and foreign matter. Maintain material water content during the placing period to obtain the compaction specified. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to insure a satisfactory base course.

3.3 COMPACTING AND FINISHING

Immediately following the placing, spread the finished mixture uniformly in a layer and bring to optimum moisture content. The loose thickness and the surface of the layer shall be such that the specified density and the required thickness shall be obtained after compaction. Compact the layer with steel-faced, vibrating or pneumatic-tired rollers, or other suitable compacting equipment or combinations thereof. Continue compacting until the layer is compacted through the full depth to a field density of at least 100 percent of the maximum density at optimum moisture content tested in accordance with ASTM D1556. In areas not accessible to rollers or compactors, compact the mixture with mechanical hand tampers. If the mixture is excessively moistened by rain, aerate by blade graders, or other suitable equipment. Aerate until the moisture content of the material is that needed to obtain the required density. Finish the surface of the layer by a combination of rolling and blading. Final surface shall be smooth and free from waves, irregularities, and ruts or soft yielding spots.

3.4 FINISHING AT EDGES OF BASE COURSE

Place earth or other approved materials along the edges of the base course in such quantity that it will compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, place material to the thickness of each layer. In each operation, allow at least a one foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer.

3.5 FIELD QUALITY CONTROL

Approve materials and material sources in advance of the use of such materials in the work.

3.5.1 Sampling

3.5.1.1 Aggregates at the Source

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D75/D75M. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 50 pounds. Repeat above sampling when source of material is changed or when unacceptable deficiencies or variations from specified grading of materials are found in testing.

3.5.1.2 During Construction

Take one random sample from each 1000 tons of completed course material, but not less than one random sample per day's run. Take samples in accordance with ASTM D75/D75M.

3.5.2 Testing

3.5.2.1 Aggregates

Test each sample of base course material without delay. Make gradation tests from each sample in accordance with ASTM C136. Make sieve analysis on material passing the No. 200 sieve in accordance with ASTM C117.

3.5.2.2 Smoothness Tests

Test with a 10 foot straightedge, applied parallel with and at right angles to the center line of the paved area. Correct deviations in the surface in excess of 1/2 inch by loosening, adding or removing material, reshaping, watering, and compacting. The smoothness requirements specified herein apply only to the top layer when base course is constructed in more than one layer.

3.5.2.3 Field Density Tests

ASTM D1556. Take one test for each 500 square yards of each layer of base course.

3.5.2.4 Laboratory Density Tests

In accordance with ASTM D1557, Method D.

3.5.2.5 Thickness Tests

Measure thickness of base course at intervals such that there will be a depth measurement for at least each 500 square yards of complete base course. Make depth measurements by test holes, at least 3 inches in diameter, through the base course. Where base course deficiency is more than 1/2 inch, correct by scarifying, adding mixture of proper gradation, reblading, and recompacting. Where the measured thickness is more than 1/2 inch thicker than indicated, consider it as the indicated thickness plus 1/2 inch for determining the average. The average thickness is the average of the depth measurements and shall not underrun the thickness indicated.

3.6 MAINTENANCE

After construction is completed, maintain the base course throughout, except where portion of the succeeding course is under construction thereon. Maintenance includes drainage, rolling, shaping, and watering, as necessary, to maintain the course in proper condition. Correct deficiencies in thickness, composition, construction, smoothness, and density, which develop during the maintenance, to conform to the requirements specified herein. Maintain sufficient moisture by light sprinkling with water at the surface to prevent a dusty condition.

-- End of Section --

SECTION 32 11 29

LIMEROCK BASE COURSE, SUBBASE, OR SUBGRADE
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
AASHTO T 2	(2006) Standard Method of Test for Sampling of Aggregates (same as ASTM D 75)
AASHTO T 87	(2004) Standard Method of Test for Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test
AASHTO T 89	(2002) Standard Method of Test for Determining the Liquid Limit of Soils
AASHTO T 90	(2004) Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2922	(2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-621	(1995) Subgrade, Subbase and Test Method for Pavement Base-Course Materials

1.2 DEFINITIONS

1.2.1 Degree of Compaction

Degree of compaction shall conform to ASTM D 1556.

1.2.2 Coverage

Coverage is the application of one tire print over each point in the surface of the designated area.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Test Reports from samples shall be submitted by the Contractor not less than 30 days before material is required in the work. Final approval of material shall be the completed layer ready for next layer.

Test reports for Limerock shall be submitted according to the paragraph entitled, "Quality Control Testing During Construction," of this section.

1.4 JOB DESCRIPTION

The work specified consists of the construction of a limerock base course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes, and typical sections shown in the drawings. Sources of materials shall be selected well in advance of the time when materials will be required in the work.

1.5 APPROVAL OF MATERIALS

Test results from samples shall be submitted by the Contractor not less than 30 calendar days before material is required in the work. Final approval shall be required prior to delivery of any material.

1.6 QUALITY ASSURANCE

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved testing laboratory or by the Contractor, subject to approval. Tests shall be performed to ensure that materials meet specified requirements. Copies of test results shall be furnished to the Contracting Officer.

1.7 OPERATION OF MATERIAL SOURCES

Clearing, stripping, and excavating involved in the operation of pits or

quarries shall be performed by the Contractor. Pits or quarries on private lands shall be conditioned in agreement with the local laws and authorities.

1.8 SAMPLING AND TESTING

1.8.1 Tests for Proposed Limerock Materials

Limerock proposed for use in the work shall be tested and copies of the test results submitted by the Contractor at least 10 calendar days prior to start of the work, as follows:

		PROPOSED LIMEROCK MATERIAL	
MATERIAL	REQUIREMENT	TEST METHOD	SOIL MATERIAL TESTED AND NUMBER OF TESTS
Limerock	Sampling	AASHTO T 2	One for each source of material
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregate	ASTM C 136	
	Amount of material passing (No. 200) sieve in aggregate	ASTM C 117	
	Liquid limit of soils	ASTM D 4318	
	Plastic limit of soils	ASTM D 4318	
	Plasticity index of soils	ASTM D 4318	
	Moisture-density-relations	AASHTO T 180, method B or D	

1.8.2 Quality Control Testing During Construction

Limerock delivered to the project site and each 6-inch layer of material-in-place (after compaction) shall be sampled by the Contractor and tested as follows:

TESTING DURING CONSTRUCTION

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Limerock	Sieve analysis of fine and coarse aggregate	ASTM C 136 ASTM C 117	One daily; additional test when there is an apparent change
	Amount of material passing No. 200 sieve in aggregate		
	Density of in-place material	ASTM D 1556 Sand-Cone Method or ASTM D 2922, Nuclear Method (when approved by the Contracting Officer)	At least three daily for each subgrade soil material and for each 6-inch layer of crushed stone pavement material; additional test when there are any changes in moisture conditions

1.8.3 Reports

Contractor's testing service shall report in writing all test results the same day that tests are made.

1.8.4 Evaluation of Test Results

Results of density in-place tests shall be considered satisfactory if the average of any four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if not more than one density test in four has a value more than two percentage points below the specified density.

1.9 CONSTRUCTION EQUIPMENT LIST

Construction equipment list for all major equipment used for transporting, spreading and finishing shall be submitted to the Contracting Officer prior to construction.

1.10 STOCKPILING MATERIALS

Select material, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Before stockpiling material, storage sites shall be cleared and sloped to drain. Materials obtained from different sources shall be stockpiled separately.

1.11 WEATHER LIMITATIONS

Work on the base course shall not be performed during freezing temperatures. When the temperature is below 40 degrees F, the completed base course shall be protected against freezing by a sufficient covering of straw, or by other approved methods, until the course has dried out.

Any areas of completed base course that are damaged by freezing, rainfall, or other weather conditions shall be brought to a satisfactory condition without additional cost to the Government. Lime shall not be applied when the atmospheric temperature is less than 40 degrees F. No lime shall be applied to soils that are frozen or contain frost, or when the underlying material is frozen. If the temperature falls below 35 degrees F completed lime-treated areas shall be protected against any detrimental effects of freezing.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Limerock

Limerock shall consist of fossiliferous limestone of uniform quality, containing no hard or flinty pieces to prevent construction of a smooth pavement surface free of pits or pockets. Limerock shall be obtained from pits where overburden has been removed previous to blasting. Limerock shall show no tendency to air-slake and shall undergo no chemical change when exposed to weather; it shall contain not more than three percent roots, leaf mold, or other organic matter. Broken limerock shall conform to the following gradation: 100 percent shall pass a 3-1/2-inch mesh sieve and shall be continuously well graded down to dust. Fine materials shall consist of the dust and fine particles of fracture. In no case will material be permitted which has a liquid limit in excess of 35 or a plasticity index in excess of 10 when tested in accordance with AASHTO T 89, and AASHTO T 90. Chemical analysis of limerock shall consist of determining the insoluble silica, the iron oxide, and the alumina by solution of sample in hydrochloric acid; by evaporating, dehydrating, redissolving, and neutralizing the residue with ammonium hydroxide; and by filtering, washing, and igniting the residue limerock. The difference between the percentage of insoluble matter and 100 percent is reported as carbonates of calcium and magnesium. Limerock shall be either Ocala or Miami oolite.

2.1.1.1 OCALA LIMEROCK

Ocala limerock shall be composed of not less than 90 percent carbonates of calcium and magnesium from approved deposits.

2.1.1.2 MIAMI OOLITE LIMEROCK

Miami oolite limerock shall be composed of not less than 75 percent carbonates of calcium and magnesium and not more than 2 percent oxides of iron and aluminum. Any component other than the carbonates and oxides shall be silica.

2.1.1.3 TESTING

For purposes of geological designation, all limerock mined north of the 28th degree parallel of latitude in the State of Florida shall be tested as and shall meet the requirements specified above for Ocala limerock; all limerock mined south of that parallel shall be tested as and shall meet the specified requirements for Miami oolite limerock. Test Reports shall be submitted for approval.

PART 3 EXECUTION

3.1 EQUIPMENT

All plant, equipment, tools, and machines used in the performance of the work covered by this section shall be subject to approval by the Contracting Officer and shall be maintained in satisfactory working condition at all times.

3.1.1 Rollers

Rollers shall be self-propelled and shall be of such a type and weight that sufficient compactive effort will be exerted on the stabilized area to obtain the required density.

3.1.2 Blade Graders

Blade graders shall have a wheel base of not less than 15 feet, a blade of not less than 12 feet, and shall be self-propelled.

3.1.3 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other equipment designed to apply water uniformly and at controlled quantities to variable widths of surface.

3.1.4 Pulvermixer

Pulvermixer may be tow-type or self-propelled and shall have variable mixing speed to allow smooth, uniform mixes to the full depth of section shown on the drawings.

3.1.5 Hauling Equipment

Hauling equipment shall consist of pneumatic-tired vehicles having dump bodies suitable for dumping materials on the subgrade or select material base course.

3.1.6 Tampers

Hand tampers shall weigh not less than 50 pounds and shall have a face area of not more than 100 square inches. Mechanical tampers shall be of an approved type.

3.1.7 Miscellaneous Equipment

Scarifiers, tractors, spring-tooth or spike-tooth harrows, windrow equalizers, spreaders, and other equipment shall be of approved types, suitable for constructing stabilized aggregate base course.

3.2 PREPARATION OF SUBGRADE

Prior to constructing the limerock base course, the previously constructed subgrade course shall be cleaned of foreign substances. Surface of the subgrade or subbase course shall be inspected for adequate compaction and/or subbase course surface tolerances. Subgrade shall conform to the requirements of Section 31 00 00 EARTHWORK.

Ruts or soft, yielding spots that may appear in the subgrade or subbase

course, areas having inadequate compaction, and deviations of the surface from the requirements in the applicable section shall be corrected. Correction shall be performed by loosening the affected areas, removing unsatisfactory material, adding approved material, and by reshaping and recompacting to line and grade to the specified density requirements, as directed.

3.3 GRADE CONTROL

The finished and completed surface course shall conform to lines, grades, cross sections, and dimensions as indicated. Lines and grades shall be maintained as indicated by means of line and grade stakes placed at the worksite.

3.4 FURNISHING WATER

Provisions shall be made by the Contractor for furnishing water at the site of the work by equipment of such capacity and design as will ensure application of the approved amounts of each of the construction operations in the following paragraphs.

3.5 PLACING AND SPREADING

Transporting of limerock over finished subgrade or subbase course will be permitted only when approved. Rutting shall be repaired as described in the paragraph entitled, "Preparation of Subgrade or Subbase Course." Limerock shall be transported in approved vehicles over the previously placed course to the areas under construction, and shall be dumped at the end of the spread limerock. Limerock shall be spread uniformly on the subgrade or subbase course by means of shovels, forks, bulldozers, or other approved equipment. Loose thickness of the layer shall be such that the compaction requirements will be obtained and the compacted thickness will conform to the thickness of the layer as indicated. Compacted thickness of a single layer of limerock base course shall not exceed 6 inches. When more than one layer of base course is required, the first layer shall be constructed to not less than 4-inches compacted thickness. Prior to the spreading of any material for the upper course, the lower course shall have passed all required compaction tests to the satisfaction of the Contracting Officer. Surface cross section of the lower course shall be approximately parallel to the finished line and grade. Portions of a layer that become segregated in spreading shall be corrected, or if necessary, replaced with satisfactory material.

Surface of each layer of base course shall be compacted to the line and grade indicated.

Rolling and blading shall continue until entire depth of the layer is bonded and compacted to at least 98 percent minimum density for roads and 95 percent minimum density for shoulders, turnouts, and crossovers. Additional water shall be applied to the limerock during rolling operations to obtain the density specified. In areas not accessible to rollers, the limerock shall be tamped with approved mechanical tampers to the density specified. If at any time the subgrade or subbase course becomes mixed with the limerock, the Contractor shall remove the affected mixture, reshape and compact the subgrade or subbase course, and replace the limerock base course. Cracks, checks, or other defects in the finished base course shall be removed by scarifying to a depth of 4-inches, reshaping, adding limerock as required, and recompacting as directed by the Contracting Officer.

3.6 COMPACTION

When the stabilized areas have been bladed, shaped, and smoothed to the grades or levels required, the areas shall have water added as required and shall be rolled with tamping rollers, power rollers, or by combination thereof. Rolling shall continue until the layer or layers are compacted through the full depth to at least 100 percent of the maximum density as determined by test procedure presented in MIL-STD-621, Method 100, Compaction Effort Designation CE-55. Surface of the layer shall be finished by blading and rolling with a power roller or rubber-tired rollers, or combination thereof. In all places not accessible to the rolling equipment, the mixture shall be compacted with tamping equipment as specified. Blading, rolling, and tamping shall continue until the surface is smooth and free from waves and inequalities. If at any time the mixture is excessively moistened by rain, it shall be aerated by means of blade graders, harrows, or other approved equipment, until the moisture content of the mixture is satisfactory; the surface shall then be recompacted and finished as specified above.

3.7 EDGES OF BASE COURSE

Approved material shall be placed along edges of the base course in such quantity as will compact to the thickness of course being constructed or, when the course is being constructed in two or more layers, to the thickness of each layer of the course. In each operation, at least a 1-foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the base course shall be allowed.

3.8 TESTS

3.8.1 Smoothness Test

The finished surface shall indicate no deviations in excess of 3/8-inch when tested with a 10-foot straightedge applied parallel with, and at right angles to, centerline of the paved area. Deviations exceeding 3/8-inch shall be corrected by scarifying to a depth of 4-inches, removing or adding limerock as may be required, reshaping, watering, and compacting, until approved. When the base course is constructed in more than one layer, the smoothness requirements shall apply to the top layer.

3.8.2 Thickness

Thickness of the stabilized subbase, shoulder, or other areas shall be not less than that shown on the drawings, and shall be measured at intervals in such a manner that there will be a depth measurement for at least 500 square yards of completed stabilization. Depth measurements shall be made by test holes, at least 3 inches in diameter through the subbase, shoulder, or other areas. Where the deficiency is more than 1/2 inch, the Contractor shall correct such areas by scarifying, adding stabilizing material, watering, reblading, and recompacting. Where the thickness is more than called for on the drawings, it shall be considered as the specified requirement.

3.8.3 Density Control

During construction and upon completion of the stabilized area, field density tests shall be performed in sufficient numbers to ensure that

required density is being obtained. These tests shall be made by the Contractor and shall be in accordance with ASTM D 1556, Method D, or ASTM D 2167, except that the volume occupied by the sample prior to removal shall not be determined through the use of oil.

3.9 MAINTENANCE

Limerock base course shall be maintained to meet all requirements specified herein until prime coat is applied. If the finished surface of the base course has become so glazed that the prime coat will not readily penetrate, the glaze shall be removed, prior to applying the prime coat, by blading, power brooms, or other equipment, as directed by the Contracting Officer.

-- End of Section --

SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 301	(2010; Errata 2011) Specifications for Structural Concrete
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C215	(2010) Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2006; E2011) Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A966/A966M	(2008; R 2012) Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM C1077	(2013b) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C143/C143M	(2012) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C1602/C1602M	(2012) Standard Specification for Mixing

	Water Used in Production of Hydraulic Cement Concrete
ASTM C171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2013) Standard Specification for Concrete Aggregates
ASTM C494/C494M	(2013) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2013) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C78/C78M	(2012; E 2013) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2013a) Standard Specification for Ready-Mixed Concrete
ASTM C989/C989M	(2012a) Standard Specification for Slag Cement for Use in Concrete and Mortars

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED GBDC	(2009) LEED Reference Guide for Green Building Design and Construction
LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing materials; (LEED NC)

Admixtures; (LEED NC)

Dowel; (LEED NC)

Reinforcement

Submit a complete list of materials including type, brand and applicable reference specifications.

Cementitious Materials; (LEED NC)

Aggregate; (LEED NC)

Submit documentation relative to each material credit in accordance with the LEED GBDC.

SD-05 Design Data

Concrete mix design

Thirty days minimum prior to concrete placement, submit a mix design, with applicable tests, for each strength and type of concrete for approval. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required. Submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted. Obtain acknowledgement of approvals prior to concrete placement. Submit a new mix design for each material source change.

SD-06 Test Reports

Aggregate tests

Concrete slump tests

Air content tests

Flexural strength tests

Cementitious materials

SD-07 Certificates

Ready-mixed concrete plant

Batch tickets

Cementitious materials

1.3 DELIVERY, STORAGE, AND HANDLING

ASTM C94/C94M.

1.4 QUALITY ASSURANCE

1.4.1 Ready-mixed Concrete Plant Certification

Unless otherwise approved by the Contracting Officer, ready mixed concrete shall be produced and provided by a National Ready-Mix Concrete Association (NRMCA) certified plant. If a volumetric mobile mixer is used to produce the concrete, rather than ready-mixed concrete, the mixer(s) must conform to the standards of the Volumetric Mixer Manufacturers Bureau (VMMB). Verification shall be made by a current VMMB conformance plate affixed to the volumetric mixer equipment.

1.4.2 Required Information

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports shall include mill test and all other test for cementitious materials, aggregates, and admixtures. Provide maximum nominal aggregate size, combined aggregate gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Test reports shall be submitted along with the concrete mix design. Sampling and testing of materials, concrete mix design, sampling and testing in the field shall be performed by a commercial testing laboratory which conforms to ASTM C1077. The laboratory shall be approved in writing by the Government.

1.4.3 Batch Tickets

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials in concrete mix shall be 20 to 50 percent non-portland cement pozzolanic materials by weight.

2.1.1.1 Cement

ASTM C150/C150M, Type I or II or ASTM C595/C595M, Type IP (MS) or IS (MS).

2.1.1.2 Fly Ash and Pozzolan

ASTM C618, Type C, F, or N. Fly ash certificates shall include test results in accordance with ASTM C618.

2.1.1.2 Slag

ASTM C989/C989M, Slag Cement (formerly Ground Granulated Blast Furnace Slag) Grade 100 or 120. Certificates shall include test results in accordance with ASTM C989/C989M.

2.1.2 Water

Water shall conform to ASTM C1602/C1602M. Hot water shall not be used unless approved by the Contracting Officer.

2.1.2 Aggregate

Coarse aggregate shall consist of crushed or uncrushed gravel, crushed stone, or a combination thereof. Aggregates, as delivered to the mixers, shall consist of clean, hard, uncoated particles. Coarse aggregate shall be washed. Washing shall be sufficient to remove dust and other coatings. Fine aggregate shall consist of natural sand, manufactured sand, or a combination of the two, and shall be composed of clean, hard, durable particles. Both coarse and fine aggregates shall meet the requirements of ASTM C33/C33M.

2.1.2.1 Fine Aggregates

ASTM C33/C33M.

2.1.2.2 Coarse Aggregates

ASTM C33/C33M.

2.1.3 Admixtures

ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures. Where not shown or specified, the use of admixtures is subject to written approval of the Contracting Officer.

ASTM C260/C260M: Air-entraining.

2.1.4 Reinforcement

2.1.4.1 Dowel Bars

Bars shall conform to ASTM A615/A615M, Grade 40 for plain billet-steel bars of the size and length indicated. Remove all burrs and projections from the bars.

2.1.4.2 Coated Dowel Bars

Bars shall conform to ASTM A615/A615M, Grade 40 for plain billet-steel bars of the size and length indicated. Remove all burrs or projections from the dowel bars. Coating system shall conform to AWWA C215, Type 2. Coat the bars with a double coat system or an epoxy coating system for resistance to penetration of oil and salt solutions. The systems shall be in accordance with manufacturer's recommendation for coatings which are not bondable to concrete. Bond the coating to the dowel bar to resist laps or folds during movement of the joint. Coating thickness shall be 7 mils minimum and 20 mils maximum.

2.1.4.3 Tie Bars

Bars shall be billet or axle steel deformed bars and conform to ASTM A615/A615M or ASTM A966/A966M Grade 40.

2.1.4.4 Reinforcement

Deformed steel bar mats shall conform to ASTM A184/A184M. Bar reinforcement shall conform to ASTM A615/A615M, Grade 60.

2.1.5 Curing Materials

2.1.5.1 White-Burlap-Polyethylene Sheet

ASTM C171, 0.004 inch thick white opaque polyethylene bonded to 10 oz/linear yard (40 inch) wide burlap.

2.1.5.2 Liquid Membrane-Forming Compound

ASTM C309, white pigmented, Type 2, Class B, free of paraffin or petroleum.

2.1.5.3 Liquid Chemical Sealer-Hardener Compound

Compound shall be magnesium fluosilicate which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound shall not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.1.6 Joint Fillers and Sealants

Provide as specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

2.2 CONCRETE PAVEMENT

2.2.1 Joint Layout Drawings

See Joint Plan in drawings. The joint layout plan indicates and describes in the detail the proposed jointing plan for contraction joints, and expansion joints, in accordance with the following:

a. Indicate locations of contraction joints and expansion joints. Spacing between contraction joints shall not exceed 15 feet unless noted otherwise or approved by the Contracting Officer.

b. The larger dimension of a panel shall not be greater than 125% of the smaller dimension.

c. The minimum angle between two intersecting joints shall be 80 degrees, unless noted otherwise or approved by the Contracting Officer.

d. Joints shall intersect pavement-free edges at a 90 degree angle the pavement edge and shall extend straight for a minimum of 1.5 feet from the pavement edge, where possible.

e. Align joints of adjacent panels.

f. Align joints in attached curbs with joints in pavement when possible.

g. Ensure joint depth, widths, and dimensions are specified.

h. Minimum contraction joint depth shall be 1/4 of the pavement thickness. The minimum joint width shall be 1/2 inch.

2.3 CONTRACTOR-FURNISHED MIX DESIGN

Contractor-furnished mix design concrete shall be designed in accordance with ACI 211.1 except as modified herein, and the mix design shall be as specified herein under paragraph entitled "Submittals." The concrete shall have a minimum flexural strength of 650 pounds per square inch at 28 days. The concrete may be air entrained. If air entrainment is used the air content shall be 5.0 plus or minus 1.5 percent. Maximum size aggregate for slip forming shall be 1.5 inches. The minimum cementitious factor is 564 lbs per cubic yard and slump shall be 1 to 3 inches (or less when slip form is used).

If the cementitious material is not sufficient to produce concrete of the flexural strength required it shall be increased as necessary, without additional compensation under the contract. The cementitious factor shall be calculated using cement, Class F fly ash, and or GGBF slag. The mix shall use a cement replacement (by weight) of 25 percent - 35 percent Class F fly ash, or 40 percent - 50 percent GGBF slag, or a combination of the two. In the combination, each 5 percent of Class F fly ash shall be replaced by 8 percent GGBF slag.

PART 3 EXECUTION

3.1 FORMS

3.1.1 Construction

Construct forms to be removable without damaging the concrete.

3.1.2 Coating

Before placing the concrete, coat the contact surfaces of forms except existing pavement sections where bonding is required, with a non-staining mineral oil, non-staining form coating compound, or two coats of nitro-cellulose lacquer.

3.1.3 Grade and Alignment

Check and correct grade elevations and alignment of the forms immediately before placing the concrete.

3.2 REINFORCEMENT

3.2.1 Dowel Bars

Install bars accurately aligned, vertically and horizontally, at indicated locations and to the dimensions and tolerances indicated. Before installation thoroughly grease the sliding portion of each dowel. Dowels must remain in position during concrete placement and curing.

3.2.2 Coated Dowel Bars

Install bars, accurately aligned vertically and horizontally, at indicated locations and to the dimensions and tolerances indicated. Reject coatings which are perforated, cracked or otherwise damaged. While handling avoid scuffing or gouging of the coatings.

3.2.3 Tie Bars

Install bars, accurately aligned horizontally and vertically, at indicated locations.

3.2.4 Setting Slab Reinforcement

Reinforcement shall be positioned on suitable chairs prior to concrete placement. At expansion and contraction joints, place the reinforcement as indicated. Reinforcement, when placed in concrete, shall be free of mud, oil, scale or other foreign materials. Place reinforcement accurately and wire securely. The laps at splices shall be 12 inches minimum and the distances from ends and sides of slabs and joints shall be as indicated.

3.3 MEASURING, MIXING, CONVEYING, AND PLACING CONCRETE

3.3.1 Measuring

ASTM C94/C94M.

3.3.2 Mixing

ASTM C94/C94M, except as modified herein. Begin mixing within 30 minutes after cement has been added to aggregates. When the air temperature is greater than 85 degrees F, place concrete within 60 minutes. With the approval of the Contracting Officer, a hydration stabilizer admixture meeting the requirements of ASTM C494/C494M Type D, may be used to extend the placement time to 90 minutes. Additional water may be added to bring slump within required limits as specified in Section 11.7 of ASTM C94/C94M, provided that the specified water-cement ratio is not exceeded.

3.3.3 Conveying

ASTM C94/C94M.

3.3.4 Placing

Follow guidance of ACI 301, except as modified herein. Do not exceed a free vertical drop of 5 feet from the point of discharge. Deposit concrete either directly from the transporting equipment or by conveyor on to the pre-wetted subgrade or subbase, unless otherwise specified. Do not place concrete on frozen subgrade or subbase. Deposit the concrete between the forms to an approximately uniform height. Place concrete continuously at a uniform rate, with minimum amount of segregation, without damage to the grade and without unscheduled stops except for equipment failure or other emergencies. If this occurs within 10 feet of a previously placed expansion joint, remove concrete back to joint, repair any damage to grade, install a construction joint and continue placing concrete only after cause of the stop has been corrected.

3.3.5 Vibration

Immediately after spreading concrete, consolidate concrete with internal type vibrating equipment along the boundaries of all slabs regardless of slab thickness, and interior of all concrete slabs 6 inches or more in thickness. Limit duration of vibration to that necessary to produce consolidation of concrete. Excessive vibration will not be permitted. Vibrators shall not be operated in concrete at one location for more than 15 seconds. At the option of the Contractor, vibrating equipment of a type approved by the Contracting Officer may be used to consolidate concrete in unreinforced pavement slabs less than 6 inches thick.

3.3.5.1 Vibrating Equipment

Operate equipment, except hand-manipulated equipment, ahead of the finishing machine. Select the number of vibrating units and power of each unit to properly consolidate the concrete. Mount units on a frame that is capable of vertical movement and, when necessary, radial movement, so vibrators may be operated at any desired depth within the slab or be completely withdrawn from the concrete. Clear distance between frame-mounted vibrating units that have spuds that extend into the slab at intervals across the paving lane shall not exceed 30 inches. Distance between end of vibrating tube and side form shall not exceed 2 inches. For pavements less than 10 inches thick, operate vibrators at mid-depth parallel with or at a slight angle to the subbase. For thicker pavements, angle vibrators toward the vertical, with vibrator tip preferably about 2 inches from subbase, and top of vibrator a few inches below pavement surface. Vibrators may be pneumatic, gas driven, or electric, and shall be operated at frequencies within the concrete of not less than 8,000 vibrations per minute. Amplitude of vibration shall be such that noticeable vibrations occur at 1.5 foot radius when the vibrator is inserted in the concrete to the depth specified.

3.3.6 Cold Weather

Except with authorization, do not place concrete when ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. When authorized, when concrete is likely to be subjected to freezing within 24 hours after placing, heat concrete materials so that temperature of concrete when deposited is between 65 and 80 degrees F. Methods of heating materials are subject to approval of the Contracting Officer. Do not heat mixing water above 165 degrees F. Remove lumps of frozen material and ice from aggregates before placing aggregates in mixer. Follow practices found in ACI 306.1.

3.3.7 Hot Weather

Maintain required concrete temperature in accordance with Figure 2.1.5 in ACI 305R to prevent evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. After placement, use fog spray, apply monomolecular film, or use other suitable means to reduce the evaporation rate. Start curing when surface of fresh concrete is sufficiently hard to permit curing without damage. Cool underlying material by sprinkling lightly with water before placing concrete. Follow practices found in ACI 305R.

3.4 PAVING

Pavement shall be constructed with paving and finishing equipment utilizing fixed forms.

3.4.1 Fixed Form Paving

Forms shall be steel, except that wood forms may be used for curves having a radius of 150 feet or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. The base width of the form shall be not less than eight-tenths of the vertical height of the form, except that forms 8 inches or less in vertical height shall have a base width not less than the vertical height of the form. Wood forms for curves and fillets shall be adequate in strength and rigidly braced. Forms shall be set on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Forms shall not be set on blocks or on built-up spots of underlying material. Forms for overlay pavements and for other locations where forms must be set on existing pavements shall be held securely in place with stakes or by other approved methods. Holes in existing pavements for form stakes shall be carefully drilled without cracking or spalling the existing pavement. Prior to setting forms for paving operations, the Contractor shall demonstrate the proposed form setting procedures at an approved location and shall not proceed further until the proposed method is approved. Forms shall remain in place at least 12 hours after the concrete has been placed. Forms shall be removed without injuring the concrete.

3.4.2 Placing Reinforcing Steel

Reinforcement shall be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement.

3.4.3 Placing Dowels and Tie Bars

Dowels shall be installed with alignment not greater than 1/8 inch per ft. Except as otherwise specified below, location of dowels shall be within a horizontal tolerance of plus or minus 5/8 inch and a vertical tolerance of plus or minus 3/16 inch. The portion of each dowel intended to move within the concrete or expansion cap shall be painted with one coat of rust inhibiting primer paint, and then oiled just prior to placement.

3.4.3.1 Contraction Joints

Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place by means of rigid metal basket assemblies. The dowels and tie bars shall be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from becoming distorted during paving operations. The basket assemblies shall be held securely in the proper location by means of suitable anchors.

3.4.3.2 Dowels Installed in Hardened Concrete

Installation shall be by bonding the dowels into holes drilled into the hardened concrete. Holes approximately 1/8 inch greater in diameter than the dowels shall be drilled into the hardened concrete. Dowels shall be bonded in the drilled holes using epoxy resin injected at the back of the

hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel shall not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic collar fitted around the dowel. The vertical alignment of the dowels shall be checked by placing the straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel.

3.4.3.3 Expansion Joints

Dowels in expansion joints shall be installed by the bonded-in-place method or by bonding into holes drilled in hardened concrete, using procedures specified above.

3.5 FINISHING CONCRETE

Start finishing operations immediately after placement of concrete.

3.5.1 Joint Finish

Before concrete is hardened, correct edge slump of pavement, exclusive of edge rounding, in excess of 0.02 foot. Finish concrete surface on each side of construction joints to the same plane, and correct deviations before newly placed concrete has hardened.

3.5.2 Hand Finishing

Strike-off and screed surface of concrete to elevations slightly above finish grade so that when concrete is consolidated and finished pavement surface is at the indicated elevation. Vibrate entire surface until required compaction and reduction of surface voids is secured with a strike-off template.

3.5.3 Longitudinal Floating

After initial finishing, further smooth and consolidate concrete by means of hand-operated longitudinal floats. Use floats that are not less than 12 feet long and 6 inches wide and stiffened to prevent flexing and warping.

3.5.4 Texturing

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement shall be given a texture as described herein. Following initial texturing on the first day of placement, the Placing Foreman, Contracting Officer representative, and a representative of the Using Agency shall inspect the texturing for compliance with design requirements. After curing is complete, all textured surfaces shall be thoroughly power broomed to remove all debris. The concrete in areas of recesses for tie-down anchors, lighting fixtures, and other outlets in the pavement shall be finished to provide a surface of the same texture as the surrounding area.

3.5.4.1 Brooming

Finish the surface of the slab by brooming the surface with a new wire

broom at least 18 inches wide. Gently pull the broom over the surface of the pavement from edge to edge just before the concrete becomes non-plastic. Slightly overlap adjacent strokes of the broom. Broom perpendicular to centerline of pavement so that corrugations produced will be uniform in character and width, and not more than 1/16 inch in depth. Broomed surface shall be free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface.

3.5.5 Edging

At the time the concrete has attained a degree of hardness suitable for edging, carefully finish slab edges, including edges at formed joints, with an edge having a maximum radius of one-eighth inch. When brooming is specified for the final surface finish, edge transverse joints before starting brooming, then operate broom to obliterate as much as possible the mark left by the edging tool without disturbing the rounded corner left by the edger. Clean by removing loose fragments and soupy mortar from corners or edges of slabs which have crumbled and areas which lack sufficient mortar for proper finishing. Refill voids solidly with a mixture of suitable proportions and consistency and refinish. Remove unnecessary tool marks and edges. Remaining edges shall be smooth and true to line.

3.5.6 Repair of Surface Defects

Follow guidance of ACI 301.

3.6 CURING AND PROTECTION

Protect concrete adequately from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Use White-Burlap-Polyethylene Sheet or liquid membrane-forming compound, except as specified otherwise herein. Do not use membrane-forming compound on surfaces where its appearance would be objectionable, on surfaces to be painted, where coverings are to be bonded to concrete, or on concrete to which other concrete is to be bonded. Maintain temperature of air next to concrete above 40 degrees F for the full curing periods.

3.6.1 White-Burlap-Polyethylene Sheet

Wet entire exposed surface thoroughly with a fine spray of water, saturate burlap but do not have excessive water dripping off the burlap and then cover concrete with White-Burlap-Polyethylene Sheet, burlap side down. Lay sheets directly on concrete surface and overlap 12 inches. Make sheeting not less than 18 inches wider than concrete surface to be cured, and weight down on the edges and over the transverse laps to form closed joints. Repair or replace sheets when damaged during curing. Check daily to assure burlap has not lost all moisture. If moisture evaporates, resaturate burlap and re-place on pavement (re-saturation and re-placing shall take no longer than 10 minutes per sheet). Leave sheeting on concrete surface to be cured for at least 7 days.

3.6.2 Liquid Membrane-Forming Compound Curing

Apply compound immediately after surface loses its water sheen and has a

dull appearance and before joints are sawed. Agitate curing compound thoroughly by mechanical means during use and apply uniformly in a two-coat continuous operation by suitable power-spraying equipment. Total coverage for the two coats shall be at least one gallon of undiluted compound per 200 square feet. Compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. Apply an additional coat of compound immediately to areas where film is defective. Respray concrete surfaces that are subject to heavy rainfall within 3 hours after curing compound has been applied in the same manner.

3.6.2.1 Protection of Treated Surfaces

Keep concrete surfaces to which liquid membrane-forming compounds have been applied free from vehicular traffic and other sources of abrasion for not less than 72 hours. Foot traffic is allowed after 24 hours for inspection purposes. Maintain continuity of coating for entire curing period and repair damage to coating immediately.

3.6.3 Liquid Chemical Sealer-Hardener

Apply sealer-hardener to interior floors not receiving floor covering and floors located under access flooring. Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer-hardener shall not be applied until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.7 FIELD QUALITY CONTROL

3.7.1 Sampling

The Contractor's approved laboratory shall collect samples of fresh concrete in accordance with ASTM C172/C172M during each working day as required to perform tests specified herein. Make test specimens in accordance with ASTM C31/C31M.

3.7.2 Consistency Tests

The Contractor's approved laboratory shall perform concrete slump tests in accordance with ASTM C143/C143M. Take samples for slump determination from concrete during placement. Perform tests at the beginning of a concrete placement operation and and for each batch (minimum) or every 20 cubic yards (maximum) of concrete to ensure that specification requirements are met. In addition, perform tests each time test beams and cylinders are made.

3.7.3 Flexural Strength Tests

The Contractor's approved laboratory shall test for flexural strength in accordance with ASTM C78/C78M. Make four test specimens for each set of tests. Test two specimens at 7 days, and the other two at 28 days. Concrete strength will be considered satisfactory when the minimum of the 28-day test results equals or exceeds the specified 28-day flexural strength, and no individual strength test is less than 650 pounds per square inch. If the ratio of the 7-day strength test to the specified 28 -day strength is less than 65 percent, make necessary adjustments for conformance. Frequency of flexural tests on concrete beams shall be not

less than four test beams for each 50 cubic yards of concrete, or fraction thereof, placed. Concrete which is determined to be defective, based on the strength acceptance criteria therein, shall be removed and replaced with acceptable concrete.

3.7.4 Air Content Tests

Test air-entrained concrete for air content at the same frequency as specified for slump tests. Determine percentage of air in accordance with ASTM C231/C231M on samples taken during placement of concrete in forms.

3.7.5 Surface Testing

Surface testing for surface smoothness and plan grade shall be performed as indicated below by the Testing Laboratory.

3.7.5.1 Surface Smoothness Requirements

The finished surfaces of the pavements shall have no abrupt change of 1/8 inch or more, and all pavements shall be within the tolerances specified when checked with a 12 foot straightedge: 1/4 inch for both directions for parking areas.

3.7.5.2 Surface Smoothness Testing Method

The surface of the pavement shall be tested with the straightedge to identify all surface irregularities exceeding the tolerances specified above. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines approximately 15 feet apart. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface, in the area between these two high points.

3.7.6 Plan Grade Testing and Conformance

The surfaces shall vary not more than 0.10 foot above or below the plan grade line or elevation indicated. Each pavement category shall be checked by the Contractor for conformance with plan grade requirements by running lines of levels at intervals to determine the elevation at each joint intersection.

3.7.7 Test for Pavement Thickness

Measure during concrete placement to determine in-place thickness of concrete pavement.

3.7.8 Reinforcement

Inspect reinforcement prior to installation to assure it is free of loose flaky rust, loose scale, oil, mud, or other objectionable material.

3.7.9 Dowels

Inspect dowel placement prior to placing concrete to assure that dowels are of the size indicated, and are spaced, aligned and painted and oiled

as specified. Dowels shall not deviate from vertical or horizontal alignment after concrete has been placed by more than 1/8 inch per foot.

3.8 WASTE MANAGEMENT

In accordance with the Waste Management Plan. Protect excess material from contamination and return to manufacturer, or reuse on-site for walkways, patching, ditch beds, speed bumps, or curbs.

-- End of Section --

SECTION 32 16 13

CONCRETE SIDEWALKS AND CURBS AND GUTTERS
04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A 185/A 185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 615/A 615M	(2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 143/C 143M	(2009) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2008) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173/C 173M	(2009) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(2009a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2009) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 920	(2008) Standard Specification for Elastomeric Joint Sealants

ASTM D 1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 5893	(2004) Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Provide plant, equipment, machines, and tools used in the work subject to approval and maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.2.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete (LEED NC)

Copies of certified delivery tickets for all concrete used in the construction.

SD-06 Test Reports

Field Quality Control

Copies of all test reports within 24 hours of completion of the

test.

1.4 ENVIRONMENTAL REQUIREMENTS

1.4.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.4.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 95 degrees F at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Provide concrete conforming to the applicable requirements of Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE except as otherwise specified. Concrete shall have a minimum compressive strength of 3000 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

2.1.1 Air Content

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

The concrete slump shall be 2 inches plus or minus 1 inch where determined in accordance with ASTM C 143/C 143M.

2.1.3 Reinforcement Steel

Reinforcement bars shall conform to ASTM A 615/A 615M. Wire mesh reinforcement shall conform to ASTM A 185/A 185M.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 1/2 inch thick, unless otherwise indicated.

2.5 JOINT SEALANTS

Joint sealant, cold-applied shall conform to ASTM C 920 or ASTM D 5893.

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted in conformance with Section 32 11 29 LIMEROCK BASE COURSE, SUBBASE, OR SUBGRADE.

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily

repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope of 1/4 inch per foot with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove

in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Expansion joints shall be formed with 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D 1752 or building paper. Joint filler shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with cold-applied joint sealant. Joint sealant shall be gray or stone in color. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.

a. Contraction joints (except for slip forming) shall be constructed by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

b. When slip forming is used, the contraction joints shall be cut in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. The depth of cut shall be at least one-fourth of the gutter/curb depth and 1/8 inch in width.

3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 1/2 inch in width shall be provided at intervals not less than 30

feet nor greater than 120 feet. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. Expansion joints and the top 1 inch depth of curb and gutter contraction-joints shall be sealed with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.7 CURING AND PROTECTION

3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18-inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. The second coat shall be applied

in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Completed concrete shall be protected from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.8 FIELD QUALITY CONTROL

3.8.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

Provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 250 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance

shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

3.8.2.2 Air Content

Determine air content in accordance with ASTM C 173/C 173M or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours

old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

SECTION 32 17 23.00 20

PAVEMENT MARKINGS
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 792	(2008) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM E 28	(1999; R 2009) Softening Point of Resins Derived from Naval Stores by Ring and Ball Apparatus

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

FDOT Standard 710	(2010) Painted Pavement Markings

1.2 SUBMITTALS

Not used.

1.3 DELIVERY AND STORAGE

Deliver paints, paint materials and thermoplastic compound materials in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer. Provide storage facilities at the job site, only in areas approved by the Contracting Officer or authorized representative, for maintaining materials at temperatures recommended by the manufacturer.

1.4 WEATHER LIMITATIONS

Apply paint to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 5 degrees above the dew point and the air and pavement temperatures are above 40 degrees F and less than 95 degrees F for oil-based materials; above 50 degrees F and less than 110 degrees F for water-based materials. Maintain paint temperature within these same limits.

1.5 EQUIPMENT

Machines, tools, and equipment used in the performance of the work shall be approved by the Contracting Officer and maintained in satisfactory operating condition.

1.5.1 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

1.5.2 Paint Application Equipment

1.5.2.1 Self-Propelled or Mobile-Drawn Pneumatic Spraying Machines

Provide self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges. Provide paint applicator with paint reservoirs or tanks of sufficient capacity and suitable gages to apply paint in accordance with requirements specified. Equip tanks with suitable air-driven mechanical agitators. Equip spray mechanism with quick-action valves conveniently located, and include necessary pressure regulators and gages in full view and reach of the operator. Install paint strainers in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Provide pneumatic spray guns for hand application of paint in areas where the mobile paint applicator cannot be used. Applicator for water-based markings shall be equipped with non-stick coated hoses; metal parts in contact with the paint material shall be constructed of grade 302, 304, 316, or equal stainless steel.

1.5.3 Thermoplastic Application Equipment

1.5.3.1 Thermoplastic Material

Thermoplastic material shall be applied to the primed pavement surface by spray techniques or by the extrusion method, wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material. By either method, the markings shall be applied with equipment that is capable of providing continuous uniformity in the dimensions of the stripe.

1.5.3.2 Application Equipment

a. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. The equipment shall be capable of applying varying widths of traffic markings.

c. The applicator shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at

controlled rates of flow. The bead dispenser shall be automatically operated and shall begin flow prior to the flow of composition to assure that the strip is fully reflectorized.

1.5.3.3 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

1.5.3.4 Portable Application Equipment

The portable applicator shall be defined as hand-operated equipment, specifically designed for placing special markings such as stopbars and arrows. The portable applicator shall be capable of applying thermoplastic pavement markings by the extrusion method. The portable applicator shall be loaded with hot thermoplastic composition from the melting kettles on the mobile applicator. The portable applicator shall be equipped with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature of 375 to 425 degrees F, of extruding a line of 3 to 12 inches in width, and in thickness of not less than 0.120 inch nor more than 0.190 inch and of generally uniform cross section.

1.5.4 Surface Preparation Equipment

1.5.4.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.5.4.2 Waterblast Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

1.5.5 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

1.5.5.1 Shotblasting Equipment

Shotblasting equipment shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

1.5.5.2 Chemical Equipment

Chemical equipment shall be capable of application and removal of

chemicals from the pavement surface, and shall leave only non-toxic biodegradeable residue.

1.5.6 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

1.6 MAINTENANCE OF TRAFFIC

1.7 WEATHER LIMITATIONS FOR REMOVAL

Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials conforming to the requirements specified herein.

2.1.1 Paints for Roads and Streets

Provide color as indicated on the drawings and ensure that it meets FDOT Standard 710. If the Contractor's means and methods require traffic to use paved areas before the permanent painting pavement markings are applied, apply temporary pavement markings at no additional cost to the Government. Final painted pavement markings shall receive two coats of paint.

2.1.2 Thermoplastic Compound

The thermoplastic reflectorized pavement marking compound shall be extruded or sprayed in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking shall be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.

2.1.2.1 Composition Requirements

The binder component shall be formulated as a hydrocarbon resin. The pigment, beads and filler shall be uniformly dispersed in the binder resin. The thermoplastic composition shall be free from all skins, dirt, and foreign objects and shall comply with the following requirements:

Component	Percent by Weight White
Binder	17 min

Component	Percent by Weight White
Titanium dioxide	10 min
Glass beads	20 min
Calcium carbonate and inert fillers	49 min
Yellow pigments	-

2.1.2.2 Physical Properties

a. Drying time: When installed at 70 degrees F and in thicknesses between 0.120 and 0.190 inch, the composition shall be completely solid and shall show no damaging effect from traffic after curing 15 minutes.

b. Softening point: The composition shall have a softening point of not less than 194 degrees F when tested in accordance with ASTM E 28.

c. Specific gravity: The specific gravity of the composition shall be between 1.9 and 2.2 as determined in accordance with ASTM D 792.

2.1.2.3 Primer

a. Asphalt concrete primer: The primer for asphalt concrete pavements shall be a thermosetting adhesive with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved or dispersed in a volatile organic solvent. The solids content shall not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch, plus or minus 0.001 inch, shall dry to a tack-free condition in less than 5 minutes.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Allow new pavement surfaces to cure for a period of not less than 30 days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove rubber deposits, residual curing compounds, and other coatings adhering to the pavement by water blasting. Do not commence painting in any area until pavement surfaces are dry and clean.

3.2 APPLICATION

3.2.1 Testing for Moisture

Apply pavement markings to dry pavement only. The Contractor shall test the pavement surface for moisture before beginning work after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the CO or authorized representative. Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 300 mm by 300 mm (12 inch by 12 inch) section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap

for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap.

3.2.2 Rate of Application

3.2.2.1 Reflective Markings

Apply paint evenly to the pavement area to be coated at a rate of 105 plus or minus 5 square feet per gallon. Apply glass spheres uniformly to the wet paint on pavement at a rate of (6) plus or minus (0.5) pounds of glass spheres per gallon. Collect and record readings for white retroreflective markings at the rate of one reading per 1000 linear feet. The minimum acceptable average for white markings is 200 millicandelas per square meter per lux (mcd/m2/lx) (measured with Mirolux 12 Retroreflectometer or similar instrument as agreed). Readings shall be computed by averaging a minimum of 10 readings taken within the area at random locations. Areas not meeting the retroreflective requirements stated above shall be re-marked.

3.2.2.2 Nonreflective Markings

Apply paint evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet per gallon.

3.2.2.3 Thermoplastic Compound

After surface preparation has been completed, prime the asphalt or concrete pavement surface with spray equipment. Allow primer materials to "set-up" prior to applying the thermoplastic composition. Allow the asphalt concrete primer to dry to a tack-free condition, usually occurring in less than 10 minutes. Apply asphalt concrete primer to all asphalt concrete pavements at a wet film thickness of 0.005 inch, plus or minus 0.001 inch 265 to 400 square feet per gallon. After the primer has "set-up", apply the thermoplastic at temperatures no lower than 375 degrees F nor higher than 425 degrees F at the point of deposition. Immediately after installation of the marking, apply drop-on reflective glass spheres mechanically at the rate of one pound per 20 square feet such that the spheres are held by and imbedded in the surface of the molten material. Apply all extruded thermoplastic markings at the specified width and at a thickness of not less than 0.125 inch nor more than 0.190 inch. Apply all sprayed thermoplastic markings at the specified width and the thickness designated in the contract plans.

3.2.3 Painting

Apply paint pneumatically with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. Discontinue painting operations if there is a deficiency in drying of the markings until cause of the slow drying is determined and corrected.

3.2.4 Thermoplastic Compound

Place thermoplastic pavement markings upon dry pavement. At the time of installation the pavement surface temperature shall be a minimum of 40

degrees F and rising. Thermoplastics, as placed, shall be free from dirt or tint. Place all special markings, stop bars, and arrows with a portable applicator, using the extrusion method.

3.3 FIELD TESTING, INSPECTION, AND DEMONSTRATIONS

3.3.1 Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. A certificate of compliance shall be accompanied by test results substantiating conformance to the specified requirements.

3.3.2 Surface Preparations and Application Procedures

Surface preparations and application procedures will be examined by the Contracting Officer to determine conformance with the requirements specified. Approve each separate operation prior to initiation of subsequent operations.

3.3.2.1 Surface Preparation Demonstration

Prior to surface preparation, demonstrate surface preparation using the proposed materials, methods and equipment. Prepare areas large enough to determine cleanliness, adhesion of remaining coating and rate of cleaning.

3.3.2.2 Test Stripe Demonstration

Prior to paint application, demonstrate test stripe application within the work area using the proposed materials and equipment. Apply separate test stripes in each of the line widths and configurations required herein using the proposed equipment. The test stripes shall be long enough to determine the proper speed and operating pressures for the vehicle(s) and machinery, but not less than 50 feet long.

3.3.2.3 Application Rate Demonstration

During the Test Stripe Demonstration, demonstrate compliance with the application rates specified herein. Document the equipment speed and operating pressures required to meet the specified rates in each configuration of the equipment and provide a copy of the documentation to the Contracting Officer or authorized representative prior to proceeding with the work.

3.3.2.4 Retroreflective Value Demonstration

After the test stripes have cured to a "no-track" condition, demonstrate compliance with the average retroreflective values specified herein. Take a minimum of ten readings on each test stripe with a Mirolux 12 Retroreflectometer, or similar instrument with the same measuring geometry and direct readout in millicandelas per square meter per lux (mcd/m2/lx).

3.3.2.5 Level of Performance Demonstration

The Contracting Officer or authorized representative will be present the application demonstrations to observe the results obtained and to validate the operating parameters of the vehicle(s) and equipment. If accepted by the Contracting Officer or authorized representative, the test stripe shall be the measure of performance required for this project. Work shall

not proceed until the demonstration results are satisfactory to the Contracting Officer or authorized representative.

3.4 TRAFFIC CONTROL AND PROTECTION

Place warning signs near the beginning of the work site and well ahead of the work site for alerting approaching traffic from both directions. Place small markers along newly painted lines to control traffic and prevent damage to newly painted surfaces. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation. Do not use foil-backed material for temporary pavement marking because of its potential to conduct electricity during accidents involving downed power lines.

3.5 QUALITY ASSURANCE

Demonstrate success of bond of reflective media, new paint marking and the pavement surface, vacuum cured surface of new marking after a seven (7) day dry time. Inspect newly applied markings for signs of bond failure based on visual inspection and comparison to results from Test Stripe Demonstration paragraph.

3.5.1 Reflective Media and Coating Bond Verification

Within seven (7) days after pavement marking application, use industrial vacuum to sweep new markings. Visually inspect the pavement markings and the material captured by the vacuum. Verify that no significant loss of reflective media has occured to the pavement marking due to the vacuum cleaning.

3.5.2 Reflective Media and Coating Application Verification

Use a wet film thickness guage to masure the application of wet paint.

Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50% of the beads embedded and 50% of the beads exposed.

TABLE II
PREAPPROVED HBACs

Manufacturer	Products
TMT-Pathway 1021 N. Mission Road Los Angeles, CA 90033 (800) 338-7680	Legend Build, #2712A9, White Legend Build, #2713A9, Yellow
Pervo Paints 6624 Stanford Ave. Los Angeles, CA 90001 (323) 758-1147	Pervo 6050, White Pervo 6053, Yellow
Vogel Traffic Services 1920 Albany Place South PO Box 140 Orange City, IA 51041 (712) 737-4016	UC-1516, White UC-3588, Yellow

-- End of Section --

SECTION 32 84 24

IRRIGATION SPRINKLER SYSTEMS
08/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Std 598	(2009) Valve Inspecting and Testing

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1010	(2004) Performance Requirements for Water Hammer Arresters (ANSI approved 2004)
ASSE Series 5000	(2009) Cross-Connection Control Professional Qualification Standard

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C500	(2009) Metal-Seated Gate Valves for Water Supply Service
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains
AWWA C901	(2008) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13mm) Through 3 In. (76 mm), for Water Service

ASME INTERNATIONAL (ASME)

ASME B16.18	(2012) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2012) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B40.100	(2005; R 2010) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B32	(2008) Standard Specification for Solder

Metal

ASTM B43	(2009) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM D1785	(2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2009) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2464	(2013) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2774	(2012) Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	(1996; R 2010) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3261	(2012) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR List	(continuously updated) List of Approved Backflow Prevention Assemblies

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2011) Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2013) Plastics Piping System Components and Related Materials

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-51145	(Rev D; Notice 1; Notice 2) Flux, Soldering, Non-Electronic, Paste and Liquid

UNDERWRITERS LABORATORIES (UL)

UL 651	(2011; Reprint Mar 2012) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings

1.2 SYSTEM DESCRIPTION

This system is designed with a water pressure minimum of 30 pounds per square inch (psi) maximum of 60 psi at connection to main meter backflow prevention device and 30 psi at the last head in each zone. Provide a system pressure calculations and irrigation requirements of the area. If pressure falls above or below indicated values, Contractor shall notify Contracting Officer. For Irrigation Sprinkler System, indicate the following:

a. Head, piping, valve, controller, sensor layout.

b. Pipe, valve, backflow preventer, and controller.

c. Invert elevations. Indicate obstructions interfering with operation.

d. Water source equipment, including existing mains, piping, valves and meters.

e. System and supply pressures.

f. Indicate wiring diagram between existing power source and controller/water pump.

g. Number and extent of control valve circuits.

h. Provide details of all irrigation components and accessories.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Irrigation sprinkler system

Drawings including irrigation legend prepared by a licensed, registered or certified Landscape Architect or Irrigation Specialist.

SD-03 Product Data

Piping materials, tubing, and fittings

Valves and accessories

Sprinkler heads

Backflow preventers

Automatic controller

Solvent cement

Control wiring

Water hammer arresters

Water meter

Rain shut-off device

Moisture Sensing Device

Tapping tee

Valve boxes and lids

Drip Head Accessories

SD-05 Design Data

System pressure calculations

Irrigation requirements

SD-06 Test Reports

Valves, and accessories tests

Backflow preventer accessories

Pressure test

Operation test

Including verification of sprinkler head layout

Submit record of pressure tests conducted on recording gage.

SD-07 Certificates

Backflow preventers

ASSE Series 5000, Submit a certificate of Full Approval or a current Certificate of Approval from FCCCHR List for size, and make of backflow preventer being provided for this project. A Certificate of Provisional Approval will not be acceptable.

SD-08 Manufacturer's Instructions

Automatic controller

Sprinkler heads

Piping materials

Tubing and fittings.

Backflow preventers

Valves

Solvent cement

Control wiring

Water hammer arresters

Water meter

Rain shut-off device

Soil moisture sensor

Submit mounting details for automatic controllers.

SD-10 Operation and Maintenance Data

Piping materials and fittings, Data Package

Sprinkler heads and accessories, Data Package

Backflow preventers, Data Package

Valves, Data Package

Automatic controller, Data Package

Water hammer arresters, Data Package

Water meter, Data Package

Rain shut-off device, Data Package

Soil moisture sensor, Data Package

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include troubleshooting procedures with respect to valve and controller problems.

SD-11 Closeout Submittals

Controller Charts

1.4 PROJECT CONDITIONS

Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver materials in original rolls, packages, cartons, and containers with the name of manufacturer, brand, and model. Inspect materials delivered to the site for damage.

Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

1.5.2 Storage

Store materials on site in enclosures or under protective covering. Store plastic piping and rubber gaskets under cover out of direct sunlight. Do not store materials directly on ground. Keep inside of pipes and fittings free from dirt and debris. Support to prevent sagging and bending.

1.5.3 Handling

Handle and carry pipe, fittings, valves, and accessories in such a manner as to ensure delivery to trench in sound undamaged condition. Do not drag pipe.

1.6 EXTRA STOCK

Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Spray Sprinklers: Equal to 5 percent of amount installed for each type and size indicated, but no fewer than 3 units.

a. 2 additional sprinkler heads (nozzles, bodies, screens, pressure compensating devices) of each size and type;

b. 2 valve keys for operating manual valves;

c. 2 wrenches for removing and installing each type of head;

d. 2 quick coupler keys and hose swivels;

e. 4 irrigation controller housing keys.

f. 4 irrigation controller enclosure keys; and

g. 2 hand-held remotes compatible with controller system.

1.7 QUALITY ASSURANCE

1.7.1 Required Test

Submit tests signed by an authorized official of a testing laboratory of sprinkler head, valve, automatic controller, emitter heads, vacuum breaker, backflow preventer, and water hammer arrester.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

2.1.1 Copper Tubing and Associated Fittings

2.1.1.1 Fittings

ASME B16.22 and ASME B16.18, solder joint. Solder, ASTM B32 alloy Grade Sn95 or Sn94. Flux, CID A-A-51145, Type I.

2.1.2 Red Brass Pipe and Associated Fittings

2.1.2.1 Pipe

ASTM B43, regular.

2.1.3 Galvanized Steel Pipe and Associated Fittings

2.1.3.1 Pipe

ASTM A53/A53M, Schedule 40.

2.1.3.2 Fittings

ASME B16.3, Class 150.

2.1.4 Polyvinyl Chloride (PVC) Pipe, Fittings and Solvent Cement

NSF/ANSI 14, seal of approval for potable water.

2.1.4.1 Pipe

ASTM D1785, PVC 1120 Schedule 40; or ASTM D2241, PVC 1120 SDR 21, Class 200.

2.1.4.2 Fittings

a. Solvent Welded Socket Type: ASTM D2466, Schedule 40.

b. Threaded Type: ASTM D2464, Schedule 80.

2.1.4.3 Solvent Cement

ASTM D2564.

2.1.5 Polyethylene (PE) Plastic Piping

2.1.5.1 Pipe

AWWA C901, outside diameter (od) base with dimension ratio (DR) of 9.3 to provide 150 psi minimum pressure rating.

2.1.5.2 Fittings

ASTM D3261, DR of 9.3.

2.1.6 Pipe Sleeving

a. Provide Schedule 40 piping two times the diameter of main or lateral piping.

b. Provide grey PVC electrical conduit sized according to number of control wires. Minimum 2 inch size.

2.2 IRRIGATION AND DRIP SPRINKLER HEADS

2.2.1 Fixed Riser Irrigation Heads

2.2.1.1 Spray Irrigation Heads, Full or Part Circle

Sprinkler body, nozzle, and screen constructed of heavy-duty, ultra-violet resistant plastic. Matched precipitation rate plastic nozzle with an adjustable screw capable of regulating the radius and the flow. Capable of housing under the nozzle; protective, non-clogging filter screen and/or pressure compensating devices. Screen used in conjunction with the adjusting screw from regulating. Provide check valve below each sprinkler body on riser.

2.2.1.2 Pressure Compensating Flood Bubbler Head

Plastic inlet filter screen bubbler assembly to protect the nozzle against clogging. Permanently assembled design constructed of durable, ultra-violet resistant plastic with a integral rubber flow washer for regulating the discharge rate at an operating pressure range of 20 to 90 psi.

2.2.2 Pop-Up Irrigation Head

2.2.2.1 Spray Irrigation Head, Full or Part Circle

Sprinkler body, nozzle, and screen constructed of heavy-duty, ultra-violet resistant plastic with wiper seal. Plastic nozzle with matched precipitation rate and an adjustable screw capable of regulating the radius and flow. Capable of housing under the nozzle; protective, non-clogging filter screen and/or pressure compensating devices. Screen used in conjunction with the adjusting screw from regulating. Pop-up height as specified on drawings. Provide check valve below each sprinkler body on riser.

2.2.3 Bubbler Irrigation Head

2.2.3.1 Pressure Compensating Flood Bubbler

Plastic inlet filter screen bubbler assembly to protect the nozzle against clogging. Permanently assembled design constructed of durable, ultra-violet resistant plastic with an integral rubber flow washer for regulating the discharge rate at an operating pressure range of 20 to 90 psi.

2.3 VALVES

2.3.1 Isolation Valve

2.3.1.1 Ball Valves

API Std 598, plastic body, threaded ends.

2.3.1.2 Gate Valves

AWWA C500, bottom wedging double discs, parallel seats, non-rising stems, open by counterclockwise turning. Provide flanged end connections. Provide bronze interior construction of valves including stem containing a maximum 2 percent aluminum and maximum 16 percent zinc.

2.3.2 Control Valves

2.3.2.1 Pressure Regulating Master Control Valve

Automatic mechanical self-cleaning, self-purging control system having an adjustable pressure setting operated by a solenoid on alternating current per manufacturer's recommendations. Valve shall close slowly and be free of chatter in each diaphragm position. Provide a manual flow stem to adjust closing speed and internal flushing. Provide an adjusting screw for setting pressure and schrader valve for monitoring pressure. Provide inlet tappings capable of being installed as a straight pattern valve. Provide heavy duty valve body with brass seat that is removable and serviceable from top without removing valve body from system. Maximum working pressure of valve is 150 psi and pilot range from 10 to 125 psi.

2.3.2.2 Remote Control Valve, Electrical

Solenoid actuated globe valves. Size per drawings. Provide plastic valve housing suitable for service at 150 psi operating pressure. Provide pressure regulating module capable of regulating outlet pressure between 15 to 25 psi (plus or minus) 5 psi and adjustable screw for setting pressure schrader valve connection for monitoring pressure.

2.3.3 Quick Coupling Valves

Two piece unit consisting of a coupler water seal valve assembly and a removable upper body to allow spring and key track to be serviced without shutout of main. Provide brass parts. Provide lockable lids with springs for positive closure on key removal.

2.4 ACCESSORIES AND APPURTENANCES

2.4.1 Water Meter

Meter to include roll sealed register, magnetic drive, straight reading (odometer shall indicate in gallons, large numerals, glass lens for legibility,) low flow indicator to detect leaks, tamper proof seal pin to detect theft; sturdy durable, corrosion resistant main case, electrical grounding continuity; nutating disc measuring chamber with minimum head loss.

2.4.2 Drip Head Accessories

2.4.2.1 Valve Boxes

Plastic valve box for each isolation valve, control valve, quick coupling valve. Provide box sizes that are suitable and adjustable for valve used.

a. Cast the word "IRRIGATION" on cover.

b. Stencil, engrave, or brand controller and valve sequence on remote control valve cover. Letters minimum 4 inches height.

2.4.3 Backflow Preventer Accessories

2.4.3.1 Pressure Gages

ASME B40.100, single style pressure gage for water with 4 1/2 inch dial, brass or aluminum case, bronze tube, gage cock, pressure snubber, and siphon. Provide scale range suitable for irrigation systems.

2.4.3.2 Water Hammer Arresters

ASSE 1010; stainless steel construction with an encased and sealed bellows compression chamber.

2.4.3.3 Backflow Preventer Enclosure

Frame to be constructed of 3/16 inch stainless steel angle iron with 1 1/2 inch No. 9 expanded metal covering. Construct in a one piece single swing hinge configuration. Provisions for pad locking and lighting handles. Size to fit backflow assembly to installed. Color to be black. Lock for enclosure provided by others.

2.4.4 Moisture Sensing Device

2.4.4.1 Automatic Rain Shut-Off Device

One piece, maintenance and adjustment free, reacts to a minimum 1/8 inch of rain water, unaffected by humidity levels, commercial grade materials, no exposed mechanical switch or electrodes, solid state construction with internal relay operating voltage of, static charge pretested, maximum switch current of.

2.4.5 Water Booster Package

2.4.5.1 Soil Moisture Sensor

2.4.5.2 Piping and Fittings

Piping and fittings to be flanged spools of Schedule 40 steel and Class 150 weld flanges, hot dipped galvanized after fabrication. Spacer spools to be welded and galvanized. Companion flanges at suction and discharge header connections to be Schedule 40 steel and galvanized.

2.4.5.3 Gages

Gages shall be 2 1/2 inch diameter, liquid filled for vibration dampering, 0-200 pounds, stainless steel casing, with brass needle valve shut-off cocks.

2.4.5.4 Check Valves

A combination pressure reducing and non-slam check valve to be installed with booster pump package to reduce effect of varying suction pressure.

2.5 Automatic Controller Electrical

Controller operating with indicated station, and grounded chassis. Provide enclosure NEMA ICS 6 Type 3R, with locking hinge cover, wall mounted.

2.5.1 Controller Features

a. 8-station controller with flow sensing and water management capacilities.

2.6 ELECTRICAL CIRCUITS

2.6.1 Control Wiring for Electrically Operated Valves

NFPA 70, copper conductor 14 gage wire, Type UF.

2.6.2 Conduit

UL 651, rigid polyvinyl chloride conduit, Schedule 40.

PART 3 EXECUTION

3.1 INSTALLATION

Install sprinkler system after site grading has been completed.

3.1.1 Trenching

Hand trench around roots to pipe grade when roots of 2 inches diameter or greater are encountered. Make width of trench 4 inches minimum or 1 1/2 times diameter of pipe, whichever is wider. Backfill and hand tamp over excavation. When rock is encountered, excavate 4 inches deeper and backfill with silty sand (SM) or well-graded sand (SW) to pipe grade. Keep trenches free of obstructions and debris that would damage pipe. Do not mix subsoil with topsoil. Bore under existing concrete walks, drives and other obstacles at a depth conforming to bottom of adjacent trenches. Install pipe sleeve, two pipe diameters larger than sprinkler pipe, to fill bore. Prior to backfilling of trench, Contracting Officer shall verify and approve location of all irrigation heads.

3.1.2 Piping System

3.1.2.1 Clearances

a. Minimum horizontal clearances between lines: 4 inches for 2 inch pipe and less; 12 inches for 2 inch pipe and more.

b. Minimum vertical clearances between lines: One inch.

3.1.2.2 Minimum Pitch

Down 6 inches per 100 feet in direction of drain valves.

3.1.2.3 Thrust Blocks

Install thrust blocks at bends, tees, plugs and valves or 2 1/2 inches and larger mainline piping. Place concrete so that sides subject to thrust or load are against undisturbed earth, and valves and fittings are serviceable after concrete has set.

3.1.2.4 Minimum Backfill Cover

a. 1 inches for pressure mainline pipe and valve control wire.

b. 12 inches for non-pressure lateral pipe.

c. 24 inches for all piping under paved or non-paved pedestrian paths.

d. 36 inches for all piping under traffic loads, freezing temperatures.

e. Install pipe sleeves at depths indicated in "c" and "d".

3.1.2.5 Restoration

Fill top 3 inches with topsoil and compact with same density as surrounding soil. Restore turf and plants according to Section 32 92 23 SODDING, and Section 32 93 00 EXTERIOR PLANTS.

3.1.2.6 Sterilization

Sprinkler system fed from a potable water system sterilized upstream of backflow preventer in accordance with AWWA C651. Sterilize new water lines for a minimum of 24 hours to meet local, state, and federal health test requirements before placing in service. Minimum retention period shall be 3 hours.

3.1.3 Piping Installation

3.1.3.1 Polyvinyl Chloride (PVC) Pipe

a. Solvent-Cemented Joints: ASTM D2855.

b. Threaded Joints: full cut with a maximum of three threads remain exposed on pipe and nipples. Make threaded joints tight without recourse to wicks or fillers, other than polytetrafluoroethylene thread tape.

c. Piping: ASTM D2774 or ASTM D2855, and pipe manufacturer's instructions. Install pipe in a serpentine (snaked) manner to allow for expansion and contraction in trench before backfilling. Install pipes at temperatures over 40 degrees F.

3.1.4 Irrigation Heads

Install plumb and level with terrain.

3.1.4.1 Fixed Riser Irrigation Heads

Nozzle mounted on fixed riser minimum 6 inches above grade in mulched planter beds, 12 inches above grade in planter beds with groundcover. Provide swing joint assembly attachment between lateral lines and fixed

risers.

3.1.4.2 Pop-Up Irrigation Head

Install plumb and level with terrain. Provide swing joint assembly attachment between lateral line and pop-up body. Top of irrigation head shall be flush wit surrounding finish grade.

3.1.5 Valves

3.1.5.1 Isolation Valves

Install in a valve box extending from grade to below valve body, with a minimum of 4 inches cover measured from finish grade to top of valve stem.

3.1.5.2 Control Valves

Plumb valve in a valve box extending from grade to below valve body, with minimum of 4 inch cover measured from grade to top of valve. Install automatic valves beside sprinkler heads with a valve box.

3.1.5.3 Quick Coupling Valves

Install in a valve box extending from grade to below valve body, with a minimum of 4 inches cover measured from finish grade to top of valve stem.

3.1.6 Backflow Preventers

a. Install backflow preventer in new connection to existing water distribution system, between connection and control valves. Install with concrete pads.

b. Flush pipe lines prior to installing device.

c. Device shall not be installed in pits or where any part of the device could become submerged in standing water

d. Install device a minimum of 12 inches from trees, walls, fences, structures and other obstructions.

3.1.7 Accessories

3.1.7.1 Connection To Existing Water Supply Systems (Tapping Tee)

Use tapping or drilling machine valve and mechanical joint type sleeves for connections to be made under pressure. Bolt sleeves around mains; bolt valve conforming to AWWA C500 to the branch. Open valve, attach drilling machine, make tap, close valve, and remove drilling machine, without interruption of service. Notify Contracting Officer in writing at least 15 days prior to the date the connections are required; receive approval before any service is interrupted. Provide materials required to make connections into the existing water supply systems and perform excavating, backfilling, and other incidental labor as required. Furnish the labor and the tapping or drilling machine for making the actual connections to the existing systems.

3.1.7.2 Water Meter

Install meter upstream of backflow preventer per manufacturer's recommendations and local PWC Utility Department Instructions.

3.1.7.3 Valve Boxes and Lids

a. Install with one cu ft pea gravel sump below valve.

b. Support valve box with brick .

c. For turf areas, install flush with finish grade.

d. For planter beds, install 2 inches above finish grade.

e. For sloped conditions, install valve box level with terrain.

3.1.7.4 Backflow Preventer Enclosure

a. Install with concrete pad.

b. Place hinges so direction of swing will not conflict with other site features.

3.1.7.5 Rain Shut-Off Device

a. Install as per manufacturer's recommendations.

b. For wall mounted controllers, attach device to side of building or eave, minimum 8 feet above finish grade and a minimum of 12 inches from building wall or eave.

3.1.8 Electrical Circuits

Bury wires beside mainline pipe in same trench. Provide grey electrical conduit where wires run under paved or non-paved pedestrian paths and vehicular roads. Tag wires at controller and control valve location with plastic tie wrapped tags. Provide one control wire to each control valve location and one common wire looped from controller to each control valve. provide one separate control valve wire of a different color from controller to each control valve cluster.

3.1.8.1 Loops

Provide a 12 inch loop of wire at each valve where controls are connected.

3.1.8.2 Expansion and Contraction

Bundle multiple tubes or wires and tape together at 20 foot intervals with 12 inch loop for expansion and contraction.

3.1.8.3 Splices

Make electrical splices waterproof. Locate all field electrical splices in valve boxes.

3.1.9 Automatic Controller

Determine exact location of controllers in field before installation.

Coordinate the electrical service to these locations. Install in accordance with manufacturer's recommendations and NFPA 70.

3.1.10 Flushing

After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads and valves, flush piping system under a full head of water. Maintain flushing for 3 minutes.

3.1.11 Adjustment

After grading, plant installation, and rolling of planted areas, adjust sprinkler heads flush with finished grade. Make adjustments by providing new nipples of proper length or by use of heads having an approved device, integral with head, which will permit adjustment in height of head without changing piping.

3.1.12 Sterilization

Sprinkler system fed from a potable water system shall be sterilized upstream of backflow preventer in accordance with AWWA C651. Sterilize new waterlines for a minimum of 24-hours, to meet local, state, federal, health test requirements before placing in service. Minimum retention period shall be 3 hours.

3.2 FIELD QUALITY CONTROL

The Contractor will conduct and the Contracting Officer and the QC representative will witness field inspections and field tests specified in this section. Perform field tests, and provide labor, equipment, and incidentals required for testing.

3.2.1 Pressure Test

3.2.1.1 Duration

During pressure test, maintain a hydrostatic pressure of 150 psi without pumping for a period of one hour with an allowable pressure drop of 5 psi before backfilling system.

3.2.1.2 Leaks

Correct leaks. Make necessary corrections to stop leakage.

3.2.1.3 Retest

Retest system twice until pressure can be maintained for duration of test.

3.2.2 Operation Test

3.2.2.1 Accessories

At conclusion of pressure test, install irrigation heads and test entire system for operation under normal operating pressure. Make necessary corrections or adjustments to raise or lower pressure for each system if tests results do not match pressure requirements.

3.2.2.2 Acceptance

Operation test is acceptable if system operates through at least one complete cycle for areas to be irrigated.

3.2.3 Controller Charts

Provide one chart for each controller supplied. Indicate in chart area controlled by automatic controller. The chart is a reduction of the actual plan that will fit the maximum dimensions inside controller housing. Use black line print for chart and a different pastel or transparent color to indicate each station area of coverage. After chart is completed and approved for final acceptance, seal chart between two 20 mil pieces of clear plastic.

3.2.4 Demonstration

Train Owner's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

-- End of Section --

SECTION 32 92 19

SEEDING
10/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 4972	(2001; R 2007) pH of Soils

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R 1998) Federal Seed Act
DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.2 DEFINITIONS

1.2.1 Stand of Turf

95 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK and Section 32 92 23 SODDING.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil composition tests (reports and recommendations).

SD-07 Certificates

State certification and approval for seed

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 Fertilizer Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Seed, Fertilizer Storage

Store in cool, dry locations away from contaminants.

1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is frozen, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Classification

Provide State-certified seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Field mixes will be acceptable when field mix is performed on site in the presence of the Contracting Officer.

2.1.2 Seed Purity

Common Name	Min. Percent Pure Seed	Min. Percent Germination and Hard Seed	Max. Percent Weed Seed
Bahia	95	80	5

2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor.

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH shall be tested in accordance with ASTM D 4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

Silt	25-50 percent
Clay	10-30 percent
Sand	20-35 percent
pH	5.5 to 7.0
Soluble Salts	600 ppm maximum

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Sand

Clean and free of materials harmful to plants.

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Fertilizer shall be Commercial Grade 16-4-8 mixed fertilizer.

2.5 MULCH

Mulch shall be free from noxious weeds, mold, and other deleterious materials.

2.5.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw shall contrain no fertile seed.

2.5.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay shall be sterile, containing no fertile seed.

2.6 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation, containing no elements toxic to plant life.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.1.1 Topsoil

Provide 4 inches of off-site topsoil,on-site topsoil and/or existing soil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.1.2 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site.

3.2 SEEDING

3.2.1 Seed Application

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy frozen or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Mulching

3.2.2.1 Hay or Straw Mulch

Hay or straw mulch shall be spread uniformly at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

3.2.3 Rolling

Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width.

3.2.4 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.4 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

SECTION 32 92 23

SODDING
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 92	(2005) Wire-Cloth Sieves for Testing Purposes

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI GSS	(1995) Guideline Specifications to Turfgrass Sodding

1.2 DEFINITIONS

1.2.1 Stand of Turf

100 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK and Section 32 92 19 SEEDING.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fertilizer

Include physical characteristics, and recommendations.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Sod Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 Sod Delivery

Dumping from vehicles will not be permitted. If stacked during transit or storage, the sod shall be placed roots to roots or grass to grass. During delivery and while in stacks, sod shall be kept moist and cool, and protected from sun, air, and freezing.

1.5.2 Storage

1.5.2.1 Sod Storage

Lightly sprinkle with water, cover with moist burlap, straw, or other approved covering; and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that internal heat will not develop. Do not store sod longer than 24 hours. Do not store directly on concrete or bituminous surfaces.

1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Sod

Place sod a maximum of thirty six hours after initial harvesting, in accordance with TPI GSS as modified herein.

PART 2 PRODUCTS

2.1 SODS

2.1.1 Classification

Argentine Bahia sod shall be well matted with live grass roots. Sod shall be sufficiently thick to hold together during handling operations and to obtain a satisfactory growth of grass. Sod shall be live, fresh, and uninjured at the time of planting and it shall be the Contractor's responsibility to ensure that it contains sufficient moisture at planting to produce growth. Before the sod is harvested, the grass shall be mowed to the average height normally maintained for that variety of grass and shall have all clippings removed. Presence of weeds or other material which might be detrimental to the proposed planting will be cause for rejection of sod.

Rectangular sections used for sodding may vary in length but shall be of

equal width and of a size that will permit lifting on boards or that can be otherwise handled without breaking and without loss of native soil attached to the roots.

2.1.2 Purity

Sod species shall be genetically pure, free of weeds, pests, and disease.

2.2 TOPSOIL

2.2.1 Topsoil

Topsoil previously removed and stockpiled shall be used in the work. Topsoil shall be free from subsoil, litter, and other objectionable material.

Topsoil shall be fertile, friable, natural surface soil obtained from well-drained areas and possessing characteristics of representative soils in the project vicinity that produce heavy growths of crops, grass, or other vegetation. Topsoil shall be free of material that might be harmful to plant growth or hindrances to planting or maintenance operations.

Chemical and physical properties of topsoil proposed for use in the work shall be as follows:

Organic matter shall be at least 6 percent as determined by loss on ignition of moisture-free samples of topsoil.

The pH range shall be from 5.0 to 7.0.

The physical analysis of the topsoil shall be within the following limits: (AASHTO M 92)

SIEVE SIZE	PERCENT PASSING
1 inch	99 to 100
1/4 inch	97 to 99
No. 100	40 to 60
No. 200	20 to 40

2.2.2 Topsoil Blend

Where insufficient topsoil is removed from the project site, the topsoil removed shall be stockpiled and blended with compost at the site to achieve the required volume.

2.3 FERTILIZER

2.3.1 Granular Fertilizer

Fertilizer shall be commercial Grade 16-4-8 mixed fertilizer.

16 percent available nitrogen
4 percent available phosphorus
8 percent available potassium

2.4 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation containing no element toxic to plant life.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation fertilizing, and sodding of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.2 Placing Topsoil

Suitable topsoil shall be placed in the top 6 inches of all grassed areas stripped under this project. All areas to receive topsoil, including cut and fill areas, shall be shaped to provide a minimum of 6 inches topsoil. Prior to placement of the topsoil, the subgrade shall be scarified to a depth of 2 inches. Topsoil shall be uniformly distributed and evenly spread to an average thickness of 6 inches. Spreading shall be performed in such a manner that planting can proceed with little additional soil preparation or tillage, and the area shall be left smooth and suitable for lawns. Irregularities in the surface from topsoiling or other operations shall be corrected so as to prevent the formation of depressions where water will stand. Topsoil shall not be hauled and placed when wet or when the subgrade is excessively wet, extremely dry, or in a condition otherwise detrimental to the proposed planting or to proper grading. Topsoil shall be spread uniformly but shall not be compacted. Where any portion of the surface becomes gullied or otherwise damaged, the affected area shall be repaired to establish the condition and grade prior to topsoiling, and then shall be re-topsoiled.

3.1.2.1 Fertilizer Application Rates

Fertilizer shall be uniformly distributed over the topsoil surface. For bidding purposes only apply at rates for the following:

Organic Granular Fertilizer 86.5 pounds per acre .002 pounds per 1000 square feet.

3.2 SODDING

3.2.1 General

After the sod has been harvested, it shall be delivered to the site and laid in place within 48 hours. Any sod that has been damaged by handling or storage, turned yellow or shows definite indications of dying, will be rejected.

3.2.2 Solid Sodding

Sod shall be laid smoothly, edge to edge, and with staggered joints. Sod shall immediately be pressed firmly into contact with the sod bed by tamping or rolling with approved equipment, to eliminate all air pockets, provide a true and even surface, and ensure knitting without displacement

of the sod or deformation of the surfaces of sodded areas. Any excess soil accumulated from handling of the sod shall be used to fill voids or cracks between the sections of sod.

3.3 GRASS ESTABLISHMENT

3.3.1 General

The period of grass establishment shall begin immediately after the completion of sodding in an area and shall continue for a period of 2-months after the completion of sodding on the entire project unless the desired grass cover is established in a shorter period of time and shortening of the grass-establishment period is authorized.

3.3.2 Watering

Contractor shall provide and maintain temporary piping and lawn-watering equipment required to convey water from the water source to uniformly water the grassed areas. Water shall be free from substances detrimental to the growth of vegetation. Water sources located on Government property will be subject to approval prior to use. Temporary watering equipment shall be removed after grass area acceptance.

Watering schedules shall be arranged and lawn-watering equipment laid out in a manner to avoid the necessity of walking over muddy and newly grassed areas.

After the initial watering, the grassed areas shall be watered as required to maintain the soil in a moist condition for the entire grass-establishment period.

3.3.3 Mowing

When the average height of grass reaches 2-1/4 inches, seeded lawn areas shall be mowed with approved mowing equipment to a grass height of 1-1/2 inches. When the amount of cut grass is heavy, the cuttings shall be removed to prevent smothering the grass.

3.3.4 Weeding

Weeds or other undesirable vegetation that threaten to smother the grass shall be uprooted and removed from the area.

3.3.5 Resodding

The area on which an acceptable stand of grass is not present shall be sodded as specified for the original planting. An acceptable stand is living grass from at least 90 percent of the sod placed according to this specification. Areas on which there is not an acceptable stand of grass shall continue to be replanted throughout the following year until an acceptable stand of grass is present.

3.4 SAMPLING AND TESTING

Sampling and testing of grass seed and topsoil shall be by an approved testing service and show compliance with all specified requirements.

3.5 ACCEPTANCE PROVISIONS

3.5.1 Acceptance Requirements

Completed grass areas shall have been recently mowed and be covered with a uniform stand of the specified grass, be free of rank growths of weeds or other undesirable vegetation, and be free of irregular surface changes and other depressions where water will accumulate.

Scattered bare spots not larger than 6 inches in any dimension will be allowed, up to a maximum of 3 percent of any grass area.

Condition of grass areas at the time of inspection will be noted and a determination, made whether the grass-establishment period shall be extended for any area.

3.5.2 Repairs

If, before completion and final acceptance of the facility, portions of the surface become gullied or otherwise damaged the grass areas have been destroyed, the affected area shall be repaired to re-establish the condition and grade of the soil prior to sodding and then re-sodded, and the grass established as specified.

3.6 PROTECTION

Grassed areas shall be protected against traffic or other use by erecting barricades around each area immediately after sodding is completed and by placing warning signs of an approved type on each grassed area.

3.7 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.8 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

SECTION 32 93 00

EXTERIOR PLANTS
02/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NURSERY & LANDSCAPE ASSOCIATION (ANLA)

ANSI/ANLA Z60.1	(2004) American Standard for Nursery Stock

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2013a) Standard Specification for Stainless Steel Wire
ASTM D4972	(2001; R 2007) pH of Soils
ASTM D5268	(2007) Topsoil Used for Landscaping Purposes

L.H. BAILEY HORTORIUM (LHBH)

LHBH	(1976) Hortus Third

TREE CARE INDUSTRY ASSOCIATION (TCIA)

TCIA A300P1	(2008) ANSI A300 Part1: Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance Standard Practices - Pruning
TCIA Z133.1	(2006) American National Standard for Arboricultural Operations - Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush - Safety Requirements

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 RELATED REQUIREMENTS

Section 32 84 24 IRRIGATION SPRINKLER SYSTEMS, Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS, Section 32 92 23 SODDING, applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

State Landscape Contractor's License

Time Restrictions and Planting Conditions

Indicate anticipated dates and locations for each type of planting.

SD-03 Product Data

Local/Regional Materials; (LEED NC)

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

Peat
Organic Mulch Materials

Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.

Gypsum; (LEED NC)
Mulch
Ground Stakes
Hose; (LEED NC)

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

Fertilizer

Weed control fabric

Staking Material
Ground Stakes

Submit documentation certifying products are from salvaged/recovered lumber sources and indicating percentage of salvaged/recovered content per unit of product.

Metal anchors

Antidesiccants

Photographs

SD-04 Samples

Mulch

Submit one pint of mulch.

SD-06 Test Reports

Topsoil composition tests; Soil Test of proposed area;

Percolation Test; Percolation Test of proposed area

SD-07 Certificates

Forest Stewardship Council (FSC) Certification; (LEED NC)

Nursery certifications

Indicate names of plants in accordance with the LHBH, including type, quality, and size.

1.4 QUALITY ASSURANCE

1.4.1 Topsoil Composition Tests

Commercial test from an independent testing laboratory including basic soil groups (moisture and saturation percentages, Nitrogen-Phosphorus-Potassium (N-P-K) ratio, pH (ASTM D4972), soil salinity), secondary nutrient groups (calcium, magnesium, sodium, Sodium Absorption Ratio (SAR)), micronutrients (zinc, manganese, iron, copper), toxic soil elements (boron, chloride, sulfate), cation exchange and base saturation percentages, and soil amendment and fertilizer recommendations with quantities for plant material being transplanted. Soil required for each test shall include a maximum depth of 18 inches of approximately 1 quart volume for each test. Areas sampled should not be larger than 1 acre and should contain at least 6-8 cores for each sample area and be thoroughly mixed. Problem areas should be sampled separately and compared with samples taken from adjacent non-problem areas. The location of the sample areas should be noted and marked on a parcel or planting map for future reference.

1.4.2 Nursery Certifications

a. Indicate on nursery letterhead the name of plants in accordance with the LHBH, including botanical common names, quality, and size.

b. Inspection certificate.

1.4.2.1 Other Certifications

Forest Stewardship Council (FSC) Certification

1.4.3 State Landscape Contractor's License

Construction company shall hold a landscape contractors license in the state where the work is performed and have a minimum of five years landscape construction experience. Submit copy of license and three references for similar work completed in the last five years. Pesticide Applicator is required to be State licensed, commercial.

1.4.4 Plant Material Photographs

Contractor shall submit nursery photographs, for government approval prior to ordering, for each tree larger than 24-inch box/ 2-inch caliper size.

1.4.5 Percolation Test

Immediately following rough grading operation, identify a typical location for one of the largest trees and or shrubs and excavate a pit per the project details. Fill the pit with water to a depth of 12 inches. The length of time required for the water to percolate into the soil, leaving the pit empty, shall be measured by the project Landscape Architect and verified by the Contracting Officer. Within six hours of the time the water has drained from the pit, the Contractor, with the Contracting Officer and project Landscape Architect present, shall again fill the pit with water to a depth of 12 inches. If the water does not completely percolate into the soil within 9 hours, a determination shall be made whether a drainage system or a soil penetrant will be required for each tree and or shrub being transplanted.

1.4.6 Soil-Testing Laboratory Qualifications

An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Branched Plant Delivery

Do not prune trees and shrubs before delivery. Deliver with branches tied and exposed branches covered with material which allows air circulation. Prevent damage to branches, trunks, root systems, and root balls and desiccation of leaves. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape.

1.5.1.2 Soil Amendment Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer, gypsum, sulfur, iron, and lime may be furnished in bulk with a certificate indicating the above information. Store in dry locations away from contaminates. Accompany each delivery of bulk

fertilizers and soil amendments with appropriate certificates.

1.5.1.3 Plant Labels

Deliver plants with durable waterproof labels in weather-resistant ink. Provide labels stating the correct botanical and common plant name and variety as applicable and size as specified in the list of required plants. Attach to plants, bundles, and containers of plants. Groups of plants may be labeled by tagging one plant. Labels shall be legible for a minimum of 60 days after delivery to the planting site.

1.5.2 Storage

1.5.2.1 Plant Storage and Protection

Store and protect plants not planted on the day of arrival at the site as follows:

a. Shade and protect plants in outside storage areas from the wind and direct sunlight until planted.

b. Protect balled and burlapped plants from freezing or drying out by covering the balls or roots with moist burlap, sawdust, wood chips, shredded bark, peat moss, or other approved material. Provide covering which allows air circulation.

c, Keep plants in a moist condition until planted by watering with a fine mist spray.

d. Do not store plant material directly on concrete or bituminous surfaces, structures, utilities, or on existing turf areas or plants..

e. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

1.5.2.2 Fertilizer, Gypsum, pH Adjusters and Mulch Storage

Store in dry locations away from contaminants.. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.5.3 Handling

Do not drop or dump plants from vehicles. Avoid damaging plants being moved from nursery or storage area to planting site. Handle balled and burlapped container plants carefully to avoid damaging or breaking the earth ball or root structure. Do not handle plants by the trunk or stem. Remove damaged plants from the site.

1.5.4 Time Limitation

Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

Heel-in bare-root stock. Soak roots that are in dry condition in

water for two hours. Reject dried-out plants.

Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.

Do not remove container-grown stock from containers before time of planting.

Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

The time limitation between installing the plant material and placing the mulch shall be a maximum of 24 hours.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when ground is muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.6.2 Field Measurements

Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

1.6.3 Interruption of Existing Services or Utilities

Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

Notify Architect no fewer than two days in advance of proposed interruption of each service or utility.

Do not proceed with interruption of services or utilities without Architect's written permission.

1.6.4 Weather Limitations

Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.6.5 Coordination with Turf Areas (Lawns):

Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.7 GUARANTEE

All plants shall be guaranteed for one year beginning on the date of inspection by the Contracting Officer to commence the plant establishment period, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by the Government or by weather conditions unusual for the warranty period.

Remove and replace dead planting materials immediately unless required to plant in the succeeding planting season. At end of warranty period, replace planting materials that die or have 25 percent or more of their branches that die during the construction operations or the guarantee period.

1.8 SUSTAINABLE DESIGN REQUIREMENTS

1.8.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Landscaping materials may be locally available.

PART 2 PRODUCTS

2.1 PLANTS

2.1.1 Regulations and Varieties

Furnish nursery stock in accordance with ANSI/ANLA Z60.1, except as otherwise specified or indicated. Each plant or group of planting shall have a "key" number indicated on the nursery certifications of the plant schedule. Shall be in compliance with Florida Grade #1 as outlined in the Florida Grades & Standards for Nursery Plants. Furnish plants, including turf grass, grown under climatic conditions similar to those in the locality of the project. Spray plants budding into leaf or having soft growth with an antidesiccant before digging. Plants of the same specified size shall be of uniform size and character of growth. All plants shall comply with all Federal and State Laws requiring inspection for plant diseases and infestation.

2.1.2 Shape and Condition

Well-branched, well-formed, sound, vigorous, healthy planting stock free from disease, sunscald, windburn, abrasion, and harmful insects or insect eggs and having a healthy, normal, and undamaged root system.

Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.

Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated

2.1.2.1 Evergreen Trees

Well developed symmetrical tops with typical spread of branches for each particular species or variety.

2.1.2.2 Ground Covers

Number and length of runners and clump sizes indicated, and of the proper age for the grade of plants indicated, furnished in removable containers, integral containers, or formed homogeneous soil section.

2.1.3 Plant Size

Minimum sizes measured after pruning and with branches in normal position, shall conform to measurements indicated, based on the average width or height of the plant for the species as specified in ANSI/ANLA Z60.1. Plants larger in size than specified may be provided with approval of the owner's representative. When larger plants are provided, increase the ball of earth or spread of roots in accordance with ANSI/ANLA Z60.1.

2.1.4 Root Ball Size

All box-grown, field potted, field boxed, collected, plantation grown, bare root, balled and burlapped, container grown, processed-balled, and in-ground fabric bag-grown root balls shall conform to ANSI/ANLA Z60.1. All wrappings and ties shall be biodegradable. Root growth in container grown plants shall be sufficient to hold earth intact when removed from containers. Root bound plants will not be accepted. Furnish trees with root balls measured from top of root ball, which shall begin at root flare. Root flare shall be visible before planting.

2.1.5 Growth of Trunk and Crown

2.1.5.1 Palms

Palms shall have the specified height as measured from the base of the trunk to the base of the fronds or foliage in accordance with ANSI/ANLA Z60.1. The palm shall have straight trunk and healthy fronds or foliage as typical for the variety grown in the region of the project. Palms trimmed or pruned for delivery shall retain a minimum of 6 inches of foliage at the crown as a means of determining plant health.

2.1.5.2 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material shall have the height-to-spread ratio recommended by ANSI/ANLA Z60.1. Acceptable plant material shall be well shaped and recognized by the trade as typical for the variety grown in the region of the project.

2.1.5.3 Ground Cover Plant Material

Ground cover and plant material shall have the minimum number of runners and length of runner recommended by ANSI/ANLA Z60.1. Plant material shall have heavy, well developed and balanced crown with vigorous, well developed root system and shall be furnished in containers.

2.2 TOPSOIL

2.2.1 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor.

2.2.2 Composition

Evaluate soil for use as topsoil in accordance with ASTM D5268. From 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, plants, and other debris and objectionable materials. Other components shall conform to the limits as stated in the drawings.

2.3 PLANTING SOIL MIXTURES

100 percent topsoil as specified herein.

1/3 parts topsoil, 1/3 parts sand, and 1/3 parts peat. Thoroughly mix all parts of planting soil mixture to a uniform blend throughout.

2.4 FERTILIZER

2.4.1 Fertilizer Tablets

Agriform 20-10-5 Tables, (1) per shrub/groundcover and (3) per tree or palm. Organic, plant tablets composed of tightly compressed fertilizer chips forming a tablet that is insoluble in water, is designed to provide a continuous release of nutrients for at least 24 months and contains the following minimum percentages, by weight, of plant food nutrients:

20 percent available nitrogen
10 percent available phosphorus
5 percent available potassium

2.5 MULCH

Free from noxious weeds, mold, pesticides, or other deleterious materials.

2.5.1 Organic Mulch Materials

Pine bark mulch.

2.6 STAKING AND GUYING MATERIAL

2.6.1 Staking Material

2.6.1.1 Tree Support Stakes

Rough sawn FSC-certified hard wood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Stakes shall be minimum 2 inches square or 2 1/2 inch diameter by 8 feet long, pointed at one end. Paint or stain wood stakes dark brown..

2.6.1.2 Palm Bracing

Battens or blocks, struts, straps, and protective padding as indicated.

Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-4-inch nominal by lengths indicated.

Straps: Adjustable steel or plastic package banding straps.

Padding: Burlap.

2.6.1.3 Ground Stakes

FSC-certified or 100 percent post-consumer recycled content plastic, 2 inches square are by 3 feet long, pointed at one end.

2.6.2 Guying Material

2.6.2.1 Guying Wire

12 gauge annealed galvanized steel, ASTM A580/A580M.

2.6.2.2 Guying Cable

Minimum five-strand, 3/16 inch diameter galvanized steel cable plastic coated.

2.6.3 Hose Chafing Guards

New or used 2 ply 3/4 inch diameter reinforced rubber or plastic hose, black or dark green, all of same color.

2.6.4 Flags

White surveyor's plastic tape, 12 inches long, fastened to guying wires or cables.

2.6.5 Turnbuckles

Galvanized or cadmium-plated steel with minimum 3 inch long openings fitted with screw eyes. Eye bolts shall be galvanized or cadmium-plated steel with one inch diameter eyes and screw length 1 1/2 inches, minimum.

2.6.6 Deadmen

4 by 8 inch rectangular or 8 inch diameter by36 inch long, pine or fir wood material.

2.6.7 Metal Anchors

2.6.7.1 Driven Anchors

Malleable iron, arrow shaped, galvanized, sized as follows:

Tree Caliper	Anchor Size
2 inches and under	3 inches
3 to 6 inches	4 inches
6 to 8 inches	6 inches
8 to 10 inches	8 inches
10 to 12 inches	10 inches

2.6.7.2 Screw Anchors

Steel, screw type with welded-on 3 inch round helical steel plate, minimum 3/8 inch diameter, 15 inches long.

2.7 ANTIDESICCANTS

Sprayable, water insoluble vinyl-vinledine complex which produce a moisture retarding barrier not removable by rain or snow. Film shall form at temperatures commonly encountered out of doors during planting season and have a moisture vapor transmission rate (MVT) of the resultant film of maximum 10 grams per 24 hours at 70 percent humidity. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

2.8 WATER

Source of water to be approved by Contracting Officer and suitable quality for irrigation and shall not contain elements toxic to plant life.

2.9 SOURCE QUALITY CONTROL

The Contracting Officer and Landscape Architect of Record will inspect plant materials at the project site and approve them. Tag plant materials for size and quality.

2.10 WOOD PRESSURE-PRESERVATIVE TREATMENT

AWPA C2, with waterborne preservative for soil and freshwater use, acceptable to authorities having jurisdiction, and containing no arsenic; including ammoniacal copper arsenate, ammoniacal copper zinc arsenate, and chromated copper arsenate.

PART 3 EXECUTION

3.1 EXTENT OF WORK

Provide soil preparation, fertilizing, tree, palm,groundcover, and planting, edging, staking and guying, installation and a mulch topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.2 PREPARATION

3.2.1 Examination

Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

Uniformly moisten excessively dry soil that is not workable and which is too dusty.

Proceed with installation only after unsatisfactory conditions have been corrected.

If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2.2 Layout

Stake out approved plant material locations and planter bed outlines on the project site before digging plant pits or beds. The Contracting Officer reserves the right to adjust plant material locations to meet field conditions.

3.2.3 Soil Preparation

3.2.3.1 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site.

3.2.4 Subsoil Drainage for Plant Pits and Beds

Provide as indicated.

3.3 PLANT BED PREPARATION

Verify location of underground utilities prior to excavation. Protect existing adjacent turf before excavations are made. Where planting beds occur in existing turf areas, remove turf to a depth that will ensure removal of entire root system. Measure depth of plant pits from finished grade. Depth of plant pit excavation shall be as indicated and provide proper relation between top of root ball and finished grade. Install plant material as specified in paragraph entitled "Plant Installation." Do not install trees within 10 feet of any utility lines or building walls.

Loosen subgrade of planting areas to a minimum depth of 12 inches as outlined in landscape details. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

Apply superphosphate fertilizer directly to subgrade before loosening.

Spread planting soil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

Delay mixing fertilizer with planting soil if planting will not proceed within a few days.

Mix lime with dry soil before mixing fertilizer.

Spread prepared planting soil to a depth of 12 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PLANT INSTALLATION

3.4.1 Individual Plant Pit Excavation

Excavate pits at least twice as large in diameter as the size of ball or container to depth shown.

Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

Excavate at least 24 inches wider than root spread and 12" deeper than depth of rootball for all trees.

Fill in under tree rootballs with 6" of clean soil and 6" of prepared planting soil directly under rootball.

For shrubs and groudcovers, excavate 12" wider than root spread and 12" deeper than depth of rootball. Fill in with 6" of clean soil and 6" of prepared planting soil directly under rootball.

Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving,

structures, hardscapes, or other new or existing improvements.

Maintain supervision of excavations during working hours.

Keep excavations covered or otherwise protected after working hours and when unattended by Installer's personnel.

Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

Verify percolation of all tree pits. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.4.2 Handling and Setting

Move plant materials only by supporting the container. Set plants on hand compacted layer of prepared backfill soil mixture and hold plumb in the center of the pit until soil has been tamped firmly around root ball. Replace plant material whose root balls are cracked or damaged either before or during the planting process.

Plant material shall be set in plant beds according to the drawings. Backfill soil mixture shall be placed on previously scarified subsoil to completely surround the root balls, and shall be brought to a smooth and even surface, blending to existing areas.

3.4.2.1 Tree, Palm, And Ground Cover Planting

Before planting, verify that root flare is visible at top of root ball. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

Set container-grown stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

Use planting soil for backfill.

Carefully remove root ball from container without damaging root ball or plant.

Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from

soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

Continue backfilling process. Water again after placing and tamping final layer of soil.

When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.4.2.2 Mechanized Tree Spade Planting

Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

Cut exposed roots cleanly during transplanting operations.

Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.

Plant trees as shown on Drawings, following procedures in "Tree, Shrub, and Vine Planting" Article.

Where possible, orient the tree in the same direction as in its original location.

3.4.2.3 Container Grown Stock

Remove from container and prevent damage to plant or root system.

3.4.2.4 Ground Covers

Smooth planting areas before planting to provide even, smooth finish. Plant after placing weed control fabric and mulch topdressing. Do not remove plant material from flats or containers until immediately before planting. Space at the intervals indicated. Plant at a depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of 6 inches without run off or puddling. Add mulch topdressing as needed.

3.4.3 Earth Mounded Watering Basin for Individual Plant Pits

Form with topsoil around each plant by replacing a mound of topsoil around the edge of each plant pit. Watering basins shall be 6 inches deep for trees and 4 inches deep for shrubs. Eliminate basins around plants in plant beds containing multiple plants.

3.4.4 Placement of Mulch Topdressing

Place mulch topdressing to a depth of 3 inches. Mulch backfilled surfaces

of planting areas and other areas indicated.

Trees and Palms in Turf Areas: Apply organic mulch ring of 2-inch average thickness (3-inch max.), with 24-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.

Organic Mulch in Planting Areas: Apply 2-inch average thickness (3-inch max.) of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades.

3.4.5 Mulch Topdressing

Provide mulch topdressing over entire planter bed surfaces and individual plant surfaces including earth mound watering basin around plants to a depth of 3 inches after completion of plant installation and before watering.

3.4.6 Fertilization

3.4.6.1 Fertilizer Tablets

Place fertilizer planting tablets evenly spaced around the plant pits to the manufacturer's recommended depth.

3.4.6.2 Granular Fertilizer

Apply granular fertilizer as a top coat prior to placing mulch layer and water thoroughly.

3.4.7 Watering

Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of 12 inches without run off.

3.4.8 Staking and Guying

3.4.8.1 Staking

Stake plants as indicated on drawings.

3.4.8.2 Guying

Guy plants as indicated on drawings.

3.4.8.3 Chafing Guards

Use hose chafing guards, as specified where guy wire will contact the plant.

3.4.8.4 Wood Ground Stakes

Drive wood ground stakes into firm ground outside of plant pit with top of stake flush with ground. Place equal distance from tree trunk and around the plant pit.

3.4.8.5 Iron Anchors

Drive malleable iron anchors into firm ground outside of plant pit a minimum 30 inches below finish grade. Place equal distance from tree trunk and around the plant pit.

3.4.8.6 Steel Screw Anchors

Insert steel screw anchors as recommended in manufacturer's data. Place equal distance from tree trunk and around the plant pit.

3.4.8.7 Flags

Securely fasten flags on each guy wire andcable approximately two-thirds of the distance up from ground level.

3.4.9 Pruning

Prune in accordance with safety requirement of TCIA Z133.1.

3.4.9.1 Trees and Palms

Remove dead and broken branches. Prune to correct structural defects only. Retain typical growth shape of individual plants with as much height and spread as practical. Do not cut central leader on trees. Make cuts with sharp instruments. Do not flush cut with trunk or adjacent branches. Collars shall remain in place. Pruning shall be accomplished by trained and experienced personnel and shall be accordance with TCIA A300P1.

3.4.9.2 Wound Dressing

Do not apply tree wound dressing to cuts.

3.5 RESTORATION AND CLEAN UP

3.5.1 Restoration

Turf areas, pavements and facilities that have been damaged from the planting operation shall be restored to original condition at the Contractor's expense.

3.5.2 Clean Up

Excess and waste material shall be removed from the installed area and shall be disposed offsite at an approved landfill, recycling center, or composting center.

-- End of Section --

SECTION 32 96 00

TRANSPLANTING EXTERIOR PLANTS
02/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NURSERY & LANDSCAPE ASSOCIATION (ANLA)

ANSI/ANLA Z60.1	(2004) American Standard for Nursery Stock

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2013a) Standard Specification for Stainless Steel Wire
ASTM D4972	(2001; R 2007) pH of Soils

TREE CARE INDUSTRY ASSOCIATION (TCIA)

TCIA A300P1	(2008) ANSI A300 Part1: Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance Standard Practices - Pruning
TCIA Z133.1	(2006) American National Standard for Arboricultural Operations - Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush - Safety Requirements

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 RELATED REQUIREMENTS

Section 32 84 24 IRRIGATION SPRINKLER SYSTEMS, Section 32 92 23 SODDING, and Section 32 93 00 EXTERIOR PLANTS applies to this section for requirements, with additions and modifications herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

State Landscape Contractor's License & Tree Relocation References

Permits

Photographs

SD-02 Shop Drawings

Transplanting Plan

SD-03 Product Data

Equipment

A listing of equipment to be used for the transplanting operation,including size model, year and type of mechanical tree transplanting equipment.

Mulches Topdressing; (LEED NC)
Ground Stakes
Hose; (LEED NC)

Documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

Local/Regional Materials; (LEED NC)

Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

Peat
Organic Mulch Materials

Documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.

Staking Material
Ground Stakes

Documentation certifying products are from salvaged/recovered lumber sources and indicating percentage of salvaged/recovered content per unit of product.

SD-06 Test Reports

Soil Test; Soil Test of proposed area; Soil Test location map

Percolation Test; Percolation Test of proposed area

1.4 QUALITY ASSURANCE

1.4.1 State Landscape Contractor's License & Tree Relocation References

Contractor shall be a professional tree moving company holding a landscape contractor's license in the state where the work is to be performed and have a minimum of 10 years tree relocation experience. Submit a copy of license and 3 references of tree relocation work in the past 5 years.

1.4.2 Permits

The Contractor shall obtain and pay for permits and fees for the alteration of overhead lines or any other related moving permit or fee that requires compliance with Federal, State and local regulatory requirements.

1.4.3 Photographs

The contractor shall provide a clear 4 inch by 6 inch minimum size color photograph of the plant material to be relocated. Trees shall be documented by an individual photograph of each. Photographs shall indicate the date and species of each plant on the back or front of each photo.

1.4.4 Transplanting Plan

A transplanting plan shall be submitted showing existing and proposed locations of transplanted material. The plan shall also delineate methods, dates, and times for root pruning, digging, balling, removing, storing, transporting, planting, watering, and maintenance to ensure survivability. The plan shall also include equipment and anti-desiccant to be used. A listing of the plant material to be transplanted shall be provided by common name and botanical name as listed under "Nomenclature" in ANSI/ANLA Z60.1; classification; caliper; and height.

1.4.5 Soil Test

Commercial test from an independent testing laboratory according to the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42 including basic soil groups (sand, silt, clay, pH (ASTM D4972), soluble salts), secondary nutrient groups (calcium, magnesium, sodium, Sodium Absorption Ratio (SAR)), micronutrients (zinc, manganese, iron, copper). Soil required for each test shall include a maximum depth of 18 inches of approximately 1 quart volume for each test. Areas sampled should not be larger than 1 acre and should contain at least 6-8 cores for each sample area and be thoroughly mixed. Problem areas should be sampled separately and compared with samples taken from adjacent non-problem areas. The location of the sample areas should be noted and marked on a parcel or planting map for future reference.

1.4.6 Percolation Test

Immediately following rough grading operation, identify a typical location for one of the largest trees and or shrubs and excavate a pit per the project details. Fill the pit with water to a depth of 12 inches. The

length of time required for the water to percolate into the soil, leaving the pit empty, shall be measured by the project Landscape Architect and verified by the Contracting Officer. Within six hours of the time the water has drained from the pit, the Contractor, with the Contracting Officer and project Landscape Architect present, shall again fill the pit with water to a depth of 12 inches. If the water does not completely percolate into the soil within 9 hours, a determination shall be made and submitted by the Contractor and verified and approved by the Contracting Officer, whether a drainage system or a soil penetrant will be required for each tree and or shrub being transplanted.

1.5 DELIVERY OF MATERIALS

1.5.1 Soil Conditioners Delivery and Storage

Soil conditioners shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil conditioners may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries. Store in dry locations and away from contaminants.

1.6 PLANT MATERIAL IDENTIFICATION

Plant material to be transplanted shall be tagged and/or shown on drawings. Transplanted plant material shall be delivered with attached, durable, waterproof labels and weather-resistant ink or imprinted tags, stating the correct botanical and common plant name and size.

1.7 INSPECTION OF MATERIALS

Materials shall be inspected for compliance with paragraph PRODUCTS and paragraph PLANT MATERIAL IDENTIFICATION. Open soil amendment containers or wet soil amendments shall be rejected. Topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material larger than 1-1/2 inch diameter shall be rejected. Topsoil that contains viable plant material and plant parts shall be rejected. Unacceptable material shall be removed from the job site. The Contracting Officer reserves the right to refuse any unacceptable plant material. All rejected plant material shall be remove from the job site on the day of rejection.

1.8 HANDLING OF PLANT MATERIALS

Materials shall not be dropped from vehicles. Plant material shall be transported without scarring trunks or deforming crown branching. Materials found to be in unacceptable condition shall be replaced at no additional cost to the Government.

1.9 TIME LIMITATION

The time limitation from digging, removing, transporting, to installing transplanted plant material shall be the same day. The time limitation between installing the plant material and placing the mulch shall be a maximum 48 hours. If project conditions prevent the Contractor from transplanting and installing plant material on the same day, plant materials shall be boxed or heeled in as required. Plant material shall be maintained and protected by the Contractor.

1.10 GUARANTEE

Transplanted plant material shall have a guarantee period of 365 days. All plants that die or have 25 percent or more of their branches that die during the construction operations or the guarantee period, shall be replaced in kind in relation to size and species.

1.11 TRANSPLANTED PLANT MATERIAL TIME AND CONDITIONS

1.11.1 Transplanting Conditions

All transplanting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to all transplanting operations, proposed transplanting times shall be submitted for approval. The installing site for the plant material shall be prepared and excavated in accordance with paragraph SITE EXCAVATION, prior to removing the plant material. If project conditions prevent the Contractor from transplanting and installing plant material on the same day, plant material shall be boxed or heeled in as required. Plant material shall be maintained by the Contractor until a suitable planting time.

1.11.2 Underground Utilities

The location of underground utilities and facilities at both the removal and installing sites shall be verified and marked. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

1.11.3 Protecting Existing Vegetation

When there are established lawns at either the removal or installing sites, the turf shall be protected during the operation. Existing trees, shrubs, and plant beds at the installing site that are to be preserved shall be barricaded and protected from damage by a tree barricade or other measure. Damage to existing plant material shall be mitigated by the Contractor at no additional cost to the Government. Damage shall be accessed by a state certified arborist or other approved professional using the National Arborist Association's tree valuation guideline.

1.11.4 Protection of Plant Material to be Transplanted

Contractor shall protect plant material slated for transplanting that is not transplanted at the beginning of construction operations. Prior to construction operations, Contractor shall tag plants to be transplanted with plastic or vinyl tape tied to the plant caliper. Plants to be transplanted shall be protected from root compaction and any other damage (with barrier of metal poles a maximum of 8 feet on center with plastic fluorescent netting) at a minimum of 20 foot diameter from outside of the plant's trunk prior to the start of any construction operations. Where tree drip lines are greater than 10 feet from the tree's trunk, locate barrier fencing at the drip line of the tree. Plastic tape and barrier fencing shall not be removed until transplanting operations are ready to begin and or instructed by the Contracting Officer. Contractor shall water and prune plant material as necessary to keep healthy and vigorous, particularly when water is shut off. Contractor shall be responsible for watering existing plant material to be transplanted from the start of construction operations until the maintenance period is over or until

regular irrigation service is in working order. Outside storage locations shall be continually shaded and protected from the wind. Bare root plants shall be heeled in. Plants stored on the project shall be protected from any drying at all times covering the balls or roots with moist sawdust, wood chips, shredded bark, peat moss, or other similar mulching material.

1.11.5 Protection of Plant Material During Transplanting

Plant material shall be protected during transplanting to prevent desiccation and damage to the branches, trunk, and root system. Branches of shrubs, palms, vines shall be protected by tying-in. Exposed branches shall be covered during transport. The root area shall be treated with mycorrhizal fungi inoculum. Plant material shall be undamaged, vigorous and healthy with a well-branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion after transplanting. Plant material showing desiccation, abrasion, sun scald injury or structural branching damage shall be replaced at no cost to the government.

1.12 SUSTAINABLE DESIGN REQUIREMENTS

1.12.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Landscaping materials may be locally available.

PART 2 PRODUCTS

2.1 TOPSOIL

Topsoil to be placed around root balls of transplanted material at new planting site shall match topsoil of existing site where material is transplanted from, based on soil tests taken at both the current growing area and the proposed growing site. Minimum matching characteristics shall include: ph, organic matter, soluble salts, percentages of silt, clay and sand. Additional topsoil shall be furnished by the Contractor. Soil conditioners may be added to topsoil to bring into compliance.

2.2 SOIL CONDITIONERS

Provide singly or in combination as required to meet specified requirements for topsoil. Soil conditioners shall be nontoxic to plants.

2.2.1 Peat

Natural product of peat moss derived from a freshwater site and conforming to latest ASTM standard as modified herein. Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation. Biobased content shall be a minimum of 100 percent. Peat shall not contain invasive species, including seeds.

2.2.2 Sand

Clean and free of materials harmful to plants.

2.3 MULCHES TOPDRESSING

Free from noxious weeds, mold, pesticides, or other deleterious materials.

2.3.1 Organic Mulch Materials

Pine bark mulch.

2.4 STAKING AND GUYING MATERIAL

2.4.1 Staking Material

2.4.1.1 Tree Support Stakes

Rough sawn FSC-certified hard wood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Stakes shall be minimum 2 inches square or 2 1/2 inch diameter by 8 feet long, pointed at one end.

2.4.1.2 Ground Stakes

FSC-certified wood or 100 percent post-consumer recycled content plastic, 3 feet long.

2.4.2 Guying Material

2.4.2.1 Guying Wire

12 gauge annealed galvanized steel, ASTM A580/A580M.

2.4.2.2 Guying Cable

Minimum five-strand, 3/16 inch diameter galvanized steel cable plastic coated.

2.4.2.3 Hose Chafing Guards

New or used 2 ply 3/4 inch diameter reinforced rubber or plastic hose, black or dark green, all of same color.

2.4.2.4 Flags

White surveyor's plastic tape, 12 inches long, fastened to guying wires or cables.

2.4.2.5 Turnbuckles

Galvanized or cadmium-plated steel with minimum 3 inch long openings fitted with screw eyes. Eye bolts shall be galvanized or cadmium-plated steel with one inch diameter eyes and screw length 1 1/2 inches, minimum.

2.4.2.6 Metal Anchors

a. Driven Anchors

Malleable iron, arrow shaped, galvanized, sized as follows:

Tree Caliper	Anchor Size
2 inches and under	3 inches
3 to 6 inches	4 inches
6 to 8 inches	6 inches
8 to 10 inches	8 inches
10 to 12 inches	10 inches

2.5 WATER

Unless otherwise directed, water shall be the responsibility of the Contractor. Water shall be potable, supplied by an existing irrigation system.

2.5.1 Hose

Hoses used for watering shall be a minimum of 70 percent post-consumer rubber or plastic.

PART 3 EXECUTION

3.1 PLANT MATERIAL PREPARATION AND HANDLING

3.1.1 Pruning

3.1.1.1 Root Pruning

Large canopy and specimen plant material shall be root pruned a minimum of 6 months before transplanting. Minimum root ball sizes shall be in accordance with ANSI/ANLA Z60.1.

3.1.1.2 Canopy Pruning

Canopy pruning shall conform to TCIA A300P1.

3.1.2 Plant Material Preparation

Plant material designated for transplanting shall be watered thoroughly several days before root pruning, digging or moving. Broken or interfering growth shall be pruned. Large canopy and specimen plant material shall be wire balled and burlapped, spaded. Mark north side of plants prior to excavation. Relocate in new location with north facing same direction.

3.1.3 Palms

Sabal Palms shall be "Hurricane Cut".

3.2 SITE PREPARATION

3.2.1 Finish Grade and Topsoil

The Contractor shall verify that finish grades are as indicated on

drawings, and that the placing of topsoil, the smooth grading, and the compaction requirements have been completed in accordance with Section 31 00 00 EARTHWORK and prior to the commencement of the transplanting operation.

3.2.2 Layout

Relocate plant material as shown on drawings. Plant material locations may be adjusted to meet field conditions, only with Contracting Officer approval.

3.3 SITE EXCAVATION

3.3.1 Obstructions Above or Below Ground

When obstructions above or below ground affect the work, shop drawings showing proposed adjustments to plant material location, and planting method shall be submitted for Government approval.

3.3.2 Turf Removal and Replacement

Where the installation operation occurs in an existing lawn area, the turf shall be removed from the excavation area to a depth that will ensure the removal of the entire root system.

3.3.3 Plant Pits

Plant pits shall be dug to a depth equal to the height of the root ball as measured from the base of the ball to the base of the plant trunk. Plant pits shall be dug a minimum of 2 times the diameter of the root system to allow for root expansion. The pit shall be constructed with sides sloping towards the base as a cone, to encourage well-aerated soil to be available to the root system for favorable root growth. Cylindrical pits with vertical sides shall not be used. Pits shall be dug immediately before plants are placed in the pit.

3.4 INSTALLATION

3.4.1 Setting Plant Material

Plant material shall be set plumb and held in position until sufficient top soil has been firmly placed around root system or ball. In relation to the surrounding grade, the plant material shall be set even with the grade at which it was grown. The root system shall be spread out and arranged in its natural position. Damaged or girdled roots shall be removed with a clean cut. The beginning of the root flare shall be visible at soil level when the tree is planted, since it is critical not to plant the tree too deep. The following shall be performed:

a. Plumb plant materials and backfill half of the hole with topsoil.

b. Prior to backfilling, all metal, wood, and synthetic products shall be removed from the ball or root system avoiding damage to the root system. Biodegradable burlap and tying material shall be carefully opened and folded back from the top a minimum 1/3 depth from the top of the root ball.

c. Water the hole to collapse air pockets.

d. Backfill and gently firm topsoil.

e. Clear soil mounded against trunk.

f. An earth berm, consisting of backfill soil mixture, shall be formed with a minimum 4 inch height around the edge of the plant pit to aid in water retention and to provide soil for settling adjustments.

3.4.2 Watering

A regular watering schedule shall be established. Slow deep watering shall be used. Plant pits and plant beds shall be watered immediately after backfilling, until completely saturated. Run-off and puddling shall be prevented. Watering of other plant material or adjacent areas shall be prevented.

3.4.3 Staking and Guying

Staking will be required when trees are unstable or will not remain set due to their size, shape, or exposure to high wind velocity. When required the following staking and guying procedures shall apply:

3.4.3.1 Three Bracing or Ground Stakes

Trees over a minimum 8 feet height and less than a maximum 6 inch caliper shall be held firmly in place with 3 bracing or ground stakes spaced at equal intervals around the tree. Ground stakes shall be avoided in areas to be mowed. Stakes shall be driven into firm ground outside the earth berm. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. For trees over a minimum 3 inch diameter at breast height, turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used when metal is the guying material.

3.4.4 Flags

A flag shall be securely fastened to each guy line between the tree, stake, deadmen, or earth anchor. The flag shall be visible to pedestrians.

3.5 FINISHING

All planting operations shall conform to TCIA Z133.1.

3.5.1 Plant Material

Prior to placing mulch, the installed area shall be uniformly edged to provide a clear division line between the planted area and the adjacent turf area, shaped as indicated. The installed area shall be raked and smoothed while maintaining the earth berms.

3.5.2 Placing Mulch

The placement of mulch shall occur a maximum of 48 hours after planting. Mulch, used to reduce soil water loss, regulate soil temperature and prevent weed growth, shall be spread to cover the installed area with a minimum 3 inch uniform thickness. Mulch shall be kept out of the crowns of shrubs, ground cover, and vines and shall be kept off buildings, sidewalks and other facilities.

3.5.3 Pruning

Pruning shall be accomplished by a certified arborist. The pruning of trees and palms shall be in accordance with TCIA A300P1. Only dead or broken material shall be pruned from installed plants. The typical growth habit of individual plant material shall be retained. Broken branches shall be removed.

3.6 MAINTENANCE

Plant maintenance shall be coordinated with owner's representative.

3.7 RESTORATION AND CLEAN UP

3.7.1 Restoration

Turf areas containing ruts or dead turf, as a result of work under this contract, shall be graded smooth and sodded with the same species. All pavements and facilities that have been damaged from the transplanting operation shall be restored to original condition at the Contractor's expense.

3.7.2 Backfill Removal Site Plant Pits

The Contractor shall ensure that all remaining holes from the removal site have been backfilled with on-site soil, tamped to 90 percent compaction, leveled and finished to meet existing grade after settling. Adjacent trees, shrubs, vines and groundcover destroyed by transplanting or construction operations shall be replaced in kind in relation to size and species and shall be installed in accordance with Section 32 93 00 EXTERIOR PLANTS. Turf shall be replaced with sod, and shall be installed in accordance with Section 32 92 23 SODDING.

3.7.3 Clean Up

Excess and waste material shall be removed from both removal site and the installed site and shall be disposed offsite at an approved landfill, recycling center, or composting center.

3.8 PLANT ESTABLISHMENT PERIOD

The establishment period for transplanted materials shall be the same as for newly planted exterior plants.

-- End of Section --

SECTION 33 11 00

WATER DISTRIBUTION
11/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI C1012	(2007; Errata 2009) Ductile Iron or Malleable Iron for 1/2-inch thru 1-1/2-inch

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A21.11	(2000) Rubber Gasket Joints Cast and Ductile Iron Press Pip
ANSI A21.53	(2006) AWWA Standard for Ductile-Iron Compact Fittings for Water Service

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(2009) Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies - (ANSI approved 2010)

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(2009) Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies - (ANSI approved 2010)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2008; Errata 2010) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2005) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2008) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2005) Flanged Ductile-Iron Pipe With

	Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C150/A21.50	(2002; Errata 2003; 2008) Thickness Design of Ductile-Iron Pipe
AWWA C151/A21.51	(2009) Ductile-Iron Pipe, Centrifugally Cast, for Water
ANSI/AWWA C153/A21.53	(2006) Ductile-Iron Compact Fittings for Water Service
AWWA C207	(2007) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
AWWA C502	(2005) Dry-Barrel Fire Hydrants
AWWA C510	(2007) Standard for Double Check Valve Backflow Prevention Assembly
AWWA C511	(2007) Standard for Reduced-Pressure Principle Backflow Prevention Assembly
ANSI/AWWA C515	(2009) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C550	(2005; Errata 2005) Protective Epoxy Interior Coatings for Valves and Hydrants
AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C605	(2005) Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains
AWWA C700	(2002; Errata 2008) Standard for Cold Water Meters - Displacement Type, Bronze Main Case
AWWA C701	(2007) Standard for Cold-Water Meters - Turbine Type for Customer Service
AWWA C702	(2001; R 2010) Cold-Water Meters - Compound Type
AWWA C707	(2005) Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C800	(2005) Underground Service Line Valves and Fittings

ASME INTERNATIONAL (ASME)

ASME B16.1	(2010) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.26	(2011) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B18.2.1	(2012) Square and Hex Bolts and Screws (Inch Series)
ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22.1	(1965; R 2008) Plain Washers
ASME B18.6.1	(1981; R 2008) Wood Screws (Inch Series)
ASME B18.6.3	(2010) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)
ASME SA-36/SA-36M	(2007) Carbon Structural Steel
ASME SA-675/SA-675M	(2007) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

ASTM INTERNATIONAL (ASTM)

ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 27/A 27M	(2008) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(2009a) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 47/A 47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A 489	(2004e1) Standard Specification for Carbon Steel Lifting Eyes
ASTM A 513	(2008a) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A 536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM A 563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 635/A 635M	(2009b) Standard Specification for Steel,

	Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for
ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 584	(2009a) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B 61	(2008) Standard Specification for Steam or Valve Bronze Castings
ASTM B 62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 633	(2007) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM D 1330	(2004) Rubber Sheet Gaskets
ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(2009) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM E 488	(1996; R 2003) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
ASTM F 1554	(2007a) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F 436	(2010) Standard Specification for Hardened Steel Washers
ASTM F 593	(2002; R 2008) Stainless Steel Bolts, Hex Cap Screws, and Studs

ASTM F 594	(2009) Standard Specification for Stainless Steel Nuts
ASTM F 656	(2010) Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F 879	(2010) Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR Manual	(1988e9) Manual of Cross-Connection Control

FLORIDA ADMINISTRATIVE CODE (FAC)

FAC 62-555.335	(2003) Guidance Documents for Public Water Systems
FAC 62-555.340	(2003) Disinfection and Bacteriological Evaluation of Public Water System Components

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; Corr 1 2009) Quality Management Systems- Requirements

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 8500.1	KSC Environmental Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	(2013) Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NSF INTERNATIONAL (NSF)

NSF 61	(2008) Drinking Water System Components - Health Effects
NSF/ANSI 14	(2013) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2012; Errata 1013; Addenda 2013) Drinking Water System Components - Health Effects

UNDERWRITERS LABORATORIES (UL)

UL 789	(2004; R 2008) Standard for Indicator Posts for Fire-Protection Service

1.2 DESIGN REQUIREMENTS

1.2.1 Water Distribution Mains

Provide water main accessories, and gate valves as specified and where indicated.

Provide water distribution mains indicated as 4 through 12 inch diameter pipe sizes of ductile-iron or polyvinyl chloride (PVC) plastic pipe. Provide water distribution mains indicated as 2- through 4-inch diameter pipe sizes of polyvinyl chloride (PVC) plastic pipe. Also provide water main accessories, gate valves, and automated flushing valves as specified and where indicated.

1.2.2 Water Service Lines

Provide water service lines indicated as 1- and 2-inch lines from water distribution main to building service at the point indicated. Water service lines shall be polyvinyl chloride (PVC) plastic pipe. PVC plastic pipe appurtenances, and valves as specified for water mains may also be used for service lines. Provide water service line appurtenances as specified.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Water Line Connection Plan; G

As-Built Drawings; G

SD-03 Product Data

Pipe Connections; G

Ductile-Iron Piping; G

Retainer Glands; G

Water service lines piping, fittings, joints, valves, and coupling; G

Ductile Iron Fittings; G

Valves; G

Corporation stops

Appurtenances; G

Polyvinyl Chloride (PVC) Pressure Pipe; G

Fittings for PVC Pressure Pipe; G

Unions; G

Valve Boxes; G

Hydrants; G

Service Saddles; G

Indicator Posts; G

Submit manufacturer's instructions or catalog cuts.

Pipe Insulation; G

Include insulation protective coverings, vapor barrier, adhesives, sealants, coatings, reinforcing mesh, and bands.

Water Meters; G

SD-06 Test Reports

Hydrostatic Test; G

Leakage Test; G

Bacteriological Disinfection; G

Test results from commercial laboratory verifying disinfection

SD-07 Certificates

Backflow Preventer Certification

1.4 SHOP DRAWINGS

A Water Line Connection Plan shall be submitted by the Contractor for the complete water system prior to start of work. The plan shall describe connections to existing water main, including any necessary valve closures and temporary outages.

As-built drawings are required for all systems and will be prepared by a surveyor registered in the State of Florida. As-built drawing shall contain the following information:

Location of valves, fittings, hydrants, and meters.

Elevation of top of water line at all utility crossings.

Separation between other utilities within 10 feet horizontally.

Material used.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials, and rubber

gaskets under cover out of direct sunlight. Do not exceed the manufacturer's recommended stacking height during storage. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, and hydrants free of dirt and debris.

1.5.2 Handling

Handle pipe and accessories to ensure delivery to the trench in an undamaged conditions. Take particular care not to injure the pipe coating. When the coating or lining of any pipe or fitting is damaged, the Contractor shall repair at his expense in an approved manner. Do not place other pipe or material inside of a pipe or fitting after the coating has been applied. Carry the pipe into position. Only use pinch bars and tongs for aligning or turning the pipe on the bare ends of the pipe. Clean the interiors of pipe and accessories before the pipe or accessories are lowered into the trench keep clean during laying operations by an approved method. Before installation, inspect the pipe for defects. Replace material found to be defective before or after laying with sound material without additional cost to the Government. Store rubber gaskets that are not to be installed immediately in a cool dark place out of the direct rays of the sun.

1.5.3 Protective End Caps

The Contractor shall provide protective end caps on each piece of pipe or fabricated section, completely sealing the piece from contamination during shipment and storage. Provide the same type of seals on each fitting or ship and store fittings in sealed boxes or containers.

1.6 BACKFLOW PREVENTER CERTIFICATION

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project. Certificate shall be from the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California, and shall attest that this design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval is not acceptable in lieu of the above.

PART 2 PRODUCTS

Ensure that newly installed or constructed public water system (PWS) components that come into contact with drinking water or drinking water treatment chemicals conform to NSF/ANSI 61 or Section 6 of NSF/ANSI 14.

Ensure that any pipe and pipe fitting used in the construction, alteration, or repair of any PWS is lead free (contains not more than 8 percent lead). Ensure that any plumbing fitting or fixture that is intended to dispense water for human consumption and that is used in the construction, alteration, or repair of any PWS is lead free (in compliance with Section 9 of NSF/ANSI 61 as adopted in FAC 62-555.335).

Color code or mark all water main pipes, including fittings, using blue as a predominant color to differentiate drinking water from reclaimed or other water. Apply blue stripes to the pipe wall of underground metal pipe. Ensure that pipe striped during manufacturing of the pipe has continuous stripes that run parallel to the axis of the pipe, are located at no greater than 90-degree intervals around the pipe, and will remain

intact during and after installation of the pipe. If tape or paint is used to stripe pipe during installation of the pipe, apply the tape or paint in a continuous line that runs parallel to the axis of the pipe and that is located along the top of the pipe; for pipes with an internal diameter of 24 inches or greater, apply tape or paint in continuous lines along each side of the pipe as well as along the top of the pipe.

2.1 WATER DISTRIBUTION MAIN MATERIALS

2.1.1 Piping Materials

Ensure that all materials in contact with potable water are NSF/ANSI 61 approved and are suitable for use with chloraminated water.

2.1.1.1 Ductile-Iron Piping

All ductile-iron piping shall be cement-lined manufactured in accordance with AWWA C150/A21.50 and AWWA C151/A21.51 for the following minimum operating conditions:

Pressure Class: All ductile-iron piping shall meet the following minimum working pressure classes:

(a) 4-inch through 12-inch: 350 psi

Provide buried pipe and fittings that are petroleum asphalt coated according to the manufacturer's recommendations and encased in 8-mil high-density polyethylene tubes in accordance with AWWA C105/A21.5 Method A. Paint all flanged and above-grade or exposed pipe and fittings in accordance with Section 09 96 00 HIGH PERFORMANCE PAINTING AND COATING.

Where new flanged pipe is joined with existing and other new flanges, provide adaptor flange pipe sections if necessary.

Ensure that all bolts, nuts, and stud provided are corrosion-resistant alloy with hex heads or heavy hex heads conforming to AWWA C115/A21.15 and Appendix A of AWWA C115/A21.15, except where otherwise indicated on the drawings.

2.1.1.1.1 Ductile-Iron Joints

Ductile-iron fittings below grade/buried shall be furnished with mechanical joints and ductile-iron fittings above grade/exposed shall be furnished with flanged joint ends as shown on the drawings and specified in this Section

Mechanical Joints: All buried ductile-iron fittings shall be furnished with mechanical joint ends unless noted otherwise. Mechanical joints shall conform to AWWA C111/A21.11. Glands shall be constructed of ductile-iron.

Flanged Joints: Pipe for threaded flange fabrication shall be Special Thickness Class 53 in accordance with AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C115/A21.15. Bolt circle and bolt holes shall match those of ASME B16.1 Class 125 flanges. The flanges shall be rated for a maximum working pressure of 250 psi. Threaded flanges shall be individually fitted and machine tightened on the pipe ends. Flange facing shall be smooth or with shallow serrations in accordance with AWWA C115/A21.15.

2.1.1.1.2 Ductile-Iron Fittings

General: Ductile iron pipe fittings shall be the compact type meeting the requirements of AWWA C111/A21.11, AWWA C110/A21.10, and be cement lined and seal coated. Fittings shall be manufactured in accordance with AWWA C110/A21.10. Where taps are 1/8-inch thick full-face-type and conform to the dimensions of Appendix A of AWWA C115/A21.15 shown on fittings, tapping bosses shall be provided. At a minimum, fittings shall have the same pressure rating as the connecting pipe.

Flanged Joint: AWWA C110/A21.10 and ASME B16.1, faced and drilled 125-pound ANSI standard.

Mechanical Joint: AWWA C110/A21.10.

Provide mechanical joint fittings for all buried fittings as shown in the drawings, unless noted otherwise.

Provide specified gaskets.

2.1.1.1.3 Lining and Coating

Perform all field measurements confirming the accuracy of the piping sizes and lengths shown on the drawings. Notify the Contracting Officer immediately before deviating from or altering the lining of ductile iron piping shown on the approved layout schedule.

Cement-Lined Ductile Iron Pipe and Fittings: Interior surfaces of all cement-lined ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with a standard thickness cement-mortar lining applied in conformity with AWWA C104/A21.4, Portland cement mortar. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, repair or replace damaged or unsatisfactory portions with lining conforming to these Specifications at no additional cost to the Government. Pipe linings for potable water lines shall be NSF/ANSI 61 approved.

All ductile iron pipe and fittings cement-mortar linings shall be surface sealed with an asphaltic seal coating, 1 mil, in accordance with AWWA C104/A21.4.

Coat all parts of the joint restraint system with coal tar epoxy as in Section 09 96 00 HIGH PERFORMANCE PAINTING AND COATING, Mega-Bond coating system by EBAA Iron, Inc. or Contracting Officer approved equal.

2.1.1.1.4 Manufacturers

Acceptable ductile iron pipe manufacturers include US Pipe, American Ductile Pipe, Griffin Pipe, or approved equal.

2.1.1.1.5 Gaskets

Gaskets shall be EPDM, Viton, or an approved equal. Wherever contaminated groundwater or contaminated soils are present, gaskets shall be Viton, or an approved equal. Refer to drawings for locations.

Gaskets for mechanical joints shall be compatible with potable water pipe service and be in accordance with ANSI A21.11 and ASTM D 1330.

Flange gaskets shall be in accordance with AWWA C207, except as modified in this Section. Gaskets shall be ring type. All gasket material shall be suitable for potable water and shall be resistant to free chlorine concentrations up to 10 mg/L. All gasket material shall be rated to the surge pressures noted under the paragraph entitled "Ductile-Iron Piping" of this Section.

Gaskets for flanged joints shall be 1/8-inch-thick, cloth-inserted rubber conforming to applicable parts of ASME B16.21 and AWWA C207. Gasket material shall be free from corrosive alkali or acid ingredients. Gaskets shall be full-face type for 125-pound flanges.

2.1.1.1.6 Retainer Glands

Retainer glands shall be provided for all buried ductile-iron mechanical joints, fittings, and ductile-iron pipe connections to buried valves. Retainer glands shall be designed for joint retaining through the use of a follower gland and set screw-anchoring devices that impart multiple wedging action against the pipe. The mechanical joint-restraint device shall be UL listed and shall have a working pressure of at least 250 psi with a minimum safety factor of 2.

a. Gland: Manufactured of ductile iron conforming to ASTM A536. Gland dimensions shall match ANSI A21.11 and ANSI A21.53.

b. Restraining Devices: Manufactured of ductile iron heat treated to a minimum hardness of 370 BHN. Restraining devices shall incorporate a set screw/twist-off nut bolt to ensure the proper actuating of the restraining device. The twist-off nut shall be designed to come off at the torque limit desired to anchor the restraining device in place on the pipe.

c. Joint Deflection: Retainer gland joint deflection shall be limited to manufacturer's recommended maximum deflection angle. Joint deflection shall be applied before the set screws are torqued.

d. Acceptable Manufacturers are EBAA Iron, Inc. - Megalug 1100 Series, or approved equal.

2.1.1.1.7 External Pipe Restraints

Ductile-iron pipe push-on (bell and spigot) joint restraint shall be provided by a restraining harness consisting of a restraint ring, connecting tie-rods, and split-ring assembly installed at all push-on joints. The restraint ring shall consist of wedging components made from 60-42-12 ductile-iron conforming to ASTM A 536 and wedges heat treated to minimum 370 BHN. Torque limiting twist-off nuts shall be provided on each wedge to ensure proper applied installation torque. The split ring shall be made from 60-42-12 ductile-iron conforming to ASTM A 536. The connecting rods shall be made of steel conforming to AWWA C111/A21.11. Sizes 6- to 12-inch-diameter restraining harnesses shall have 350-psi maximum working pressure rating. All harnesses shall be designed with a 2-to-1 safety factor applied to the maximum working pressure rating.

Acceptable manufacturers are EBAA Iron, Inc. - Series 1700 or approved equal.

2.1.1.1.8 Internal Pipe Restraint

Acceptable manufacturers are:

American Ductile Iron Pipe:

Fast Grip® Gasket
Flex Ring® Joint

US Pipe:

Field Lok® Gasket
TR Flex Restrained Joint Pipe and Fittings

or Contracting Officer-approved equal.

2.1.1.2 Pipe Connections

Provide fasteners in accordance with the following section unless otherwise noted.

1. General: For all exterior applications and where fastening aluminum, provide Type 304 stainless steel fasteners. Provide hot-dipped galvanized fasteners in all other applications in accordance with ASTM A 153/A 153M unless noted otherwise on the drawings. Select fasteners for type, grade, and class required.

2. High-Strength Bolts and Nuts: ASTM A 325 with heavy hex nuts ASTM A 563 and hardened carbon-steel washers ASTM F 436.

3. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, with hex nuts, ASTM A 563, and, where indicated, flat washers.

4. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group A4.

5. Stainless Steel Socket Button and Flat Countersunk Head Cap Screws: ASTM F 879.

6. Anchor Bolts: ASTM F 1554, Grade 36.

7. Eyebolts: ASTM A 489.

8. Machine Screws: ASME B18.6.3.

9. Lag Bolts: ASME B18.2.1.

10. Wood Screws: Flat head, ASME B18.6.1.

11. Plain Washers: Round, ASME B18.22.1.

12. Lock Washers: Helical, spring type, ASME B18.21.1.

13. Cast-in Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.

a. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized in accordance with ASTM A 153/A 153M.

14. Expansion Anchors: Anchor bolt and sleeve assembly with the ability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.

a. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

b. Material for Anchors in Exterior Locations: Alloy Group (A4) stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.1.1.3 Polyvinyl Chloride (PVC) Pressure Pipe

2.1.1.3.1 3-Inch and Smaller PVC Pipe

Provide pipe that is Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D 1784 and ASTM D 1785.

Provide pipe that bears the NSF logo for potable water use.

2.1.1.3.2 Solvent Cement in Other than Chemical and Chemical Carrier Water Service

Solvent cement for socket joints shall comply with ASTM D 2564 and ASTM F 656.

2.1.1.3.3 Solvent Cement in Chemical and Chemical Carrier Water Service

Solvent cement shall be free of silica. Products: IPS "Weld-On 724" or Oatey "Low VOC PVC Heavy Duty Gray."

2.1.1.4 Joints and Fittings for PVC Pressure Pipe

2.1.1.4.1 3-Inch and Smaller PVC Pipe Joints

Socket weld pipe and fitting joints except where threaded and flanged joints are required to connect to valves and equipment.

2.1.1.4.2 3-Inch and Smaller PVC Pipe Fittings

Ensure that fittings are Schedule 80 and conform to ASTM D 2464 for threaded fittings and ASTM D 2467 for socket-type fittings.

2.1.1.4.3 3-Inch and Smaller PVC Pipe Unions

Ensure that unions have socket-type ends, Viton O-rings, and are Schedule 80. Ensure that material is Type I, Grade 1 PVC in accordance with ASTM D 1784.

2.1.2 Valves, Hydrants, and Other Water Main Accessories

2.1.2.1 Gate Valves

2.1.2.1.1 Ductile-Iron Resilient Wedge Gate Valves, 3 Inches through 20 Inches, for Exposed and Buried Service (ANSI/AWWA C515)

Provide valves that are cast-iron or ductile-iron body valves and comply with ANSI/AWWA C515 and the following. Ensure that valves are of the bolted-bonnet type with nonrising stems. Ensure that the valve gate is of ductile-iron with a resilient wedge. Ensure that valve stems are Type 304 or 316 stainless-steel or cast, forged, or rolled bronze. Ensure that stem nuts are made of solid bronze. Ensure that bronze conforms to ASTM B 62 or ASTM B 584. Ensure that body bolts are Type 316 stainless-steel. Ensure that end connections for exposed valves are flanged. Ensure that end connections for buried valves are mechanical joint type. Provide reduction-thrust bearings above the stem collar. Ensure that stuffing boxes are O-ring seal type with two rings located in the stem above the thrust collar. Ensure that each valve has a smooth unobstructed waterway free from any sediment pockets. Ensure that valves are lined and coated at the place of manufacture with either fusion-bonded epoxy or heat-cured liquid epoxy. Ensure that minimum epoxy thickness is 8 mil.

Manufacturers: Clow, AVK, American Flow Control, Kennedy, or approved equal.

2.1.2.2 Backflow Preventer Assemblies

Backflow preventers shall be the double check type conforming to AWWA C510 for fire services and the reduced pressure type conforming to AWWA C511 for potable water services. Valves shall be FEBCO 850 for double check and FEBCO 825Y for reduced pressure or approved equal. The assembly shall include pressure gauge test ports and OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of 175 psi, the maximum pressure loss shall be 6 psi at a flow rate equal to the sprinkler water demand, at the location of the assembly. A test port for a pressure gauge shall be provided both upstream and downstream of the double check backflow prevention assembly valves.

Type double-check backflow devices or assemblies are used for low degree of hazard non-pollutants or contaminants. This device shall conform to AWWA C510, ASSE 1015, and FCCCHR Manual-9 Standard. This unit shall be installed a minimum of 32 inches above the ground or flood level.

The interior of the backflow preventers shall be epoxy coated in accordance with AWWA C550. Backflow preventers shall be equipped with a thermally activated valve set for freeze protection installed on the downstream side of the backflow preventer. Thermally activated valve shall be Crispin, Freezetron or approved equal. Backflow preventers shall be equipped with galvanized steel chain and security lock. Fire service backflow preventer and associated aboveground piping shall be red in color. Domestic service backflow and associated aboveground piping shall be blue in color.

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of

non-potable water. Backflow preventers shall be installed where indicated and in accordance with ICC IPC at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any non-potable substance. IN addition, backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the non-potable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any non-potable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

Backflow prevention devices shall be designed and installed to meet the NFPA's Code requirement for testing backflow prevention devices. Design shall include a method to forward flow (full flow) test downstream of the backflow prevention device and meet all design criteria as stated herein and as shown on the design drawings which accompanies this specification.

Test outlet connection shall be UL listed, FM approved for fire service. Each outlet shall be capable of supplying water flow with a minimum of 250 gpm. The outlet connection shall meet all testing and material specification as stated herein and as shown on the design drawings which accompany this specification. Test outlet connections shall be cast brass body or engineered approved equal material, NPT inlets with 2-1/2 inch NST male outlets equipped with the listed manufacturers cap and chain. The test outlet connection shall include a brass plate with engraved letter for identification as specified and shown on the contract drawings.

2.1.2.3 Fire Hydrants

Fire hydrants shall be in accordance with AWWA C502, for dry barrel-type fire hydrants. Fire hydrants shall meet the following requirements:

Catalogue and maintenance data	Required.
Type of shutoff	Compression or gate
Size of hydrant (valve opening)	5.25-inch
Inlet connection	6-inch, verify with drawings.
Outlet nozzles	Two 2.5-inch hose and one 4.5-inch pumper.
Outlet nozzle threads	See Note 1.
Direction to open	Counterclockwise.
Stem seals	O-ring.
Outlet nozzle cap chains	Required.
Drain outlet, non-corrodible	Required.

Traffic breakaway body and valve rod	Required.
Working pressure rating	200 psi (minimum).
Fire hydrant wrenches	Provide five wrenches as spare parts.
Nozzle wrenches	Provide five wrenches as spare parts for each size nozzle provided.
Breakaway repair kit	Provide five kits as spare parts.

Notes: Outlet nozzle threads shall be the Government's standard fire hydrant thread. The Contractor shall verify thread type before submittal.

Hydrants shall have Underwriter's Laboratory (UL) and Factory Mutual (FM) approvals. Hydrant exteriors shall be painted with one coat of zinc-chromate alkyd primer and two finish coats of approved paint of the color required by the Government. Hydrant is to be painted Red 11105. Hydrant interiors shall be painted with a paint system approved by NSF for use in potable water. Working parts shall be bronze. All internal parts shall be removable through the top of the hydrant. Hydrants shall conform to NFPA 24.

Fire hydrant extensions shall be provided at no additional cost to the Government to meet final grade requirements. All hydrants shall stand plumb. No portion of the fire hydrant shall be within 6 inches of a sidewalk. After installation, all hydrants shall be inspected, cleaned, and opened and closed as many times as required to verify that all aspects of the hydrant work properly.

Fire hydrants shall be M&H, Kennedy, Mueller, American Darling or approved equal.

2.1.2.4 Indicator Posts

UL 789. Provide for gate valves where indicated. The face of the indicator post shall face the nearest roadway, driveway, or parking lot.

2.1.2.5 Valve Boxes

Valve boxes shall be cast iron, complete with lock-type covers requiring a special wrench for removal. Cast-iron boxes shall be the extension type with slide adjustments and with flared bases. Concrete boxes shall be constructed in accordance with details indicated. The word "WATER" shall be cast in the cover. Boxes shall be installed over each gate valve. Boxes shall be of such a length as can be adapted, without full extension, to the depth of cover required over the pipe at the valve location. Concrete boxes may be installed only in locations not subjected to traffic.

2.1.2.6 Unions

No attempt has been made to show all unions required for the project. The Contractor shall provide unions at all connections of threaded pipe to installed equipment unless deleted by the Contracting Officer, in writing, at certain locations. The unions shall meet or exceed the quality of materials, pressure rating, service, and painting requirements of connected piping.

2.1.2.7 Warning Tape and Tracing Wire for Buried Piping

Warning tape and tracing wire for buried pipe is specified under Section 31 00 00 EARTHWORK.

2.1.2.8 Meter Vaults

Large meters shall be installed in reinforced concrete vaults manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. Large meters shall be installed in reinforced concrete vaults in accordance with the details shown on the drawings.

2.1.2.9 Water System Identification Tags

Provide a coordinated system of piping and equipment identification which includes metal-tag-identified major valves, piping-system components, and equipment.

Install identification tags made of stainless steel and indicating function of valve or similar component on such system devices. Tags shall be not less than 2 inches in diameter and the marking shall be stamped.

Provide equipment with metal identification tags bearing an equipment designation number provided by the Government and matching the drawing designations.

Secure tags to valve or equipment items with 12-gage galvanized wire.

2.1.2.10 Transition Couplings

Transition Coupling shall consist of a high-strength steel body, two steel or malleable iron flange or follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675MGR60, free of surface defect.
Followers: AISI C1012 or ASME SA-36/SA-36M
Bolts: AWWA C111/A21.11
Gasket: Grade 27 BUNA-S.
Shop Paint: Fusion bonded epoxy coating.
Acceptable Manufacturers:
Dresser Manufacturing Division of Dresser Industries, Inc.; Dresser Styles 62 and 162 or approved equal.

2.1.2.11 Flanged Coupling Adapters

Adapters shall consist of a cast-iron or high-strength steel body, two steel or ductile iron follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

3-24-inch DIP Flange Adapters

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675M GR60, free of surface defect.

Flanges: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675M GR60, free of surface defect. Bolt circles and bolt holes shall match those of ASME B16.1 Class 125 flanges.

Bolts and nuts: Alloy to AWWA C111/A21.11

Gasket: Grade 27 BUNA-S.

Acceptable Manufacturers:

Dresser Manufacturing Division of Dresser Industries, Inc.; Dresser Style 128W or approved equal.

2.1.2.12 Transition Couplings

Transition Coupling shall consist of a high-strength steel body, two steel or malleable iron flange or follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675MGR60, free of surface defect.

Followers: AISI C1012 or ASME SA-36/SA-36M.

Bolts: AWWA C111/A21.11.

Gasket: Grade 27 BUNA-S.

Shop Paint: Fusion bonded epoxy coating.

Acceptable Manufacturers:

Dresser Manufacturing Division of Dresser Industries, Inc.; Dresser Styles 62 and 162 or approved equal.

2.1.2.13 Retainer Glands

Provide retainer glands for all buried ductile-iron mechanical joints, fitting, and ductile-iron pipe connections to buried valves. Design retainer glands for joint retaining through the use of a follower gland and set screw-anchoring devices which impart multiple wedging action against the pipe. The mechanical joint restraint device shall be UL listed and shall have a working pressure of at least 250 psi with a minimum safety factor of 2.

1. Gland: Manufactured of ductile iron conforming to ASTM A 536. Gland dimensions shall match AWWA C111/A21.11 and ANSI/AWWA C153/A21.53.

2. Restraining Devices: Manufactured of ductile iron heat treated to a minimum hardness of 370 BHN. Incorporate a set screw/twist-off nut bolt into restraining devices to ensure the proper actuating of the restraining device. Design the twist-off nut to come off at the torque limit desired to anchor the restraining device in place on the pipe.

3. Joint Deflection: Limit retainer gland joint deflection to manufacturer's recommended maximum deflection angle. Apply joint deflection before the set screws are torqued.

4. Acceptable manufacturers:

a. EBAA Iron, Inc.; Megalug 1100 Series or approved equal.

2.1.2.14 Restraining Harness

Provide ductile iron pipe push-on (bell and spigot) joint restraint by a restraining harness consisting of a restraint ring, connecting tie-rods, and split-ring assembly installed at all push-on joints. The restraint ring shall consist of wedging components made from 60-42-12 ductile iron conforming to ASTM A 536 and wedges heat treated to minimum 370 BHN. Provide torque limiting twist-off nuts on each wedge to ensure proper applied installation torque. Make the split ring from 60-42-12 ductile iron conforming to ASTM A 536. Make steel connecting rods conforming to AWWA C111/A21.11. Sizes 4- to 16-inch-diameter restraining harnesses shall have a 350-psi maximum working pressure rating and a 18- to 36-inch diameter restraining harnesses shall have 250-psi maximum working pressure rating. Design all harnesses with a 20-to-1 safety factor applied to the maximum working pressure rating.

Acceptable manufacturers:

EBAA Iron, Inc.; Series 1700 or approved equal.

2.1.2.15 Tracer Wire for All Piping Including Horizontal Directional Drilling

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

2.1.2.16 Polyethylene Bagging

Polyethylene bagging for buried ductile iron pipe, fittings, and valves shall be 8 mils thickness minimum polyethylene. The installation of polyethylene bagging shall be in accordance with AWWA C105/A21.5.

2.1.2.17 Pipe Insulation

Fire hazard rating: Except for materials listed below, all insulation materials, adhesives, coatings, and other accessories shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed. Excepted are:

1. Urethane insulation for smoke developed only.
2. Asphaltic and coal tar coatings.

2.1.2.17.1 Insulation Performance

Rigid cellular foam urethane with the following requirements:

1. Density: 1.8 to 2.2 pounds per cubic foot.
2. Dimensional stability: 4 percent.
3. Thermal conductivity (BTU in/hr sw. ft. degrees F):

    a. Initial: .11
    b. Design: .14 to .16
    c. Aged: .18

4. Compressive strength: 25 psi with 10 percent deflection.
5. Open cell content: 10 percent or less by volume.
6. Temperature range: 30 degrees F to 220 degrees F.

2.1.2.17.2 Insulation Requirements

Supply all insulation in curved cylindrical segments.

Fabricate insulation in contact with the pipe to suit pipe outside dimensions.

Insulation thickness shall be 1-1/2 inches thick.

Acceptable manufacturers:

1. Owens Corning.
2. CPR Upjohn.
3. Or approved equal.

2.1.2.17.3 Insulation Adhesives, Sealants, and Coatings

Adhesives, sealants, and coatings shall be compatible with materials to which they are applied and shall not corrode, soften, or otherwise attack insulation in any manner. Materials shall be suitable for intended service.

Suitable for a minus 30 degrees F to 200 degrees F operating service.

Acceptable manufacturers:

1. Childers Products Company.
2. Benjamin Foster Company.
3. Lion Oil Company.
4. Or approved equal.

Adhere insulation to piping with suitable adhesive.

Seal all exposed edges of insulation with two coats of suitable flexible sealer.

Seal lap, butt, and longitudinal joints in insulation with one coat of flexible sealer or adhesive.

2.1.2.17.4 Insulation Protective Coverings

Exposed outside piping: Protect insulation with a 0.016-inch-thick corrugated aluminum jacket. Aluminum shall be Type 3003 or 5005, ASTM B 209, Temper H14. Exterior shall have a factory-applied baked-on acrylic coating. The inside of the covering shall have a factory-applied moisture barrier of polyethylene film on Kraft Paper. Covering shall be as manufactured by Childers, Insul-Coustic, or approved equal.

2.1.2.18 Service Saddles

Service saddles shall be epoxy coated ductile iron bodied suitable for use with PVC water main and corporation cocks specified. Saddles shall be double strap design complete with cemented-in-place O-Ring gaskets and full length threaded boss. Saddles shall have stainless-steel type straps; Clamping arrangement which is not fully contoured to the outside diameter of the pipe, or lugs which dig into the pipe or a saddle which distorts the pipe are not acceptable. Saddles shall be rated for leak free operation at a minimum of 200 psi and shall be as manufactured by Mueller Co, or approved equal.

2.2 WATER SERVICE LINE MATERIALS

2.2.1 Corporation Stops

Ground key type; bronze, ASTM B 61 or ASTM B 62; and suitable for the working pressure of the system. Ends shall be suitable for solder-joint, or flared tube compression type joint. Threaded ends for inlet and outlet of corporation stops, AWWA C800; coupling nut for connection to flared copper tubing, ASME B16.26.

2.2.2 Curb or Service Stops

Ground key, round way, inverted key type; made of bronze, ASTM B 61 or ASTM B 62; and suitable for the working pressure of the system. Ends shall be as appropriate for connection to the service piping. Arrow shall be cast into body of the curb or service stop indicating direction of flow.

2.2.3 Water Meters

2.2.3.1 Type, Size, and Capacity

All cold water meters (compound-type) furnished shall be produced from an ISO 9001 manufacturing facility and conform to AWWA C701 and AWWA C702. The size, capacity, and meter lengths shall be as specified in AWWA C701 and AWWA C702. The maximum number of disc nutations is not to exceed those specified in AWWA C701.

All meter maincases shall be made of epoxy-coated ductile iron composition. The serial number should be stamped between the outlet port of the maincase and the register. Maincase markings shall be cast raised and shall indicate size, model, direction of flow, and NSF 61 certification. Plastic maincases are not acceptable.

All no-lead maincases shall be guaranteed free from manufacturing defects in workmanship and material for the life of the meter.

All meters must be adaptable to a field programmable absolute encoder register without interruption of the customer's service.

2.2.3.2 Bolts

All maincase bolts shall be 300 series non-magnetic stainless steel to prevent corrosion.

2.2.3.3 Remote Capability

All meters shall be equipped with encoder remote registers according to AWWA C707 and shall meet all AWWA C700 performance standards. Meters and encoders shall also be compatible with Advanced Metering Infrastructure (AMI) and Automatic Reading Systems.

2.2.3.4 Performance

To ensure accuracy, each meter must be accompanied by a factory test tag certifying the accuracy at the flows required by AWWA C700. All meters shall be warranted as follows:

Size (Inches)	Low Flow	Low Flow Meter Accuracy	Low Flow Repaired Meter Accuracy
4	1 gpm @ 95 percent	2 years or 2.7 MGal	10 years or 8 MGal

Normal meter operating range shall be as follows:

Size (Inches)	Accuracy Range 1.5 Percent (plus or minus)
4	2-1/2 - 800 gpm

2.2.3.5 Manufacturer

Meters and meter parts shall be manufactured, assembled, and tested within the United States. Manufacturers shall have a minimum of 15 years of field and production experience with all sizes and models quoted. Acceptable meters shall be Omni-C2, as shown on the drawings, or approved equal.

2.2.4 Meter Boxes

Meter boxes shall be of concrete and shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. Lids and covers shall be rated for H-20 traffic. The boxes shall be of sufficient size to completely enclose the meter and shutoff valve or service stop. Box height shall extend from invert of the meter to final grade at the meter location. The lid shall have the word "WATER" cast in it.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

Any utilities damaged, both new and existing, as a result of this project shall be repaired per manufacturer's recommendations at no cost the Government.

3.1.1 General Requirements for Installation of Pipelines

3.1.1.1 Cutting Of Pipe

Cutting of pipe shall be done without damage to the pipe. Cutting shall be done with an approved mechanical cutter. Wheel cutters shall be used when practical.

3.1.1.2 Location

For the location and separation requirements of the water main with respect to other utilities, refer to the Typical Utility Conflict Detail in the drawings.

3.1.1.3 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.4 Placing, Laying And Pipe Connections

Pipe and accessories shall be carefully lowered into the trench by suitable equipment. Under no circumstances shall materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Poles used as levers for removing skids across trenches shall be made of wood and have broad flat faces to prevent damage to the pipe or coating. Except where necessary in making connections with other lines or as authorized, pipe shall be laid with the bells facing upstream. Full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that foreign material will not enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor in an approved manner, at no additional expense to the Government.

Pipe ends left for future connections shall be valved, plugged, or capped and anchored. Where connections are made between new work and existing mains, the connections shall be made by using special sections and fittings to suit the actual conditions. Where made under pressure, connections shall be installed in accordance with the recommendations of the manufacturer of the pipe being tapped.

3.1.1.5 Rubber Gaskets

Rubber gaskets shall be handled, lubricated, and installed in accordance with the pipe manufacturer's recommendations.

3.1.1.6 Couplings And Joints

Installation of couplings, mechanical joints, and flanged joints shall be in accordance with the manufacturer's recommendations. Pipe Connections between different types of pipe and accessories shall be made with transition fittings as recommended by the manufacturer.

3.1.1.7 Deflection

Maximum allowable deflection for ductile iron bell-and-spigot pipe and mechanical-joint pipe, shall be as recommended by the manufacturer.

When the alignment requires deflections in excess of the manufacturer's recommendations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth, as approved. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflections does not exceed the maximum recommended by the pipe manufacturer. Short-radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated special sections.

3.1.1.8 Installation of Tracer Wire

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

3.1.1.9 Anchoring and Restraining

Refer to drawings for thrust block requirements.

3.1.1.10 Locating Devices

Locating devices shall be located as indicated in the contract documents. For all subsurface fittings with thrust blocks, embed the device into the top surface on the thrust block such that half the device is exposed and the location is at the centroid of the thrust block top surface area. For all subsurface elbows, tees, and valves without thrust blocks installed, install the device 6 inches above the fitting unless noted otherwise. The locating devices shall be Omni Marker Model 161 Water Marker or approved equal. Locating devices shall not be installed at vertical bends.

3.1.1.11 Connections to Existing Water Lines

Make connections to existing water lines after approval is obtained and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.

3.1.1.12 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.1.13 Line Stops for Outages

The Contractor shall have line stop installation crews available at the beginning of each outage to install all line stops as directed by the Contracting Officer. The Contractor's crew shall be certified by the manufacturer for the installation of line stops or the Contractor shall have a certified manufacturer's representative onsite to supervise the installation.

3.1.1.14 Field Hydrostatic Testing

The Contractor shall hydrostatically test pipe and fittings in the field in accordance with paragraph entitled "TESTING--NON-HDPE PIPE AND FITTINGS" of this section.

Do not allow test water to remain in the pipe for more than 5 days. Drain and dry the piping after completing the testing.

3.1.2 Installation of Valves and Hydrants

a. Installation of Valves: Installation of valves shall be in accordance with manufacturer's recommendations.

b. Installation of Hydrants: Installation of hydrants shall be in accordance with manufacturer's recommendations. Install hydrants with the 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, contact the Contracting Officer for further instructions.

3.1.3 Installation of Water Service Piping

3.1.3.1 Service Line Connections to Water Mains

Connect service lines to the main by a corporation stop and install a service stop below the frostline as indicated. Connect service lines to

ductile-iron water mains in accordance with AWWA C600 for service taps. Connect service lines to PVC water mains in accordance with AWWA C605 for service taps.

3.2 TESTING -- NON-HDPE PIPE AND FITTINGS

3.2.1 Hydrostatic Test of Above ground or Exposed Piping

Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges.

Subject the piping system to the test pressure of 150 psi. Maintain the test pressure for a minimum of 2 hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

3.2.2 Leakage Test for Buried Piping

Leakage tests shall be conducted concurrently with the pressure test. Duration of each leakage test shall be at least 2 hours. During the test, the main shall be subjected to a pressure of 150 psi. Leakage is defined as the additional quantity of water supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system. The allowable leakage volume is defined by the formula:

DUCTILE IRON PIPE		**PVC PIPE**	
$L = \frac{SD(P)^{1/2}}{C}$		$L = \frac{ND(P)^{1/2}}{C}$	
in which:		in which:	
L = allowable leakage (gallons)		L = allowable leakage (gallons)	
S = length of pipe tested (feet)		N = number of rubber-gasketed joints in the pipe tested	
D = diameter of the pipe (inches)		D = diameter of the pipe (inches)	
P = specified test pressure (psig)		P = specified test pressure (psig)	
C = 133,200		C = 7,400	

Should any test of laid pipe disclose a leakage greater than that shown, the defective joints shall be located and repaired until the leakage is within the specified tolerance, at no additional cost to the Government.

3.2.3 Test Timing

Except where concrete-reaction backing necessitates a 72-hour delay, pipelines jointed with rubber gaskets, mechanical, or bolted joints may be

subjected to hydrostatic pressure, inspected, and tested for leakage after partial completion of backfill.

3.2.4 Retesting

Before permanent paving is placed over the pipeline, a measured leakage test of the entire pipeline shall be required. Leakage loss shall be within approved tolerances.

3.2.5 Sterilizing

Water piping, including valves, fittings, and other devices, shall be sterilized and tested according to AWWA C651. After successful sterilization, the piping shall be flushed before placing into service. Water for sterilization will be furnished by the Government, but disposal shall be the responsibility of the Contractor.

3.3 TEST OF BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow preventer assemblies.

Backflow prevention assembly test gauges shall be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges shall be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.4 DISINFECTION CRITERIA FOR KSC POTABLE WATER SYSTEM INSTALLATION, REPAIR, OR MODIFICATION TO WATER MAINS

The KSC Pollution Control and Sanitation Officer (PCSO) or designated representative shall approve the disinfection procedure to be used and be present during the process. A minimum of 24 hours lead time is required to schedule attendance of disinfection by PCSO or representative. Contact should be made through the Construction Management Office. Ensure proper disinfection protocol/bacteriological sampling occurs if water line is broken, tapped, modified, or if loss of pressure occurs. All repaired, modified or newly installed water system components shall be disinfected after pressure and leak tests have been performed. All existing mains

closed for outage shall be disinfected and tested prior to use. The system components to be disinfected shall be thoroughly flushed with potable water before introducing the chlorinating solution. This flushing is required to remove all debris from the systems components. The chlorinating solution shall provide a dosage of not less than 50 parts per million (ppm). The chlorine solution shall be introduced into the water line in an approved manner and be evenly distributed throughout the entire effected systems components long enough to destroy all non-spore forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and tests shall reveal not less than 25 ppm of chlorine residual after the 24 hour retention period. The line shall be flushed with potable water until the residual chlorine level is reduced to less than 1.0 ppm or to the normal background level in the area. Discharge of highly chlorinated water from disinfection shall be coordinated with URS Water and Wastewater. Samples will be collected by the Contractor or designated representative from several points in the water system for bacteriological examination. The system will remain closed and will not be accepted for use until two consecutive days of satisfactory bacteriological results have been obtained and approval has been given by the PCSO and regulatory agencies.

Taps, modification, repairs, or new lines added to the system shall be tested and disinfected following AWWA C651 and KNPR 8500.1. Successful disinfection shall be demonstrated by bacteriological testing following FAC 62-555.340(1) and FAC 62-555.340(2).

Bacteriological testing shall be provided by the Government. The Contractor shall coordinate the scheduling of tests with the Government and take corrective actions if results do not meet required standards.

3.5 DISPOSING OF HEAVILY CHLORINATED WATER

The environment to which chlorinated water may be discharged shall be inspected by the Contractor, and, if there is any question that the chlorinated discharge will cause damage to personnel or the environment, then a reducing agent shall be applied to the water (reference Appendix B of the current AWWA C651 for neutralizing chemicals). Such discharges should be coordinated with the KSC PCSO, or designated representative.

3.6 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --

SECTION 33 30 00

SANITARY SEWERS
04/08

PART 1 GENERAL

1.1 RELATED SECTIONS

The provisions of other sections of the General and Supplementary Conditions are fully applicable to this Section as if incorporated herein.

Other related or referenced sections contained herein are as listed below:

Section 03 01 30.71	CONCRETE REHABILITATION
Section 03 30 53	MISCELLANEOUS CAST-IN-PLACE CONCRETE
Section 03 40 00.00 10	PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION
Section 09 96 00	HIGH PERFORMANCE PAINTING AND COATING
Section 31 00 00	EARTHWORK

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI C1012	(2007; Errata 2009) Ductile Iron or Malleable Iron for 1/2-inch thru 1-1/2-inch

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2008; Errata 2010) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2008) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C504	(2006; R 2010) Standard for Rubber-Seated Butterfly Valves
AWWA C606	(2011) Grooved and Shouldered Joints

ASME INTERNATIONAL (ASME)

ASME BPVC	(2010) Boiler and Pressure Vessels Code
ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
ASME B18.2.1	(2012) Square and Hex Bolts and Screws

	(Inch Series)
ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22.1	(1965; R 2008) Plain Washers
ASME B18.6.1	(1981; R 2008) Wood Screws (Inch Series)
ASME B18.6.3	(2010) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)
ASME SA-36	(1998) Steel Designations
ASME SA-675	(1998) Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASME B31.1	(2012; INT 2-6, 8-10, 13, 15, 17-25, 27-31 and 42-46) Power Piping
ASME B31.3	(2010) Process Piping

ASTM INTERNATIONAL (ASTM)

ASTM A 126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(2009a) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 489	(2004e1) Standard Specification for Carbon Steel Lifting Eyes
ASTM A 513	(2008a) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A 530/A 530M	(2004a; R 2010) Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
ASTM A 563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 635/A 635M	(2009b) Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength

	Low-Alloy with Improved Formability, General Requirements for
ASTM A 743/A 743M	(2006) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(2009) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2855	(1996; R 2010) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3034	(2008) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3139	(1998; R 2005) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F 1554	(2007a) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F 436	(2010) Standard Specification for Hardened Steel Washers
ASTM F 477	(2008) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 593	(2002; R 2008) Stainless Steel Bolts, Hex Cap Screws, and Studs

ASTM F 594	(2009) Standard Specification for Stainless Steel Nuts
ASTM F 879	(2010) Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws
ASTM F 1417	(1992; R 2005) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends

1.3 SYSTEM DESCRIPTION

1.3.1 Sanitary Sewer Gravity Pipeline

Provide new exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.

1.3.2 Sanitary Sewer Pressure Lines

Provide pressure lines of PVC pipe.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit method of testing in accordance with the paragraph entitled "Gravity Piping."

SD-03 Product Data

Pipeline materials; G
Pipeline Appurtenances; G

Submit manufacturer's standard drawings or catalog cuts.

SD-06 Test Reports

Air Test; G

Reports for the following shall be submitted in accordance with paragraph entitled "Reports" of this section.

Reports; G

Test and inspection reports, as specified.

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Installing Contractor's License shall be current and be state certified or state registered.

1.5.1.1 Quality Control For Stainless Steel Pipe

Include the "Hydrostatic Test" and "Flattening Test" requirements described in ASTM A 530/A 530M.

Use only certified welders meeting procedures and performance outlined in Section IX of the ASME BPVC and other codes and requirements in accordance with local building and utility requirements. Obtain Welder's certificates for the project record before beginning any welding on the project. The Welder must be certified for all positions (flat, vertical, and overhead).

Have all welds conform to highest industrial practice in accordance with ASME B31.3 and ASME B31.1 or other codes and requirements in accordance with local building and utility requirements.

1.5.2 Drawings

a. Installation drawings shall be submitted showing complete detail, both plan and side view details with proper layout dimensions and elevations.

b. Record drawings for the complete sanitary sewer system shall be submitted showing complete detail with all dimensions, both above and below grade, including invert elevations.

c. Record drawings shall be signed and sealed by a Professional Surveyor. Include the following statement: "All potable water lines crossed by sanitary hazard mains are in accordance with the permitted utility separation requirements."

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery and Storage

1.6.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.6.1.2 Metal Items

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.6.1.3 Cement, Aggregate, and Reinforcement

As specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

1.6.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench.

PART 2 PRODUCTS

2.1 PIPELINE MATERIALS

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 PVC Plastic Sewer Piping

2.1.1.1 PVC Plastic Pipe and Fittings

Polyvinyl chloride (PVC) pipe and fittings shall conform to ASTM D 3034, Cell Classification 12454-B DR 35 with push-on joints and shall be green.

2.1.2 PVC Plastic Pressure Pipe and Associated Fittings

2.1.2.1 PVC Plastic Pressure Pipe and Fittings

a. Pipe and Fittings Less Than 4 inch Diameter: Pipe, couplings and fittings shall be manufactured of materials conforming to ASTM D 1784, Class 12454B.

(1) Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D 1785, Schedule 80, with joints meeting requirements of 150 psi working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified. Fittings for threaded pipe shall conform to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings. Pipe couplings when used, shall be tested as required by ASTM D 2464.

(2) Push-On Joint: ASTM D 3139, with ASTM F 477 gaskets. Fittings for push-on joints shall be iron conforming to AWWA C110/A21.10 or AWWA C111/A21.11. Iron fittings and specials shall shall be cement-mortar lined (standard thickness) in accordance with AWWA C104/A21.4.

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 150 psi working pressure and 200 psi hydrostatic test pressure. Fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467.

2.1.3 Pipeline Appurtenances

Provide fasteners in accordance with the following section unless otherwise noted.

1. General: For all exterior applications and where fastening aluminum, provide Type 304 stainless-steel fasteners. Provide hot-dipped galvanized fasteners in all other applications in accordance with ASTM A 153/A 153M unless noted otherwise on the drawings. Select fasteners for type, grade, and class required.

2. High-Strength Bolts and Nuts: ASTM A 325 with heavy hex nuts ASTM A 563 and hardened carbon-steel washers ASTM F 436.

3. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, with hex nuts, ASTM A 563, and, where indicated, flat washers.

4. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group A4.

5. Stainless Steel Socket Button and Flat Countersunk Head Cap Screws: ASTM F 879.

6. Anchor Bolts: ASTM F 1554, Grade 36.

7. Eyebolts: ASTM A 489.

8. Machine Screws: ASME B18.6.3.

9. Lag Bolts: ASME B18.2.1.

10. Wood Screws: Flat head, ASME B18.6.1.

11. Plain Washers: Round, ASME B18.22.1.

12. Lock Washers: Helical, spring type, ASME B18.21.1.

2.1.4 Transition Couplings

Transition Coupling shall consist of a high-strength steel body, two steel or malleable iron flange or follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675GR60, free of surface defect.
Followers: AISI C1012 or ASME SA-36
Bolts: AWWA C111/A21.11
Gasket: Grade 27 BUNA-S.
Shop Paint: Fusion bonded epoxy coating.
Acceptable Manufacturers:
Dresser Manufacturing Division of Dresser Industries, Inc.; Dresser Styles 62 and 162 or approved equal.

2.2 VALVES

2.2.1 Plug Valve

Conform plug valves to MSS SP-70.

Ensure that all plug valves are eccentric plug valves unless otherwise specified.

Plug valves shall be of the nonlubricated rectangular ported eccentric type with resilient faced plugs. Furnish valves in vaults or above-grade with flanged end connections. Furnish buried valves with mechanical joint end connections. Face and drill flanged valves to the ANSI 125/150-pound standard. Mechanical joint ends shall conform with AWWA C111/A21.11, grooved ends shall conform with AWWA C606. Screwed ends shall conform to the NPT standard.

Valve bodies shall be made of Class B cast iron conforming to ASTM A 126. Seat area shall be raised with raised surface completely covered with weld to ensure that the plug face contacts only nickel. Screwed-in seats are not acceptable.

Plugs shall be cast iron conforming to ASTM A 126 Class B. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat with the plug in the closed position shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be chloroprene (CR) or resilient facing suitable for application. VE option of round port valves is not acceptable.

Bearings shall have sleeve type metal bearings and shall be of sintered, soil impregnated permanently lubricated Type 316 ASTM A 743/A 743M Grade CF-8M. Non metallic bearings are not acceptable.

Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable and repackable without removing the actuator or bonnet from the valve under pressure. Valves using O-ring seals or non-adjustable packing are not acceptable. All exposed nuts, bolts, springs, washers, and other fasteners shall be 300-series stainless steel.

Pressure ratings shall be 175 psi. Test every valve with a hydrostatic and seat test and furnish certified copies of proof-of-design test reports as outlined in AWWA C504, Section 5.5.

Unless noted otherwise, equip manual valves with the following actuators:

Exposed valves 4 inches: removable lever actuators.

Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque and to provide adjustment to compensate for change in pressure differential or flow direction change.

Ensure that valves and gear actuators for buried or submerged service have seals on all shaft and gaskets on the valve and actuator covers to prevent the entry of water. Totally enclose actuator mounting brackets for buried or submerged service and provide gasket seals.

All actuators shall be furnished by the valve manufacturer and shall be factory assembled, adjusted, and tested with the valve. Test reports shall be available upon request.

The exterior of valves and actuators shall be factory prepared and primed, and field finish coated in accordance with Section 09 96 00 HIGH PERFORMANCE PAINTING AND COATING. Buried valves shall be polyethylene encased as specified herein for ductile iron pipe and fittings.

Plug valves shall be DeZURIK PEC or approved equal.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Tracer Wire for All Piping Including Horizontal Directional Drilling

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

2.4 REPORTS

Submit Test Reports. Compaction and density test shall be in accordance with Section 31 00 00 EARTHWORK. Submit Inspection Reports for daily activities during the installation of the sanitary system. Information in the report shall be detailed enough to describe location of work and amount of pipe laid in place, measured in linear feet.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

Any utilities damaged, both new and existing, as a result of this project shall be repaired per manufacturer's recommendations at no cost the Government.

3.1.1 General Requirements for Installation of Pipelines

3.1.1.1 Location

For the location and separation requirements of the water main with respect to other utilities, refer to the Typical Utility Conflict Detail in the Drawings.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Bottom of trench shall be shaped to give uniform circumferential support to the lower fourth of each pipe. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid true to line and grade in a manner to form a close concentric joint with the adjoining pipe and prevent sudden offsets of the flow line. Interior of the sewer shall be cleared of superfluous materials at all times. Where cleaning after laying is difficult, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after jointing has been completed. When the maximum width of the trench at the top of the pipe is exceeded for any reason other than by direction, the Contractor shall install, at no additional cost to the Government, such bedding as may be required to satisfactorily support the added load of the backfill. Trenches shall be kept free from water until the pipe-joining material has set. Pipe shall not be laid when the condition of the trench or the weather is unsuitable for such work. When work is not in progress, open ends of pipe and fittings shall be closed to prevent intrusion of foreign materials.

3.1.1.4 Connection to Manhole

Obtain approval from the Contracting Officer before making connection to existing manhole. Conduct work so that there is minimum interruption of service.

3.1.1.5 Installation of Tracer Wire

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

3.1.2 Installation of PVC Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with requirements of ASTM D 1785.

3.1.3 Solvent-Welded Joints

Before solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least 1 hour.

Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent-welded pipe ends as recommended by the pipe manufacturer.

Wipe away loose dirt and moisture from the inside and outside of the pipe end and the inside of the fitting before applying solvent cement. Clean the surfaces of both pipes and fittings that are to be solvent welded with a clean cloth moistened with acetone or methylethyl ketone. Do not apply solvent cement to wet surfaces.

The pipe and fitting socket shall have an interference fit. The diametrical clearance between pipe and entrance of the fitting socket shall not exceed 0.04 inch. Check the fit at every joint before applying solvent cement.

Make up solvent-welded joints in accordance with ASTM D 2855. Application of cement to both surfaces to be joined and assembly of these surfaces shall produce a continuous bond between them with visual evidence of cement at least flush with the outer end of the fitting bore around the entire circumference.

Allow at least 8 hours of drying time before moving solvent-welded joints or subjecting the joints to any internal or external loads or pressures.

Acceptance criteria for solvent-welded joints shall be as follows:

Unfilled Areas in Joint: None permitted.

Unbonded Areas in Joint: None permitted.

Protrusion of Material into Pipe Bore, Percent of Pipe Wall Thickness: Cement, 50 percent.

3.1.4 Miscellaneous Construction and Installation

3.1.4.1 Connecting to Existing Manholes

Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

3.2 INSPECTION AND TESTING

3.2.1 General

Inspect all work constructed for faults or defects and correct any deviation from these documents or omissions at once. Conduct all tests and provide necessary equipment and personnel for lamping the system in the presence of the Contracting Officer. The Contractor shall bear all costs for these tests and inspections.

Test sewers by a low-pressure air test.

Ensure that pipe testing closely follows pipe laying. No more than 1,000 feet of pipe shall remain untested at any time.

3.2.2 Gravity Piping

Submit the proposed method of testing to the Contracting Officer for approval. Perform air testing in accordance with the procedures described in ASTM F 1417. Ensure that the equipment is specifically designed and manufactured for testing pipelines with low-pressure air and is provided with an air regulator valve or air safety valve set to prevent the air pressure in the pipeline from exceeding 8 psig. If the results of the air test are unsatisfactory, perform the exfiltration test as outlined above.

The following low-pressure air testing procedures may be used. Ensure that the sewer line has an orifice through which to pass air into the pipe. Connect an air supply to the orifice at one end of the line. The air supply line will contain an on/off gas valve and a pressure gauge with a range of 0 to 5 psi. Ensure that the gauge has minimum divisions of 0.10 psi and has an accuracy of plus/minus 0.04 psi. Properly block the seals at each manhole to prevent displacement while the line is under pressure. Pressurize the pipe line under test to 4 psig. Allow the line to stabilize between 4 psig and 3.5 psig for no less than 5 minutes. If necessary, add air to the line to maintain the pressure above 3.5 psig. After the stabilization period, close the gas valve. When the line pressure drops to 3.5 psig, begin timing with a stop watch. Allow the stop watch to run until the line pressure drops to 2.5 psig. Then stop the watch and compare the time lapse to the allowable time lapse in these Specifications. If the time lapse is greater than that specified, the section undergoing the test shall have passed the low-pressure air test and the test will be discontinued at that time. If the time is less than that specified, the line has not passed the test (see Table 1 for test times).

TABLE 1 AIR TEST TABLE

Length (feet)	4	6	8	10	12	15	18	21	24
25	0:04	0:10	0:18	0:28	0:40	1:02	1:29	2:01	2:38
50	0:09	0:20	0:35	0:55	1:19	2:04	2:58	4:03	5:17
75	0:13	0:30	0:53	1:23	1:59	3:06	4:27	6:04	7:55
100	0:18	0:40	1:10	1:50	2:38	4:08	5:56	8:05	10:34
125	0:22	0:50	1:28	2:18	3:18	5:09	7:26	9:55	11:20
150	0:26	0:59	1:46	2:45	3:58	6:11	8:30	--	--
175	0:31	1:09	2:03	3:13	4:37	5:05	--	--	--
200	0:35	1:19	2:21	3:40	5:17	--	--	--	12:06
225	0:40	1:29	2:38	4:08	5:40	--	--	10:25	13:36
250	0:44	1:39	2:56	4:35	--	--	8:31	11:35	15:07
275	0:48	1:49	3:14	4:43	--	--	9:21	12:44	16:38
300	0:53	1:59	3:31	--	--	--	10:12	13:53	18:09
350	1:02	2:19	3:47	--	--	8:16	11:54	16:12	21:10
400	1:10	2:38	--	--	6:03	9:27	13:36	18:31	24:12
450	1:19	2:50	--	--	6:48	10:38	15:19	20:50	27:13
500	1:28	--	--	5:14	7:34	11:49	17:01	23:09	30:14

3.2.3 Infiltration

After the work is complete, test the sewers or sections for infiltration. Any section in which the infiltration of water is detected will be rejected until corrective work has been performed. No infiltration will be allowed for any one trunk, main, lateral, or segment between manholes.

3.2.4 Exfiltration

The Contracting Officer may require tests for exfiltration. Ensure that exfiltration is in accordance with the requirements of ASTM requirements as modified by the Contracting Officer. Permit an allowance of 10 percent of exfiltration gallonage for each additional 10-foot head over the basic top-of-manhole head.

3.2.5 Television Inspection

Inspect all new sewer mains by internal television inspection, providing accurate distances to all service, with logs and video record of inspection. Provide all equipment and labor for such inspection. Any

subcontractor must be approved by the Government before work. Acceptable procedures for televising and video recording are available from the Contracting Officer. Take digital video records of all inspection, including the manholes. Prepare the DVD and, after review by the Contracting Officer, deliver it to the Government. The Contracting Officer or Government's representative shall observe the television inspection.

3.2.6 Alignment and Deflection

Ensure that lines show full circle of light when lamped between manholes for line sections with complete pipe replacement.

Pass a nine-point mandrel through each new flexible pipe section installed after full backfill has been placed. Ensure that the maximum pipe diameter deflection does not exceed 5 percent.

3.2.7 Repair of Piping

At the option of the Contracting Officer, if piping is found to be defective during the warranty test period and if the Contracting Officer does not approve a method of pipe repair by the Contractor, the Contractor shall remove and replace the faulty pipe in an approved manner at no additional cost to the Government.

3.3 CLEANING

Thoroughly clean all precast structures of all silt, debris, and foreign matter of any kind before final inspections.

3.4 ACCEPTANCE

Sections of the sewer and manholes found defective in material, alignment, grade, or joints shall be corrected at no additional cost to the Government before acceptance.

-- End of Section --

SECTION 33 40 00

STORM DRAINAGE UTILITIES
01/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 198	(2010) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

ASTM INTERNATIONAL (ASTM)

ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM C 1103	(2003) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C 32	(2005) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 443	(2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 478	(2009) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 507	(2007) Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C 55	(2006e1) Concrete Brick
ASTM C 62	(2005) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 76	(2008a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 828	(2006) Low-Pressure Air Test of Vitrified

	Clay Pipe Lines
ASTM C 923	(2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C 924	(2002) Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM D 3212	(2007) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F 1417	(1992; R 2005) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

Section 425	(2007) Structure - Inlets, Manholes, and Junction Boxes

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following:

Gaskets
Frames, Covers, and Gratings; G
Precast Concrete Manholes and Inlets; G

SD-07 Certificates

Pipeline Testing; G
Hydrostatic Test on Watertight Joints; G

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf

life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Concrete Pipe

Concrete pipe shall conform to ASTM C 76, Class III with wall type A and with wire fabric reinforcement, and bell and spigot ends.

2.1.1.1 Reinforced Elliptical Culvert and Storm Drainpipe

Reinforced elliptical culvert and storm drainpipe shall conform to ASTM C 507 and be of the horizontal type, Class III with wire fabric reinforcement, and bell and spigot ends.

2.2 DRAINAGE STRUCTURES

2.2.1 Manhole and Catch-Basin Materials

Inlets, manholes, and boxes shall be in accordance with Section 425 of the FDOT Standard Specifications.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Brick

Brick shall conform to ASTM C 62, Grade SW; ASTM C 55, Grade S-I or S-II; or ASTM C 32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.

2.3.2 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall conform to ASTM C 478. Joints between precast concrete risers and tops shall be made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS.

2.3.3 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48/A 48M, Class 35B; or cast ductile iron, ASTM A 536, Grade 65-45-12.

2.3.4 Joints

2.3.4.1 Flexible Watertight Joints

a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C 443. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

2.4 DOWNSPOUT BOOTS

Boots used to connect exterior downspouts to the storm-drainage system shall be of gray cast iron conforming to ASTM A 48/A 48M, Class 30B or 35B. Shape and size shall be as indicated.

2.5 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C 923.

2.6 HYDROSTATIC TEST ON WATERTIGHT JOINTS

2.6.1 Concrete

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M 198 or ASTM C 443. Test requirements for joints in PE and ABS plastic pipe shall conform to ASTM D 3212.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.

3.1.1 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 31 00 00 EARTHWORK.

3.1.2 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed manufacturer's recommendations.

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Plastic	7.5

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible

pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced.

3.3.1 Concrete Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.3.2 Elliptical Reinforced Concrete Pipe

The manufacturer's reference lines, designating the top of the pipe, shall be within 5 degrees of a vertical plane through the longitudinal axis of the pipe, during placement. Damage to or misalignment of the pipe shall be prevented in all backfilling operations.

3.3.3 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

3.4 JOINTING

3.4.1 Concrete Pipe

3.4.1.1 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.5 DRAINAGE STRUCTURES

3.5.1 Precast Concrete Manholes and Inlets

Construction shall be of precast reinforced concrete, complete with frames, covers, and gratings, and with fixed galvanized steel ladders where indicated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

3.5.2 Walls and Headwalls

Construction shall be as indicated.

3.6 BACKFILLING

3.6.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 6 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below.

3.6.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 6 inches.

3.6.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.7 PIPELINE TESTING

3.7.1 Leakage Tests

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for concrete pipes shall conform to ASTM C 924. Low pressure air testing for plastic pipe shall conform to ASTM F 1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 or ASTM C 924, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C 1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device

acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 0.2 gallons per inch in diameter per 100 feet of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.

3.7.2 Deflection Testing

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

a. Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device. Ball, cylinder, or circular sections shall conform to the following:

1. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

2. A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.

3. Center bored and through bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of not less than 70,000 psi, with eyes or loops at each end for attaching pulling cables.

4. Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved by the Contracting Officer prior to use.

c. Pull-through device: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace

pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.

d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, remove pipe which has excessive deflection, replace with new pipe, and completely retest in same manner and under same conditions.

e. Warranty period test: Pipe found to have a deflection of greater than 5 percent of average inside diameter when deflection test is performed just prior to end of one-year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection.

-- End of Section --

SECTION 33 52 10

SERVICE PIPING, FUEL SYSTEMS
04/08

PART 1 GENERAL

1.1 SUMMARY

This section defines the requirements for pipe, piping components, and valves as related to fuel distribution systems (non-aviation type). Provide the entire fuel distribution system as a complete and fully operational system. Size, select, construct, and install equipment and system components to operate together as a complete system. Substitutions of functions specified herein will not be acceptable. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system. Equipment and piping specified herein shall be designed to handle a working pressure of 275 psig at 100 deg F. Equipment specified herein shall be compatible with the fuel to be handled.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 2003	(2008) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API Spec 5L	(2007) Specification for Line Pipe
API Spec 6D	(Addendum 3 2012) Specification for Pipeline Valves

ASME INTERNATIONAL (ASME)

ASME B1.1	(2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B16.11	(2011) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.34	(2009; Supp 2010) Valves - Flanged, Threaded and Welding End

ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.1	(2012) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2010) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.3	(2010) Process Piping

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A 105M	(2005) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 182/A 182M	(2008a) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 193/A 193M	(2008b) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	(2008b) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A 216/A 216M	(2008) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 234/A 234M	(2007) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 312/A 312M	(2008a) Standard Specification for Seamless, Welded, and Heavily Worked Austenitic Stainless Steel Pipes
ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel

ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 733	(2003) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B 117	(2009) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM B 687	(1999; R 2005e1) Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
ASTM D 229	(2001) Rigid Sheet and Plate Materials Used for Electrical Insulation
ASTM F 844	(2007a) Washers, Steel, Plain (Flat), Unhardened for General Use

FLORIDA ADMINISTRATIVE CODE (FAC)

FAC 62-762	(2005) Aboveground Storage Tank Systems

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 1100	(2005) Recommended Practice for Powering and Grounding Electronic Equipment
IEEE Std 142	(2007) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book (Color Book Series)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2012) Flammable and Combustible Liquids Code
NFPA 70	(2014) National Electrical Code
NFPA 77	(2007) Recommended Practice on Static Electricity
NFPA 780	(2011) Standard for the Installation of Lightning Protection Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(1999; Rev B) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting of Steel

1.2.1 Related Requirements

Section 01 91 13 COMMISSIONING applies to the work specified in this section.

Section 01 33 29 LEED(TM) DOCUMENTATION applies to the work and products specified in this section

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding; G
Pipe Hangers and Supports; G

SD-03 Product Data

Carbon Steel Pipe
Ball Valve

SD-06 Test Reports

Preliminary Pneumatic Test
Final Pneumatic Test

SD-07 Certificates

Contractor Qualifications; G
Demonstrations

1.4 QUALITY ASSURANCE

1.4.1 Contractor Qualifications

Each installation Contractor shall have successfully completed at least 3 projects of the same scope and the same size, or larger, within the last 6 years; demonstrate specific installation experience in regard to the specific system installation to be performed; have taken, if applicable, manufacturer's training courses on the installation of piping; and meet the licensing requirements in the state.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 VALVE ARRANGEMENT

Valve arrangement between major fuel system components shall be as follows Provide unions to allow removal of all valves without removing pipe sections:

At main tank port to day tank supply provide the following closely spaced in series: manual shutoff valve, solenoid valve operated by the day tank supply pumps, and manual shutoff valve (for solenoid valve isolation).

At the day tank supply port (fed by the main tank) provide the following closely spaced in series: manual shutoff valve and fuel strainer.

1.7 PROJECT/SITE CONDITIONS

Fuel required for the testing, flushing and cleaning efforts, as specified in this section, will be provided and delivered by the Contracting Officer. Do not flush, clean, or test any system with fuel or liquid not intended for final system operation. Fuel used in the system will remain the property of the Government. Fuel shortages not attributable to normal handling losses shall be reimbursed to the Government.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Internal parts and components of equipment, piping, piping components, and valves that could be exposed to fuel during system operation shall not be constructed of zinc coated (galvanized) metal, brass, bronze, or other copper bearing alloys. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

2.1.1 Standard Products

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products; that are of a similar material, design and workmanship; and that have been in satisfactory commercial or industrial use for a minimum 2 years prior to bid opening. The 2 year period shall include applications of the equipment and materials under similar circumstances and of similar size. Materials and equipment shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

2.1.2 Gaskets

Provide gaskets that are factory cut from one piece of material.

2.1.2.1 Nitrile Butadiene (Buna-N)

Provide Buna-N material that conforms to SAE AMS3275.

2.1.2.2 Acrylonitrile Butadiene Rubber (NBR)

Provide NBR material that conforms to SAE AMS3275.

2.2 ELECTRICAL COMPONENTS

2.2.1 General

Provide contactors, controls, and control wiring. Provide electrical equipment, including wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING. Provide switches and devices necessary for controlling and protecting electrical equipment. Controllers and contactors shall have a maximum of 120-volt control circuits and shall have auxiliary contacts for use with the controls provided.

2.2.2 Grounding and Bonding

Grounding and bonding shall be in accordance with NFPA 70, NFPA 77, NFPA 780, API RP 540, API RP 2003, IEEE Std 142, and IEEE Std 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.3 FLANGED END CONNECTIONS

2.3.1 Flanges

Provide flanged end connections on equipment, fittings, piping, piping components, adapters, couplers, and valves that conform to ASME B16.5, Class 150.

2.3.1.1 Carbon Steel

Carbon steel flanges shall conform to ASTM A 105/A 105M.

2.3.2 Flange Gaskets, Non-Isolating

Provide flange gaskets that are 1/8 inch thick and that conform to ASME B16.21, raised-face type unless otherwise indicated. Gaskets shall be constructed of Buna-N.

2.3.3 Flange Gaskets, Electrically Isolating

Flange gaskets shall conform to ASTM D 229 and shall provide an electrical insulating material of 1000 ohms minimum resistance. Provide gasket material that is chemically compatible with the fuel to be handled. Provide gaskets that are the full face type. Provide flanges that have a full surface 0.03 inch thick, spiral-wound mylar insulating sleeves between the bolts and the holes in the flanges. Bolts may have reduced shanks of a diameter not less than the diameter at the root of the threads. Provide high-strength 1/8 inch thick phenolic insulating washers next to the flanges with flat circular stainless steel washers over the insulating washers and under bolt heads and nuts. Provide bolts long enough to compensate for the insulating gaskets and stainless steel washers.

2.3.4 Flange Bolts, Nuts, and Washers

Bolts and nuts for pipe flanges, flanged fittings, valves and accessories shall conform to ASME B18.2.1 and ASME B18.2.2, except as otherwise specified. Bolts shall be regular hexagonal type. Bolts shall be threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes 1 inch and smaller and Eight-Pitch Thread Series for sizes larger than 1 inch. Nuts shall be the hexagonal, heavy series type. Nuts shall be threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes 1 inch and smaller and Eight-Pitch Thread Series for sizes larger than 1 inch. Bolts shall be of sufficient length to obtain full bearing on the nuts and shall project no more than two full threads beyond the nuts with the bolts tightened to the required torque.

2.3.4.1 Carbon Steel Materials

Bolts shall conform to ASTM A 307, Grade B, hot-dipped galvanized. Nuts shall conform to ASTM A 563, Grade A, hex style, hot-dipped galvanized. Washers shall conform to ASTM F 844, hot-dipped galvanized.

2.4 PIPE

Pipe shall meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein.

2.4.1 Carbon Steel Pipe

Provide carbon steel pipe that complies with one of the following:

a. Pipe shall conform to ASTM A 53/A 53M, Type E or S, Grade B, seamless or electric welded. Pipe smaller than 2-1/2 inches shall be Schedule 80. Pipe 2-1/2 inches and larger shall be Schedule 40.

b. Pipe shall conform to API Spec 5L, Product Specification Level (PSL) 1, Grade B, seamless or electric welded.

End connections for pipe or fittings smaller than 2-1/2 inches shall be forged, socket weld type conforming to ASTM A 182/A 182M and ASME B16.11, unless indicated otherwise. End connections for pipe or fittings 2-1/2 inches and larger shall be buttweld type conforming to ASTM A 234/A 234M, Grade WPB and ASME B16.9 of the same wall thickness as the adjoining pipe. Where threaded end connections are indicated, provide connections that conform to ASME B16.3, Class 150 or ASME B16.11.

2.5 PIPING COMPONENTS

Provide piping components that meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein. Pressure design class for piping components shall be Class 150 as defined in ASME B16.5.

2.5.1 Welded Nipples

Nipples shall conform to ASTM A 733 or ASTM B 687 and be constructed of the same material as the connecting pipe.

2.5.2 Steel Couplings

Couplings shall conform to API Spec 5L, seamless, extra heavy, wrought

steel with recessed ends.

2.5.3 Threaded Unions

Unions shall conform to ASME B16.39, Class 150. Unions materials shall conform to ASTM A 312/A 312M, Grade 304 or 316. Dielectric unions shall conform to dimensional, strength, and pressure requirements of ASME B16.39, Class 150. Steel parts shall be galvanized or plated. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, union shall be able to withstand a 600-volt breakdown test.

2.5.4 Joint Compound

Joint compounds shall be resistant to water and be suitable for use with fuel containing 40 percent aromatics. Threading compound shall be Locktite 567, Gasoila PLS-2, or equivolent.

2.5.5 Pipe Hangers and Supports

Hangers and supports shall be the adjustable type conforming to MSS SP-58 and MSS SP-69, except as modified herein. Provide hot-dipped galvanized finish on rods, nuts, bolts, washers, hangers, and supports. Provide miscellaneous metal that conforms to ASTM A 36/A 36M, standard mill finished structural steel shapes, hot-dipped galvanized. Where piping is in direct contact with supporting bracket, provide a non-conducting material spacer between pipe and support to reduce corrosion potential due to galvanic action.

2.6 GENERAL VALVES

Provide valves that meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein. Valves shall have flanged end connections and conform to ASME B16.34, Class 150 except as modified herein. Provide stainless steel stem and trim for each valve. Valves shall have a weatherproof housing. Seats, body seals, and stem seals shall be Viton or Buna-N.

a. Carbon Steel Piping. Provide valves with bodies, bonnets, and covers constructed of cast steel conforming to ASTM A 216/A 216M.

2.6.1 Ball Valve

Valve shall be the non-lubricated, double seated, ball type that conforms to API Spec 6D. Valve shall operate from fully open to fully closed with 90 degree rotation of the ball. Valve shall be capable of 2-way shutoff. Valve ball shall be constructed of stainless steel. For valves 2 inches and larger, provide full bore type. Valves smaller than 2 inches shall have one piece bodies and shall have a minimum bore not less than 55 percent of the internal cross sectional area of a pipe of the same nominal diameter. Balls shall be provided with trunnion type support bearings for valves 14 inches and larger. Provide valves with worm gear operators, except valves 6 inches and smaller may be lever operated with a minimum 10 adjustable positions between fully opened and fully closed.

2.7 ACCESSORIES

2.7.1 Concrete Anchor Bolts

Concrete anchors shall conform to ASTM A 307, Grade C, hot-dipped galvanized.

2.7.2 Bolts and Studs

Carbon steel bolts and studs shall conform to ASTM A 307, Grade B, hot-dipped galvanized. Stainless steel bolts and studs shall conform to ASTM A 193/A 193M, Class 2, Grade 8.

2.7.3 Nuts

Carbon steel nuts shall conform to ASTM A 563, Grade A, hex style, hot-dipped galvanized. Stainless steel nuts shall conform to ASTM A 194/A 194M, Grade 8.

2.7.4 Washers

Provide flat circular washers under each bolt head and each nut. Washer materials shall be the same as the connecting bolt and nut. Carbon steel washers shall conform to ASTM F 844, hot-dipped galvanized. Stainless steel washers shall conform to ASTM A 194/A 194M, Grade 8.

2.7.5 Pipe Sleeves

Provided sleeves constructed of hot-dipped galvanized steel, ductile iron, or cast-iron pipe .

2.7.6 Leak Detection

Provide fuel oil spill/leak detection system to monitor the following:

Annular space in each storage tank
Day tank rupture basin
Tank annular space leak detection system shall be of dry type or hydrostatic monitoring type.

Detection system shall continuously monitor the status of each monitoring point. System shall detect presence of, or absence of, hydrocarbons and other non-polar liquids. System shall function in ambient temperature range from -40 to +120°F. System response time for detection of hydrocarbon shall be programmable from 0 to 5 seconds after sensors are covered. Main tank leak detection shall comply with product registration requirements of FAC 62-762 Florida Administrative Code (FAC).

Control Unit: Microprocessor based, with RS-232 data output port, serial/parallel data output and 72 hr power-down memory backup. Liquid Crystal Displays (LCD) shall display probe number and probe status. Alarm conditions and relay closure shall be programmable with keypad entries. Double Wall Tank Interstitial Probes: Complete with sensors, detector head cap with visual status indicators, flexible cable, and stainless steel guide cable.

2.8 FINISHES

Ship, store, and handle coating materials as well as apply and cure

coatings in accordance with SSPC PA 1.

2.8.1 Exterior Coating, Aboveground Piping

Coat the exterior of aboveground steel piping, flanges, fittings, nuts, bolts, washers, valves, and piping components, as defined in this specification, in accordance with Section 09 90 00 PAINTS AND COATINGS.

2.8.2 New Equipment and Components

2.8.2.1 Factory Coating

Unless otherwise specified, provide equipment and components fabricated from ferrous metal with the manufacturer's standard factory finish. Each factory finish shall withstand 500 hours exposure to the salt spray test specified in ASTM B 117. For test acceptance, the test specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark immediately after completion of the test. For equipment and component surfaces subject to temperatures above 120 degrees F, the factory coating shall be appropriately designed for the temperature service.

2.8.2.2 Field Painting

Painting required for surfaces not otherwise specified shall be field painted as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint stainless steel and aluminum surfaces. Do not coat equipment or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

PART 3 EXECUTION

3.1 INSTALLATION

Installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with FAC 62-762, ASME B31.3 and NFPA 30, except as modified herein. Safety rules as specified in NFPA 30 shall be strictly observed. Never direct bury threaded connections, socket welded connections, unions, flanges, valves, air vents, or drains. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

3.1.1 Piping

3.1.1.1 General

Thoroughly clean pipe of all scale and foreign matter before the piping is assembled. Cut pipe accurately to measurements established at the jobsite, and worked into place without springing or forcing. Cut pipe square and have burrs removed by reaming. Install pipe to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval.

a. Use reducing fittings for changes in pipe sizes. Install equipment and piping into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and

maintenance. Provide electric isolation fittings between dissimilar metals. Install piping straight and true to bear evenly on supports. Piping shall be free of traps, shall not be embedded in concrete pavement, and shall drain as indicated. Make changes in direction with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted.

b. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. When work is not in progress, securely close open ends of pipe and fittings with an expandable pipe plug so that water, earth, or other substances cannot enter the pipe or fittings. For belowground piping, the full length of each pipe shall rest solidly on the underlying pipe bed.

3.1.1.2 Welded Connections

Unless otherwise indicated on the drawings, pipe joints shall be welded. Construct branch connections with welding tees or forged welding branch outlets. Do not weld stainless steel pipe to carbon steel pipe.

3.1.1.3 Threaded End Connections

Provide threaded end connections only on piping 2 inches in nominal size or smaller and only where indicated on the drawings. Provide threaded connections with thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is tighten.

3.1.2 Bolted Connections

For each bolted connection of stainless steel components (e.g., pipes, piping components, valves, and equipment) use stainless steel bolts or studs, nuts, and washers. For each bolted connection of carbon steel components, use carbon steel bolts or studs, nuts, and washers. Extend bolts, or studs, no less than two full threads beyond their corresponding nut when tightened to the required torque. Prior to installing nuts, apply a compatible anti-seize compound to the male threads.

3.1.3 Flanges and Unions

Except where threaded end connections and/or unions are indicated, provide flanged joints in each line immediately preceding the connection to a piece of equipment or material requiring maintenance such as pumps, general valves, control valves, strainers, and other similar items and as indicated. Assemble flanged joints square and tight with matched flanges, gaskets, and bolts. For flanges, provide washers under each bolt head and nut. Torque wrenches shall be used to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tightening pattern shall be as recommended by the gasket manufacturer. Use anti-seize compound on threads for stainless steel bolts.

3.1.4 Valves

Install ball valves on each side of each piece of equipment, at the midpoint of looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Install valves with stems vertically up unless otherwise indicated. Provide individual

supports and anchors for each valve.

3.2 PIPE HANGERS AND SUPPORTS

Install hangers with a maximum spacing as defined in Table 1 below, except where indicated otherwise. In addition to meeting the requirements of Table 1, provide additional hangers and supports where concentrated piping loads exist (e.g., valves).

Table 1. Maximum Hanger Spacing

Nominal Pipe Size (Inches)	One and Under	1.5	2	3	4	6	8	10	12
Maximum Hanger Spacing (ft)	7	9	10	12	14	17	19	22	23

3.2.1 Structural Attachments

Provide attachments to building structure concrete and masonry by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Apply inserts and anchors with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead applications of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section.

3.3 FIELD QUALITY CONTROLS

3.3.1 Tests

Furnish labor, materials, equipment, electricity, repairs, and retesting necessary for any of the tests required herein. Perform piping test in accordance with the applicable requirements of ASME B31.3 except as modified herein. To facilitate the tests, various sections of the piping system may be isolated and tested separately. Where piping sections terminate at flanged valve points, close the line by means of blind flanges in lieu of relying on the valve. Provide tapped flanges to allow a direct connection between the piping and the air compressor and/or pressurizing pump. Use tapped flanges for gauge connections. Taps in the permanent line will not be permitted. Gauges will be subject to testing and approval. Provide provisions to prevent displacement of the piping during testing. Keep personnel clear of the piping during pneumatic testing. Only authorized personnel shall be permitted in the area during pneumatic and hydrostatic testing. Isolate equipment such as pumps, tanks and meters from the piping system during the testing. Do not exceed the pressure rating of any component in the piping system during the testing. Following satisfactory completion of each test, relieve the test pressure and seal the pipe immediately.

3.3.1.1 Preliminary Pneumatic Test

Apply a 25 psig pneumatic test to product piping. Maintain the pressure while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). If leaks are discovered, repair the leaks accordingly and retest.

3.3.1.2 Final Pneumatic Test

Following the preliminary pneumatic test, apply a 50 psig pneumatic test to all product piping and hold for a period not less than 2 hours. During the test period, there shall be no drop in pressure in the pipe greater than that allowed for thermal expansion and contraction. Disconnect the pressure source during the final test period. If leaks are discovered, repair the leaks accordingly and retest. Upon completion, provide documentation of successful pressure test result to the Contracting Officer.

3.4 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the equipment/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/equipment/systems, both operational and practical theories, and associated routine maintenance procedures. The training session shall consist of a total of 4 hours of normal working time and shall start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

-- End of Section --

SECTION 33 56 10

FACTORY-FABRICATED FUEL STORAGE TANKS
01/08

PART 1 GENERAL

1.1 SUMMARY

This section defines the requirements for factory-fabricated fuel storage tanks.

1.1.1 General Requirements

1.1.1.1 Capacity

Fuel tank shall provide the capacity to meet NFPA 110 Class 25 (25 hours minimum at full load) for the Emergency Power Supply System (EPSS). Coordinate size with emergency generator(s) provided under this contract.

1.1.1.2 Leak Detection

Leak detection shall be electronic or mechanical and comply with requirements specified in FAC 62-762 of the Florida Administrative Code (FAC), specifically 62-762.851 (Alternative Requirements and Equipment Approvals) and 62-762.641 (Performance Standards for Release Detection Methods).

System shall continuously and automatically monitor the interstitial space of a vaulted tank for breaches in the integrity of the primary tank and the exterior vaulted shell.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 2003	(2008) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants

ASTM INTERNATIONAL (ASTM)

ASTM A193/A193M	(2012) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2012) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service,

	or Both
ASTM A307	(2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM F844	(2007a) Washers, Steel, Plain (Flat), Unhardened for General Use

FLORIDA ADMINISTRATIVE CODE (FAC)

FAC 62-762	(2005) Aboveground Storage Tank Systems

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment
IEEE 142	(2007) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2012) Flammable and Combustible Liquids Code
NFPA 110	(2013) Standard for Emergency and Standby Power Systems
NFPA 407	(2012; TIA 11-1) Standard for Aircraft Fuel Servicing
NFPA 70	(2014) National Electrical Code
NFPA 77	(2007) Recommended Practice on Static Electricity
NFPA 704	(2006) Standard System for the Identification of the Hazards of Materials for Emergency Response
NFPA 780	(2011) Standard for the Installation of Lightning Protection Systems

STEEL TANK INSTITUTE (STI)

STI R912	(2009) Installation Instructions for Shop Fabricated Aboveground Tanks for Flammable, Combustible Liquids

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting of Steel

UNDERWRITERS LABORATORIES (UL)

UL 142 (2006; Reprint Feb 2010) Steel Aboveground Tanks for Flammable and Combustible Liquids

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding

SD-03 Product Data

Aboveground Storage Tank; G
Tank Protective Coatings
Tank Gauges; G

SD-06 Test Reports

Aboveground Storage Tank Tightness Tests; G
Tank Manufacturer's Tests
Tank Fill Tests

SD-07 Certificates

Contractor Qualifications; G
Registration

SD-08 Manufacturer's Instructions

Aboveground Storage Tank

Tank Gauges

SD-10 Operation and Maintenance Data

Aboveground Storage Tank

Tank Gauges

1.4 QUALITY ASSURANCE

1.4.1 Contractor Qualifications

Each installation Contractor shall have successfully completed at least 3 projects of the same scope, and the same size or larger within the last 6 years, and demonstrated specific installation experience in regard to the specific system installation to be performed. Each installation Contractor shall have taken, if applicable, manufacturer's training courses on the installation of storage tanks and shall meet all applicable

licensing requirements in the state. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. The letter shall also provide evidence of prior manufacturer's training, state licensing, and other related information.

1.4.2 Regulatory Requirements

1.4.2.1 Registration

Obtain and complete all required tank registration forms required by federal, state, and local authorities. Submit all tank registration forms within 30 days after contract award. The Contracting Officer will submit the forms to the proper regulatory agencies.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 PROJECT/SITE CONDITIONS

Exposed moving parts, parts that produce high operating temperatures and pressures, parts that may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 General

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Provide materials and equipment that have been in satisfactory commercial or industrial use for a minimum 2 years prior to bid opening. The 2 year period shall include applications of the equipment and materials under similar circumstances and of similar size. Provide materials and equipment that have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

2.1.2 Nameplates

Attach nameplates to all specified equipment defined herein. List on each nameplate the manufacturer's name, address, component type or style, model or serial number, capacity or size.

2.2 MATERIALS

Internal parts and components of equipment, piping, piping components, and valves that could be exposed to fuel during system operation shall not be constructed of zinc coated (galvanized) metal. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

2.3 ELECTRICAL WORK

Provide controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of equipment. Provide electrical equipment, including motors and wiring, as specified in Sections 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING AND 26 60 13.00 40 LOW-VOLTAGE MOTORS. Provide switches and devices necessary for controlling and protecting electrical equipment. Controllers and contactors shall have a maximum of 120-volt control circuits and shall have auxiliary contacts for use with the controls provided.

2.3.1 Underground Wiring

Enclose underground electrical wiring in PVC coated conduit. Dielectrically isolate conduit at any steel storage tank connection.

2.3.2 Grounding and Bonding

Grounding and bonding shall be in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.4 STORAGE TANK

2.4.1 Aboveground Storage Tank

Provide a factory-welded single compartment aboveground fuel storage tank with integral secondary containment. The fuel system shall meet all National Fire Protection Association, state and county codes. The primary tank shall meet UL 142 requirements and both primary and secondary shall be vented. The secondary containment shall be provided with a leak detection device. One 5-gallon capacity remote fill box shall be installed adjacent to tank, for delivery of fuel to the tank. An intermal overfill protection device shall be installeld to prevent tank filling in excess of 90% tank capacity. A liquid level clock gauge (visible to fuel delivery operator), a liquid level solar gauge and safety signage shall be provided. All electrical components shall be pre-wired and wires carried to a central point. Tank location and siting shall be in accordance with NFPA 30.

2.4.2 Secondary Contained Steel Tank

The factory-assembled unit shall include a primary storage tank and an integral factory-fabricated secondary containment. Tank assembly shall be in accordance with NFPA 30 and be designed and manufactured for a horizontal installation. Primary storage tank shall be factory-welded steel that conforms to UL 142. Tank assembly shall be mounted on the tank manufacturer's standard UL listed support skid that elevates the tank assembly above the underlying concrete slab a minimum of 12 inches. Tank assembly shall have lifting lugs that allow tank relocation. Provide tank assembly with the manufacturer's standard external ladder and platform assembly, except as modified herein. The ladder and platform assembly shall be constructed of structural steel and shall allow personal access to the top of the tank system. The tank fill line shall be equipped with a three inch kamvalock style dry break male adapter.

2.5 TANK PROTECTIVE COATINGS

2.5.1 Exterior Surfaces, Aboveground Tanks

Protect the exterior surfaces of each aboveground tank as specified in Section 09 90 00 PAINTS AND COATINGS and SSPC PA 1.

2.5.1.1 Labeling

Provide labeling to tank exterior to include NO SMOKING signage, product stored, tank storage capacity, and a NFPA fire diamond placard. NFPA numbering and classification information are found on the material safety data sheet for the commodity stored. Labeling and marking shall be in accordance with requirements in NFPA 704.

2.6 TANK COMPONENTS

Storage tank system components shall be approved for use in the State of Florida in accordance with FAC 62-762.851 (FAC).

2.7 TANK GAUGES

2.7.1 Hydrostatic Tank Gauge System

System shall be the dial type calibrated in inches. Gauge shall be manually actuated. The transmission line from the gauge to the tank shall be copper tubing or chain run in Schedule 80 carrier pipe. The tank assembly (fittings, air bells, and tubing) shall be installed according to the gauge manufacturer's recommendations. Guage shall be installed to be visible from remote fill box location.

2.7.2 Digital Tank Gauge System

Gauge system shall be solar powered electronically actuated type that can continuously monitor a tank's usable liquid level storage capacity. The system shall provide a digital readout of a tank's liquid level in terms of inches and gallons. The system shall be accurate to plus or minus 1/16 inch.

2.8 ACCESSORIES

2.8.1 Concrete Anchor Bolts

Concrete anchors shall conform to ASTM A307, Grade C, hot-dipped galvanized.

2.8.2 Bolts and Studs

Carbon steel bolts and studs shall conform to ASTM A307, Grade B, hot-dipped galvanized. Stainless steel bolts and studs that conform to ASTM A193/A193M, Grade 8.

2.8.3 Nuts

Carbon steel nuts shall conform to ASTM A563, Grade A, hex style, hot-dipped galvanized. Stainless steel nuts shall conform to ASTM A194/A194M, Grade 8.

2.8.4 Washers

Provide flat circular washers under each bolt head and each nut. Washer materials shall be the same as the connecting bolt and nut. Carbon steel washers shall conform to ASTM F844, hot-dipped galvanized. Stainless steel washers shall conform to ASTM A194/A194M, Grade 8.

2.8.5 Thread Sealant Compounds

Threaded steel fittings shall utilize Loctite 567 or equivalent.

PART 3 EXECUTION

3.1 INSTALLATION

Install work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Handle storage tanks with extreme care to prevent damage during placement and install in accordance with the manufacturer's installation instructions and NFPA 30. Inspect the exterior surface of each tank for obvious visual damage prior to and during the placement of each storage tank. Repair surface damage to a storage tank according to manufacturer's requirements before proceeding with the system installation. Provide nylon dielectric bushings on pipe connections to a steel tank.

3.1.1 Equipment

Properly level, align, and secure equipment in place in accordance with manufacturer's instructions. Provide supports for equipment, appurtenances, and pipe as required. Install anchors, bolts, nuts, washers, and screws where required for securing the work in place. Sizes, types, and spacings of anchors and bolts not indicated or specified shall be as required for proper installation.

3.2 FIELD QUALITY CONTROL

3.2.1 Aboveground Storage Tank Tightness Tests

Perform tightness tests on each aboveground storage tank prior to making piping connections. Perform testing in accordance with STI R912 except as modified herein. Gauges used to monitor the tests shall have a scale with a maximum limit of 10 psig. Repair leaks discovered during the tightness tests in accordance with tank manufacturer's instructions. Following any repair, re-test the tank until the tank successfully passes the testing requirements of this paragraph. Proof that storage tank assembly passed equivolent manufacturer's testing prior to shipment may be substituted for this field testing.

3.2.2 Tank Manufacturer's Tests

In addition to the tests required herein, perform any additional tests (i.e., leak tests, cathodic protection verification tests, etc.) on each storage test that is required by the tank manufacturer's written test procedures. Manufacturer's tests that are redundant to tests already required by this specification will only be performed once per tank. Repair all leaks discovered during the tests in accordance with manufacturer's instructions. Following tank repairs, re-test the tank until the tank successfully passes the manufacturer's testing requirements.

3.3 Tank Fill Tests

Tank fill tests shall not be performed until after the flushing, cleaning, and adjusting requirements defined in manufacturer's instuctions or referenced standards. For the tank fill tests, initially fill each storage tank with fuel in order to verify the tank level monitoring system operates properly and the tank overfill protection device functions as designed. Stop filling each tank immediately once the overfill devices operates. Do not overfill any storage tank more than the 90 percent level. Correct and retest any problems with the level monitoring system or the overfill device until each operate as specified herein. During the tests, verify that all tank gauges are calibrated and operating appropriately.

3.4 FIELD PAINTING

Painting required for surfaces not otherwise specified shall be field painted as specified in Section 09 90 00.00 98 PAINTING AND COATING. Do not paint stainless steel and aluminum surfaces. Do not coat equipment or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

-- End of Section --

SECTION 33 71 02.00 20

UNDERGROUND ELECTRICAL DISTRIBUTION
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges
AASHTO M 198	(2010) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 318M	(2008; Errata 2011) Building Code Requirements for Structural Concrete & Commentary
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C478	(2009) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C857	(2011) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014) National Electrical Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005	(Basic; Notice 2) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Precast underground structures; G

SD-03 Product Data

Precast concrete structures; G

Sealing Material

Pulling-In Irons

Manhole frames and covers; G

Composite/fiberglass handholes; G

Cable racks (brackets and arms); G

1.5 QUALITY ASSURANCE

1.5.1 Precast Underground Structures

Submittal required for each type used. Provide calculations and drawings for precast manholes bearing the seal of a registered professional engineer including:

a. Material description (i.e., f'c and Fy).

b. Manufacturer's printed assembly and installation instructions.

c. Design calculations.

d. Reinforcing shop drawings in accordance with ACI SP-66.

e. Plans and elevations showing opening and pulling-in iron locations and details.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

PART 2 PRODUCTS

Provide ducts, grounding, and low voltage wiring equipment in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM AND GROUNDING. Provide medium voltage cable, cable identification (both high and low voltage) within manholes and handholes in accordance with Section 26 05 13.00 98 MEDIUM VOLTAGE CABLE. Provide additional requirements as indicated below.

2.1 CONDUIT SEALING COMPOUND

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as (1.76 degrees C) 35 degrees F, shall neither slump at a temperature of (149 degrees C) 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts;

metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials. Inflatable bladders may be used as an option.

2.2 BURIED WARNING AND IDENTIFICATION TAPE

Provide detectable tape in accordance with Section 31 00 00 EARTHWORK.

2.3 PULL ROPE

Shall be plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

2.4 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. In addition, provide concrete for encasement of underground ducts with 3000 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day compressive strength unless specified otherwise.

2.5 UNDERGROUND STRUCTURES

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C857 and ASTM C478. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers shall fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including brackets and arms, shall be adequate to accommodate the cable.

2.5.1 Cast-in-Place Concrete Structures

Concrete shall conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.5.2 Precast Concrete Structures, Risers, and Tops

In lieu of cast-in-place, Contractors, at their option, may provide precast concrete underground structures subject to the requirements specified below. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.

2.5.2.1 General

Precast concrete structures shall have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures shall have plan area and clear heights not less than those of

cast-in-place structures. Concrete materials and methods of construction shall be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work shall have a 28-day compressive strength of not less than (27279 kpa) 4000 psi. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. Structures shall be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

2.5.2.2 Design for Precast Structures

ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:

a. Angle of Internal Friction (phi) = 30 degrees

b. Unit Weight of Soil (Dry) = 110 pcf, (Saturated) = 130 pcf

c. Coefficient of Lateral Earth Pressure (Ka) = 0.33

d. Ground Water Level = 915 mm 3 feet below ground elevation

e. Vertical design loads shall include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads shall consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered. The minimum design vertical load shall be for H20 highway loading per AASHTO HB-17.

f. Horizontal design loads shall include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, shall be considered, along with a pulling-in iron design load of (2722 kg) 6000 pounds.

g. Each structural component shall be designed for the load combination and positioning resulting in the maximum shear and moment for that particular component.

h. Design shall also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

2.5.2.3 Construction

Structure top, bottom, and wall shall be of a uniform thickness of not less than 6 inches. Thin-walled knock-out panels for designed or future duct bank entrances shall not be permitted. Quantity, size, and location of duct bank entrance windows shall be as directed, and cast completely open by the precaster. Size of windows shall exceed the nominal duct bank envelope dimensions by at least (305 mm) 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows shall be a

minimum of 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of (305 mm) 12 inches in diameter and 4 inches deep for precast structures.

2.5.2.4 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to AASHTO M 198, Type B. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.5.3 Manhole Frames and Covers

Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the words "ELECTRIC" or "COMMUNICATION" in the top face of manhole covers as applicable.

2.5.4 Composite/Fiberglass Handholes and Covers

Provide vehicle traffic rated handholes and covers of polymer concrete, reinforced with heavy weave fiberglass.

2.6 CABLE RACKS (BRACKETS AND ARMS)

Cable racks shall be as specified herein and detailed on the drawings.

2.6.1 Cable Rack Brackets

Cable rack brackets shall be UL Listed heavy-duty nonmetallic glass reinforced nylon in lengths as indicated on the drawings.

2.6.2 Cable Rack Arms

Cable rack arms shall be UL Listed heavy-duty nonmetallic glass reinforced nylon and shall be of the removable type. Cable rack arm length shall be a minimum of (305 mm) 12 inches and a maximum of (356 mm) 142 inches. Hardware (bolts, nuts, washers & lock washers) shall be Type 316 stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

3.2 UNDERGROUND STRUCTURE CONSTRUCTION

Provide standard type cast-in-place and precast construction as specified

herein and on the drawings. Horizontal concrete surfaces of floors shall have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound shall conform to ASTM C309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete.

3.2.1 Precast Concrete Construction

Set commercial precast structures on (150 mm) 6 inches of level, 90 percent compacted granular fill, (19 mm) 3/4 inch to (25 mm) 1 inch size, extending (305 mm) 12 inches beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation shall additionally conform to the manufacturer's instructions.

3.2.2 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices shall be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor the irons shall be a minimum of (150 mm) 6 inches from the edge of the sump, and in the walls the irons shall be located within (150 mm) 6 inches of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron shall not be located within (150 mm) 6 inches of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the (150 mm) 6 inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a (915 mm) 3 foot length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner shall be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of (75 mm) 3 inches from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons shall have a clear projection into the structure of approximately (100 mm) 4 inches and shall be designed to withstand a minimum pulling-in load of (2722 kg) 6000 pounds. Irons shall be hot-dipped galvanized after fabrication.

3.2.3 Cable Racks

Cable racks shall be sufficient to accommodate the cables. Contractor shall choose one of the following methods for anchoring cable racks on

this project:

a. Provide a (16 mm) 5/8 inch diameter by (127 mm) 5 inch long anchor bolt with (75 mm) 3 inch foot cast in structure wall with (50 mm) 2 inch protrusion of threaded portion of bolt into structure. Provide (16 mm) 5/8 inch steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of (1191 kg per meter) 800 pounds per foot. Insert channel shall be steel of the same length as "vertical rack channel;" channel insert shall be cast flush in structure wall. Provide (16 mm) 5/8 inch steel nuts in channel insert to receive (16 mm) 5/8 inch diameter by (75 mm) 3 inch long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert shall have minimum (363 kg) 800 pound load rating. Provide (16 mm) 5/8 inch diameter by (75 mm) 3 inch long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

3.2.4 Field Painting

Cast-iron frames and covers not buried in concrete or masonry shall be cleaned of mortar, rust, grease, dirt and other deleterious materials, and given a coat of bituminous paint.

3.3 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.3.1 Requirements

Depths to top of the conduit shall be in accordance with NFPA 70. Run conduit in straight lines except where a change of direction is necessary. Numbers and sizes of ducts shall be as indicated. Ducts shall have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of (75 mm) 3 inches per (30.5 m) 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be (457 mm) 18 inches for ducts of less than (75 mm) 3 inch diameter, and (915 mm) 36 inches for ducts (75 mm) 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of (7.6 m) 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in structures.

3.3.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and

deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.3.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes (75 mm) 3 inches and larger, draw a flexible testing mandrel approximately (305 mm) 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than (75 mm) 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.3.4 Galvanized Conduit Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations shall be PVC coated and shall extend from at least (50 mm) 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of (150 mm) 6 inches from penetration).

3.3.5 Multiple Conduits

Separate multiple conduits by a minimum distance of (64 mm) 2 1/2 inches, except that light and power conduits shall be separated from control, signal, and telephone conduits by a minimum distance of 12 inches. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per (3 m) 10 feet of conduit assembly.

3.3.6 Conduit Plugs and Pull Rope

New conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weephole or screen to allow water drainage. Provide a plastic pull rope having (915 mm) 3 feet of slack at each end of unused or empty conduits.

3.3.7 Conduit and Duct Without Concrete Encasement

Provide not less than (75 mm) 3 inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional (75 mm) 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a (6 mm) 1/4 inch sieve. The first (150 mm) 6 inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in (75 to 150 mm) 3 to 6 inch layers. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.3.7.1 Encasement Under Roads and Paved Areas

Under roads and paved areas install conduits in concrete encasement of

rectangular cross-section providing a minimum of (75 mm) 3 inch concrete cover around ducts. Concrete encasement shall extend at least (1.5 m) 5 feet beyond the edges of roads and paved areas.

3.3.8 Duct Encased in Concrete

Construct underground duct lines of individual conduits encased in concrete. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least (75 mm) 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of (64 mm) 2 1/2 inches, except separate light and power conduits from control, signal, and telecommunications conduits by a minimum concrete thickness of (75 mm) 3 inches. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring. Anchoring shall be done by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.3.8.1 Connections to Manholes

Duct bank envelopes connecting to underground structures shall be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than (305 mm) 12 inches in each direction. Perimeter of the duct bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

3.3.8.2 Connections to Existing Underground Structures

For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and bend out to tie into the reinforcing of the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

3.3.8.3 Connections to Existing Concrete Pads

For duct bank connections to concrete pads, break an opening in the pad out to the dimensions required and preserve steel in pad. Cut the steel and bend out to tie into the reinforcing of the duct bank envelope. Chip out the opening in the pad to form a key for the duct bank envelope.

3.3.8.4 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks.

3.3.8.5 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by

providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of (610 mm) 2 feet back into the envelope and a minimum of (610 mm) 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, (75 mm) 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately one foot apart. Restrain reinforcing assembly from moving during concrete pouring.

3.3.8.6 Removal of Ducts

Where duct lines are removed from existing underground structures, close the openings to waterproof the structure. Chip out the wall opening to provide a key for the new section of wall.

3.4 CABLE PULLING

Test existing duct lines with a flexible mandrel and thoroughly swab out to remove foreign material before pulling cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures.

3.4.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.5 CABLES IN UNDERGROUND STRUCTURES

Except as otherwise noted, do not install cables utilizing the shortest path between penetrations, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare arm for each cable rack in each underground structure.

3.6 CONDUCTORS INSTALLED IN PARALLEL

Conductors shall be grouped such that each conduit of a parallel run contains 1 Phase A conductor, 1 Phase B conductor, 1 Phase C conductor, and 1 neutral conductor.

3.7 LOW VOLTAGE CABLE SPLICING AND TERMINATING

Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set. Make splices in underground distribution systems only in accessible locations such as manholes or handholes. Where new conductors are specified to be spliced to existing conductors, field verify the size(s) of the existing conductors prior to procuring the materials to make up these splices.

3.8 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70 and Section 31 00 00 EARTHWORK.

3.8.1 Reconditioning of Surfaces

3.8.1.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

3.8.1.2 Paving Repairs

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists, restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.

3.9 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.9.1 Concrete Slabs for Equipment

Unless otherwise indicated, the slab shall be at least (203 mm) 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh, placed uniformly (100 mm) 4 inches from the top of the slab. Slab shall be placed on a (150 mm) 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately (100 mm) 4 inches above finished grade with gradual slope for drainage. Edges above grade shall have (13 mm) 1/2 inch chamfer. Slab shall be of adequate size to project at least (203 mm) 8 inches beyond the equipment.

Stub up conduits, with bushings, (50 mm) 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.9.2 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

-- End of Section --

SECTION 34 71 13.19

ACTIVE VEHICLE BARRIERS
04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2011) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM F2656	(2007) Standard Test Method for Vehicle Crash Testing of Perimeter Barriers

U.S. DEPARTMENT OF STATE (SD)

SD-STD-02.01	(2003; Rev A) Specification For Vehicle Crash Test of Perimeter Barriers and Gates

1.2 SYSTEM DESCRIPTION

Submit a complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Furnish information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed. Barrier systems used shall be listed in either the Department of State (DoS) certified or Department of Defense (DoD) approved anti-ram vehicle barrier lists. Barrier widths shall be 'as certified/approved' on these lists. Alternatively, if a barrier system's width is between the widths of two listed barrier systems that are identical except for their widths, then that barrier system is also acceptable. Exceptions and acceptable widths will only be taken from the DoD anti-ram vehicle barrier list. The design and structural materials of the vehicle barrier furnished shall be the same as those used in the crash tested barrier. Crash test must have be performed and data compiled by an approved independent testing agency in accordance with either ASTM F2656 or SD-STD-02.01. Barriers tested and certified on the previous Department of State standard, SD-STD-02.01 and listed on the DoD approved anti-ram vehicle barrier list are also acceptable. Submit Data Package 4 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be

submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation
Bollards

SD-03 Product Data

Barrier Systems
Spare Parts

SD-06 Test Reports

Field Testing

SD-10 Operation and Maintenance Data

Barrier Systems
Operating and Maintenance Instructions

1.4 DELIVERY, STORAGE, AND HANDLING

Protect components placed in storage from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Store structural materials on sleepers or pallets and protect them from rust and objectionable materials such as dirt, grease, or oil.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment used, after approval of the detail drawings. Include in the data a complete list of parts and supplies, with current unit prices and source of supply. Provide a manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, with each barrier to facilitate 1 year of normal operation. Give particular consideration to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

PART 2 PRODUCTS

2.1 BOLLARDS

Removable Bollards: High security K4 carbon steel bollard; A53 Grade material.

Model and Manufacturer: 8" Cal Pipe Model No. PDT08080R or IBP08080; Basin Industries Inc., or equal.

Foundation: See structural drawings for foundation design.
Bollard Material: Carbon steel.
Sleeve Material: Type 316 stainless steel.
Locking: Keyed padlock with drop down lid.
Impact Resistance: 15,000 lbs traveling 30 mph.
Bollard Cap: Dome cap style.
Finish: Rust protective primer and powder coated.

Plastic Bollard Cover: Cover shall be constructed of high-impact

resistant high-density polyethylene.

Abrasion resistant.
Provide with ultraviole protection additive.
Flexural Modulus: 200,000 psi
Tensile Strength: 4000 psi.
Color to be selected by the Contrating Officer's Representative from manufacturer's full line.

Fixed Bollards: High security K4 carbon steel bollard; A53 Grade material.

Model and Manufacturer: 8" Cal Pipe Security Bollard Model No. SGTF08080 or IBF08080; Basin Industries Inc., or equal.

Foundation: See structural drawings for foundation design.
Material: Carbon steel.
Finish: Rust protective primer and powder coated.
Impact Resistance: 15,000 lbs traveling 30 mph.
Bollard Cap: Dome cap style.
Finish: Rust protective primer and powder coated.

Plastic Bollard Cover: Cover shall be constructed of high-impact resistant high-density polyethylene.

Abrasion resistant.
Provide with ultraviole protection additive.
Flexural Modulus: 200,000 psi
Tensile Strength: 4000 psi.
Color to be selected by the Contrating Officer's Representative from manufacturer's full line.

2.2 CONCRETE

The concrete shall conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.3 WELDING

Welding shall be in accordance with AWS D1.1/D1.1M.

PART 3 EXECUTION

3.1 INSTALLATION

Perform installation in accordance with manufacturer's Operating and Maintenance Instructions and in the presence of a representative of the manufacturer.

Fill bollards solid with concrete.

Provide field testing in accordance with manufacturer's instructions and recommendations.

-- End of Section --

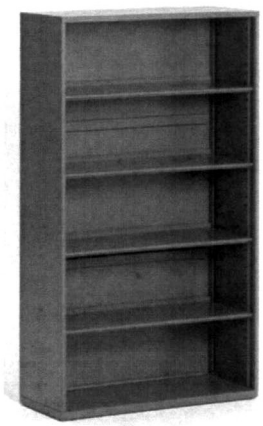
APPENDIX 1

FURNITURE CUT SHEET SPECIFICATIONS

Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	BC1
Item:	Bookcase
Manufacturer:	Steelcase or Approved Equal
Model #:	RBC15365A - Universal
Description:	4 Adjustable Shelves, Steel Construction 3'-0"W x 15"D x 65.5"H
Finish:	Powder Coated Steel - Champagne Metallic 4750
Options:	Adjustable Shelves
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Private Office's on Levels 2-7
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: BC1

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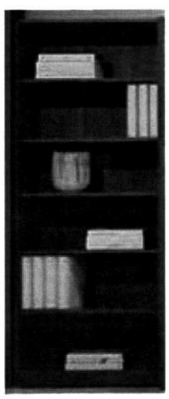
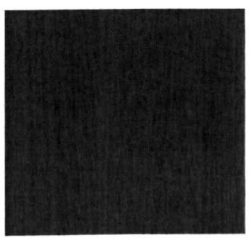
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	BC2
Item:	Bookcase
Manufacturer:	Steelcase or Approved Equal
Model #:	E6BF153672P - Elective Elements 6
Description:	Freestanding Bookcase Without Doors, 3 Adjustable Shelves, Two Fixed Shelves With Finished Back 3'-0"W x 15"D x 72 5/8"H
Finish:	Wood to Match Laminart, #2610-T Bronze Wenge
Options:	Adjustable Shelves
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Select Private Office's on 7th Level
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

Code: BC2

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Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C1
Item:	Typical Task Chair
Manufacturer:	Steelcase or Approved Equal
Model #:	46340100 - Think
Description:	Task chair with adjustable arms, mid-height back, Upholsered seat, 5-star base with casters
Finish:	Upholstered Seat and Back Black Frame and Base
Options:	Adjustable Arms, 4" Pneumatic Seat Height Adjustment, Enclosed Back, Casters
Quantity:	TBD
Fabric(s):	Fabric Upholstery - COM **MFR:** Maharam **Name:** Lariat **Number:** 440401 **Color:** TBD
Location:	Open Office, Private Office and Conference Rooms
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: C1

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Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C2
Item:	Typical Guest Side Chair with Arms
Manufacturer:	Steelcase or Aproved Equal
Model #:	466452MH - Reply
Description:	Upholstered Seat and Back 23.25"W x 23"D x 33"H
Finish:	Upholstered Seat and Back Silver Frame
Options:	Arms, Glides, Sled Base
Quantity:	TBD
Fabric(s):	Vinyl Upholstery - COM **MFR:** Maharam **Name:** Lariat **Number:** 440401 **Color:** TBD
Location:	Open Office, Private Office and Conference Rooms
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: C2

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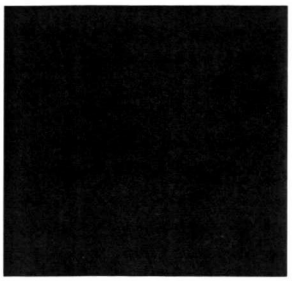
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C3
Item:	Task Chair
Manufacturer:	Steelcase or Approved Equal
Model #:	46216179 - Leap WorkLounge
Description:	Task chair with adjustable arms, mid-height back, Upholsered seat, 5-star base with casters
Finish:	Upholstered Seat and Back Polished Aluminum Base with Silver Frame
Options:	Adjustable Arms, 4" Pneumatic Seat Height Adjustment, Enclosed Ba Casters
Quantity:	TBD
Fabric(s):	Leather
MFR:	Steelcase, Coalesse
Name:	Elmosoft Leather
Number:	N/A
Color:	L112 Ebony
Location:	Select Conference Rooms and Private Office's on 7th Level
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: C3

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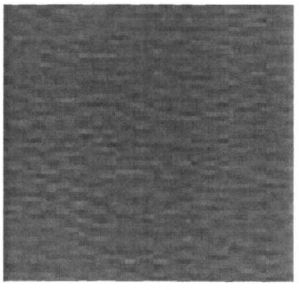
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C4
Item:	Guest Side Chair
Manufacturer:	Gunlocke or Approved Equal
Model #:	GK2801P - Olla
Description:	Cantilevered Seat, Steel Frame, Seat Frame Molded Plywood and Molded Foam, Curvilinear Back for Support, Waterfall Seat Edge 24"W x 24"D x 35"H
Finish:	Upholstered Seat, Back and Arms Chrome Frame
Options:	Glides
Quantity:	TBD
Fabric(s):	Leather
MFR:	Gunlocke
Name:	Florida
Number:	L14-2176
Color:	Morning Shadow
Location:	Select Private Office's on 7th Level
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: C4

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Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C5
Item:	Café/Break Room Side Chair
Manufacturer:	Haworth or Approved Equal
Model #:	SCH-44-0-S - Very
Description:	Molded Back with Built in Lumbar Support, Painted Metal Frame, Sled Base 23.5"W x 22"D X 34"H
Finish:	Polymer Back and Seat, Silver Frame Polymer Color: Snow
Options:	Glides
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Café Seating Area on 1st Level and Break Room's on Mulitple Levels
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: C5

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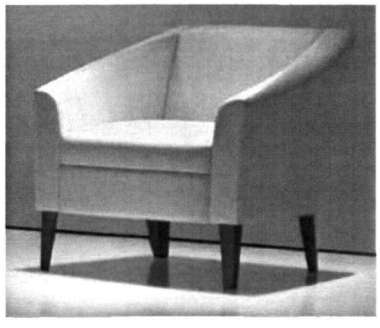
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C6
Item:	Lounge Chair
Manufacturer:	Bernhardt Design or Approved Equal
Model #:	8340 Shawl
Description:	Fully Upholstered Lounge Chair with Wood Base and Legs 28 1/2"W x 28"D x 29 5/8"H
Finish:	Upholstered Seat, Back and Arms Wood Base and Legs Wood: 866 Maple
Options:	N/A
Quantity:	TBD
Fabric(s):	Leather
MFR:	Bernhardt Design
Name:	Finesse
Number:	3100-001
Color:	Black
Location:	Outside & Inside of Conference Room 7212 & Administration on 7th Level
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Wood Finish

Leather

Code: C6

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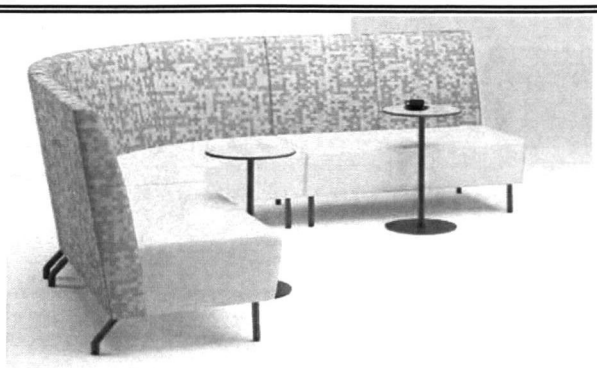
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C7
Item:	Lounge Chair
Manufacturer:	Arcadia or Approved Equal
Model #:	Intima Modular
Description:	Single and Two-Seat Units with Modular Capability, Metal Legs Curviniear and Straight Sections 41"H, Custom Radius' Available
Finish:	Uphlstered Seat and Back, Powder Coated Legs
Options:	Non-Skid Glides, Ganging Brackets
Quantity:	TBD
Fabric(s):	Leather
MFR:	Arcadia
Name:	Grade L2 Ecolife
Number:	N/A
Color:	Glacier
Location:	Lobby Furniture on Level 1
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: C7

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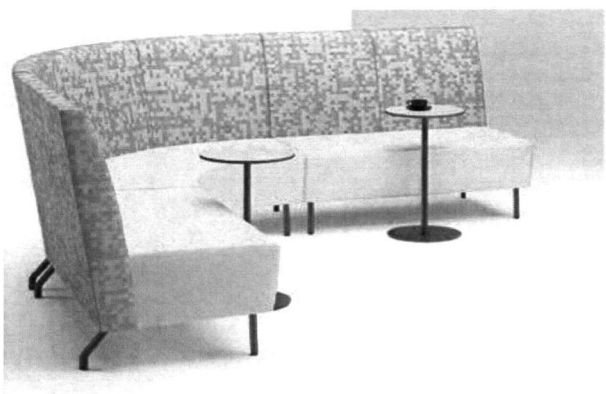
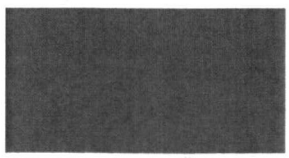
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C8
Item:	Lounge Chair
Manufacturer:	Arcadia or Approved Equal
Model #:	Intima Modular
Description:	Single and Two-Seat Units with Modular Capability, Metal Legs Curviniear and Straight Sections 41"H, Custom Radius' Available
Finish:	Uphlstered Seat and Back, Metal Legs with Several Powder Coat Colors Available
Options:	Non-Skid Glides, Ganging Brackets
Quantity:	TBD
Fabric(s):	Leather
MFR:	Arcadia
Name:	Grade L1
Number:	N/A
Color:	Fawn
Location:	Lobby Seating on Levels 3-7
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

Code: C8

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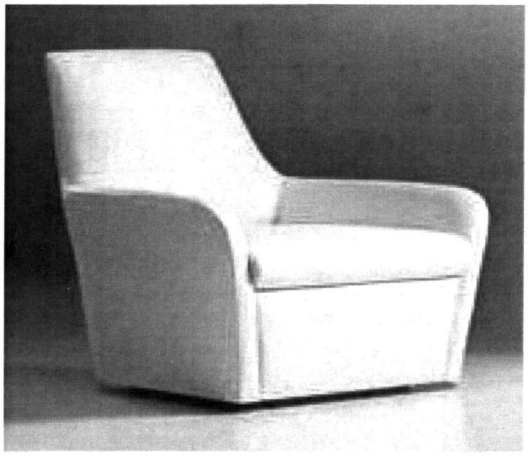
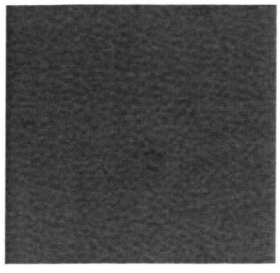
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C9
Item:	Lounge Chair
Manufacturer:	Bernhardt Design or Approved Equal
Model #:	4760 - Amri
Description:	Fully Upholstered, Mid-High Back, Upholstered Frame 33 1/2"W x 34"D x 32 3/4"H
Finish:	Upholstered Seat and Back
Options:	N/A
Quantity:	TBD
Fabric(s):	Leather
MFR:	Bernhardt Design
Name:	Finesse
Number:	3100-810
Color:	Pearl
Location:	Mother's Room on 3rd Level
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

Code: C9

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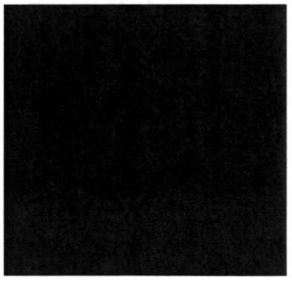
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C10
Item:	Typical Guest Side Chair with Arms
Manufacturer:	Steelcase or Aproved Equal
Model #:	466452MH - Reply
Description:	Upholstered Seat and Back 23.25"W x 23"D x 33"H
Finish:	Upholstered Seat and Back Silver Frame
Options:	Arms, Glides, Sled Base
Quantity:	TBD
Fabric(s):	Leather
MFR:	Steelcase, Coalesse
Name:	Elmosoft Leather
Number:	N/A
Color:	L112 Ebony
Location:	Open Office, Private Office and Conference Rooms
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: C10

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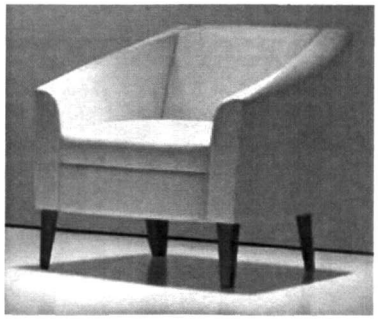
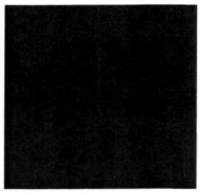
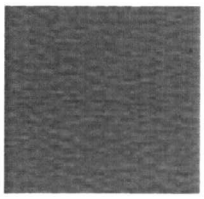
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	C11
Item:	Lounge Chair
Manufacturer:	Bernhardt Design or Approved Equal
Model #:	8340 Shawl
Description:	Fully Upholstered Lounge Chair with Wood Base and Legs 28 1/2"W x 28"D x 29 5/8"H
Finish:	Upholstered Seat, Back and Arms Wood Base and Legs Wood: 866 Maple
Options:	N/A
Quantity:	TBD
Fabric(s):	Leather
MFR:	Gunlocke
Name:	Florida
Number:	L14-2176
Color:	Morning Shadow
Location:	Outside & Inside of Conference Room 7212 & Administration on 7th Level, Refer to A700 Series, Furniture Plans
Remarks:	Refer to A700 Series, Furniture Plans
Image:	  

12.16.13

Code: C11

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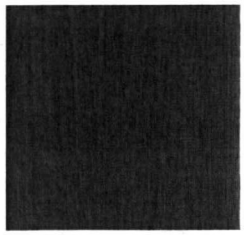
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	D1
Item:	Freestanding Desk
Manufacturer:	Steelcase or Approved Equal
Model #:	Elective Elements 6
Description:	Straight Desk Worksurface W/ Grommet & End Panels Full Height Modesty Panel, (1) Box/Box/File and (1) File/File Straight Worksurface: 3'-0"W x 6'-0"L x 29.5"H
Finish:	Wood Core with Wood Veneer Wood to Match Laminart, #2610-T Bronze Wenge
Options:	Wood Bullnose Edge, Round Gromet in 9211 Nickel Finish, Integrated Adjustable Keyboard Tray, Bar Pulls for Pedestals
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Select Offices on the 7th Floor
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: D1

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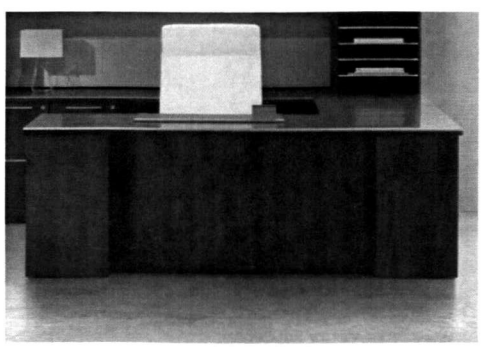
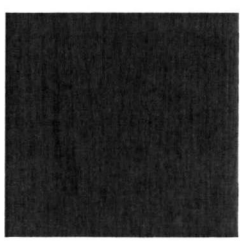
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	D2
Item:	Freestanding Desk
Manufacturer:	Steelcase or Approved Equal
Model #:	Elective Elements 6
Description:	Straight Desk Worksurface with End Panels - No Modesty Panel Straight Worksurface: 2'-0"W x 4'-0"L x 29.5"H
Finish:	Wood Core with Wood Veneer Wood to Match Laminart, #2610-T Bronze Wenge
Options:	Wood Bullnose Edge
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Select Offices on the 7th Floor
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

Code: D2

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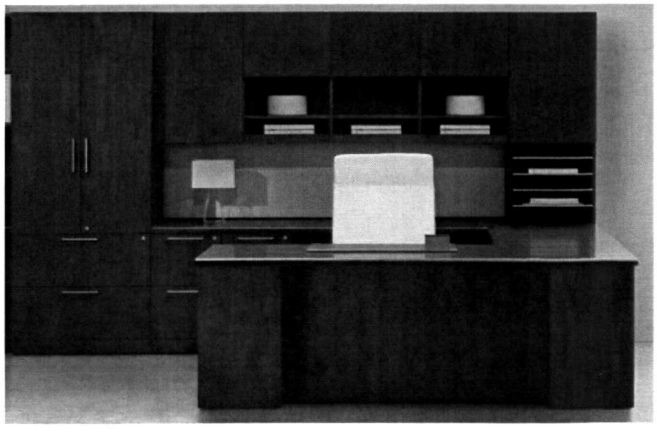
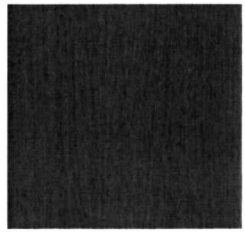
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	D3
Item:	Freestanding Desk
Manufacturer:	Steelcase or Approved Equal
Model #:	Elective Elements 6
Description:	Straight Desk Worksurface with End Panels - No Modesty Panel Straight Worksurface: 2'-0"W x 7'-6"L x 29.5"H (1) Box/Box File Overhead Cabinets with Doors and Open Shelving Tower with Doors & Adjustable Shelves, 2-H Lateral File
Finish:	Wood Core with Wood Veneer Wood to Match Laminart, #2610-T Bronze Wenge
Options:	Wood Bullnose Edge Bar Pulls
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Select Offices on the 7th Floor
Remarks:	Refer to A700 Series, Furniture Plans Refer to Enlarged Furniture Plans for Detailed Components/Descriptions
Image:	 

D3

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Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	LF1
Item:	Lateral File Cabinet
Manufacturer:	Steelcase or Approved Equal
Model #:	RLF18423P - Universal Lateral with Proud Steel
Description:	3- Drawer High Lateral File, Steel Construction 36"W x 18"D x 40"H
Finish:	Powder Coated Steel - Champagne Metallic 4750
Options:	Locks, Bar Pull
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Open Office's on Levels 2-7
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: LF1

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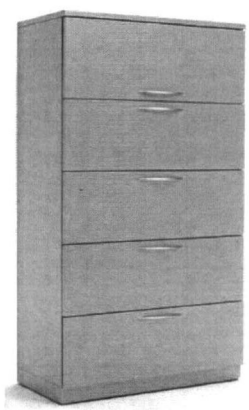
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	LF2
Item:	Lateral File Cabinet
Manufacturer:	Steelcase or Approved Equal
Model #:	RLF18305 - Universal Lateral with Proud Steel
Description:	4-Drawer and 1-Lift-Up Door with Fixed Shelf Lateral File, Steel Construction 30"W x 18"D x 65-1/2"H
Finish:	Powder Coated Steel - Champagne Metallic 4750
Options:	Locks, Bar Pull
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Corridor's on Levels 2-7, File Work Room on Levels 3-6 & Storage Room on 7th Level
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

LF2

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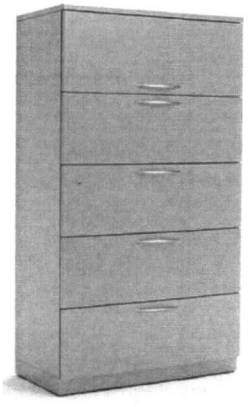
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	LF3
Item:	Lateral File Cabinet
Manufacturer:	Steelcase or Approved Equal
Model #:	RLF18365 - Universal Lateral with Proud Steel
Description:	4-Drawer and 1-Lift-Up Door with Fixed Shelf Lateral File, Steel Construction 36"W x 18"D x 65-1/2"H
Finish:	Powder Coated Steel - Champagne Metallic 4750
Options:	Locks, Bar Pull
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Private Offices on Levels 2-7, Admin #3402, Admin #4402, & Admin #5402
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

LF3

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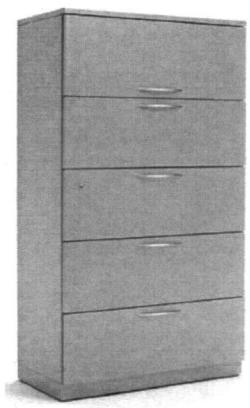
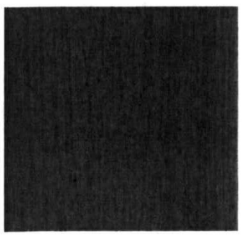
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	LF4
Item:	Lateral File Cabinet
Manufacturer:	Steelcase or Approved Equal
Model #:	RLF18365 - Universal Lateral with Proud Steel
Description:	4-Drawer and 1-Lift-Up Door with Fixed Shelf Lateral File, Steel Construction 36"W x 18"D x 65-1/2"H
Finish:	Wood to Match Laminart, #2610-T Bronze Wenge
Options:	Locks, Bar Pull
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Select Private Offices on the 7th Floor & Storage #7002B
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

Code: LF4

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HB Project No.: 12070.00
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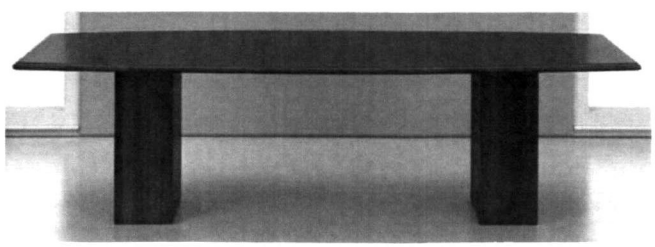
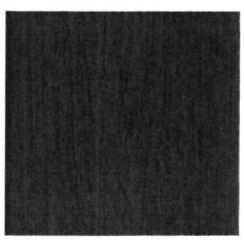
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T1
Item:	Conference Table
Manufacturer:	Nucraft or Approved Equal
Model #:	Forte
Description:	Boat Shaped Wood Table, Rectangular Wood Legs with Power, Wire Management Leg Openings, Adjustability in Grommet Locations 11'-6"L x 5'-0"W
Finish:	Wood Top and Legs Reverse Bevel Edge Wood to Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Conference Room
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

Code: T1

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HB Project No.: 12070.00
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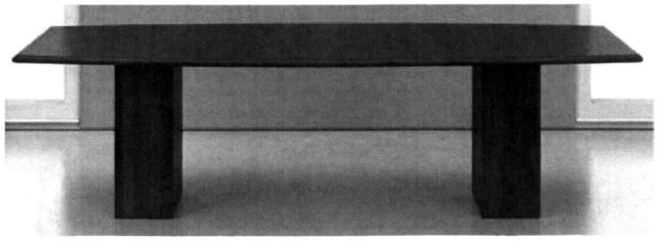
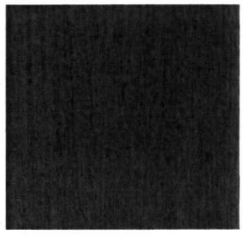
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T2
Item:	Conference Table
Manufacturer:	Nucraft or Approved Equal
Model #:	Forte
Description:	Boat Shaped Wood Table, Rectangular Wood Legs with Power, Wire Management Leg Openings, Adjustability in Grommet Locations 14'-0"L x 5'-0"W
Finish:	Wood Top and Legs Reverse Bevel Edge Wood to Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Conference Room
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

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Project Name: KSC Central Campus - Replacement Headquarters Building
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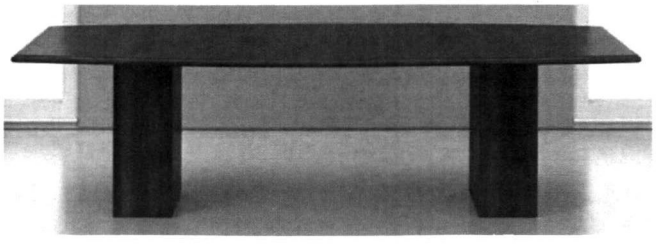
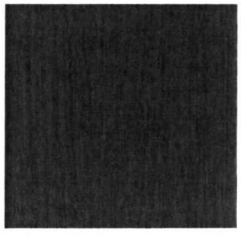
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T3
Item:	Conference Table
Manufacturer:	Nucraft or Approved Equal
Model #:	Forte
Description:	Boat Shaped Wood Table, Rectangular Wood Legs with Power, Wire Management Leg Openings, Adjustability in Grommet Locations 23'-0"L x 5'-0"W
Finish:	Wood Top and Legs Reverse Bevel Edge Wood to Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Conference Room
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

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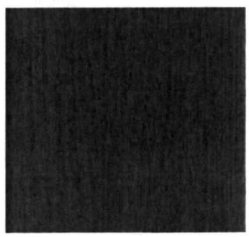
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T4
Item:	Conference Table
Manufacturer:	Nucraft or Approved Equal
Model #:	Forte
Description:	Round Wood Table, Cylinder Wood Base with Wire Management Leg Openings, Adjustability in Grommet Locations 4'-6" Diameter
Finish:	Wood Top and Legs Reverse Bevel Edge Wood to Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Conference Room
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: T4

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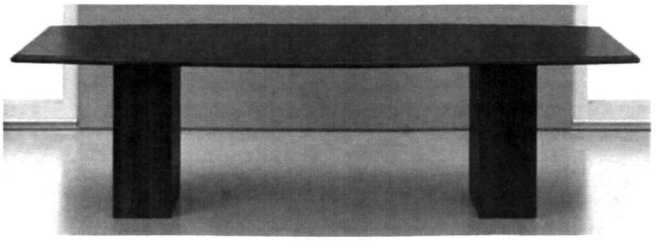
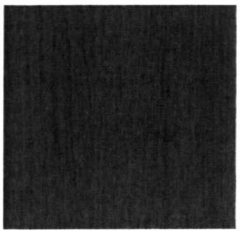
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T5
Item:	Conference Table
Manufacturer:	Nucraft or Approved Equal
Model #:	Forte
Description:	Rectangular Wood Table, Rectangular Wood Base with Wire Management Leg Openings, Adjustability in Grommet Locations 7'-0"L x 5'-0"W
Finish:	Wood Top and Legs Reverse Bevel Edge Wood to Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Conference Room
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

Code: T5

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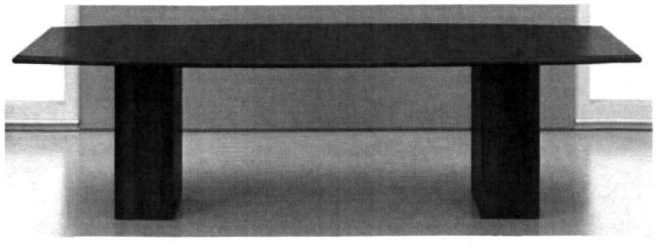
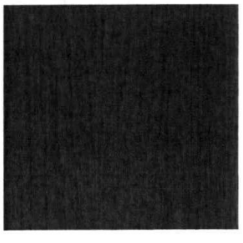
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T6
Item:	Conference Table
Manufacturer:	Nucraft or Approved Equal
Model #:	Forte
Description:	Rectangular Wood Table, Rectangular Wood Base with Wire Management Leg Openings, Adjustability in Grommet Locations 12'-0"L x 5'-0"W
Finish:	Wood Top and Legs Reverse Bevel Edge Wood to Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Conference Room
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

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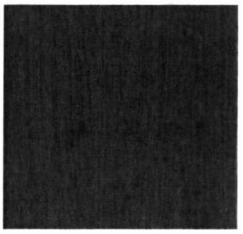
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T7
Item:	Side Work Table
Manufacturer:	Nucraft or Approved Equal
Model #:	Forte
Description:	Round Hardwood Table, Cylinder Wood Base 3'-0" Diameter
Finish:	Hardwood Top and Legs Reverse Bevel Edge Wood to Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Private Office's on Multiple Levels
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: T7

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HB Project No.: 12070.00
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HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T8
Item:	Café/ Break Room Table
Manufacturer:	Steelcase or Approved Equal
Model #:	Universal Table Series
Description:	Round Plastic Laminate Table with Steel Tubular Frame, Powder Coat X Base: 3'-0" Diameter
Finish:	Plastic Laminate: Wilsonart, 4939K-18, Vapor Standz Edge Banding to Match Top X Base - Powder Coat: 4799 Platinum Metallic
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Café Seating Area on 1st Level and Break Room's on Mulitple Levels
Remarks:	Refer to A700 Series, Furniture Plans
Image:	N/A

Code: T8

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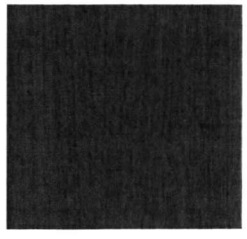
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T9
Item:	Coffee Table
Manufacturer:	Arcadia or Approved Equal
Model #:	Ovate
Description:	Round Wood Table with Wood Platform Base and Wood Legs 3'-0" Diameter
Finish:	Solid Surface Top - Corian, White Jasmine Vertical Surfaces and Legs - To Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Lobbies on Levels 1-7
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

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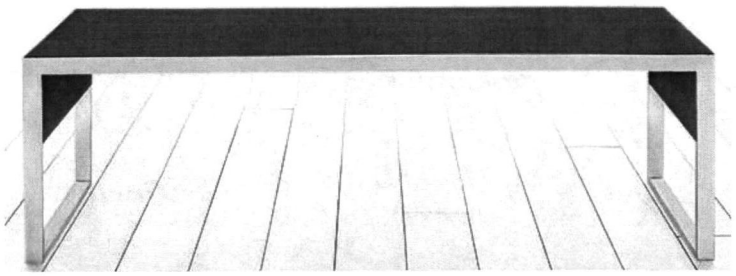
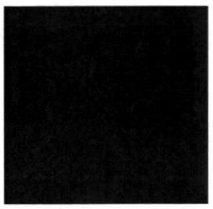
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T10
Item:	Coffee Table
Manufacturer:	Bernhardt Design or Approved Equal
Model #:	B48 - b.5 Rectangular Occassional Table
Description:	Rectangular Table with Steel Frame, Mitered Wood Top with Waterfall Edge and Continues on Sides and Underside of Table 48"L x 28"D x 15"H
Finish:	Slip Match Wood Veneer, Stainless Steel Frame Wood: 866 Maple
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Private Office on 7th Level
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

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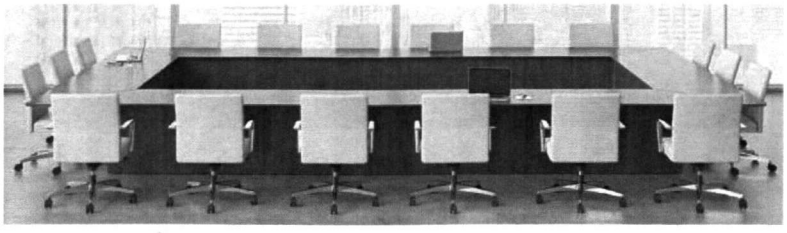
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T11
Item:	Conference Table
Manufacturer:	Nucraft or Approved Equal
Model #:	Atvia
Description:	Rectangular Wood Table, Open Center - with Power Coves Wire Management Leg Openings 132"W x 240"L x 29.5"H - Custom (Table top to be 30"W) Removable Panel for Access to Center of Table
Finish:	Wood Top and Legs Reverse Bevel Edge Wood to Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Conference Room #7212
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

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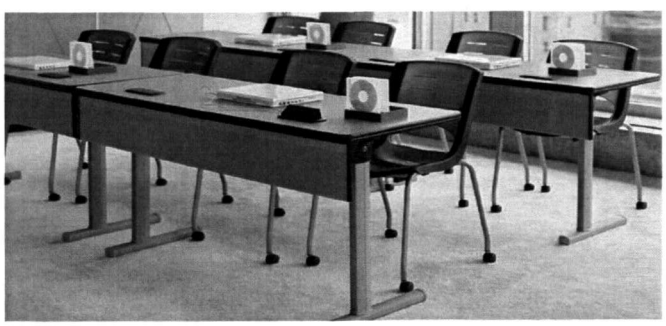
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T12
Item:	Training Table
Manufacturer:	Steelcase/Coalesse or Approved Equal
Model #:	473958 - Runner
Description:	Rectangular Laminate Top with PVC Edge Band to match Laminate Modesty Panel Flexability to be powered with Grommets on Top 30"D x 5'-0"L
Finish:	Laminate Top Metal Perforated 60"L Modesty Panel Powder Coated Frame and Base Laminate - To Match Laminart, #2610-T Bronze Wenge
Options:	Casters
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Innovation Room
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: T12

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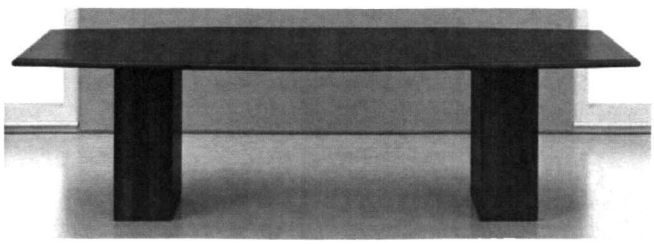
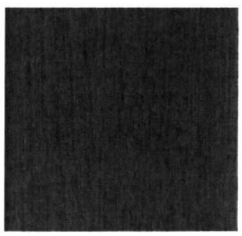
Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T13
Item:	Conference Table
Manufacturer:	Nucraft or Approved Equal
Model #:	Forte
Description:	Rectangular Hardwood Table, Rectangular Wood Base 3'-0"D x 6'-0"L
Finish:	Hardwood Top and Legs Reverse Bevel Edge Wood to Match Laminart, #2610-T Bronze Wenge
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Select Offices on the 7th Floor
Remarks:	Refer to A700 Series, Furniture Plans
Image:	 

Code: T13

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Project Name: KSC Central Campus - Replacement Headquarters Building
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HB Project No.: 12070.00
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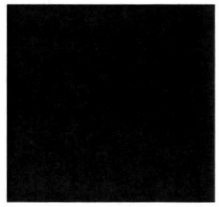
HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	T14
Item:	End Table
Manufacturer:	Bernhardt Design or Approved Equal
Model #:	B21 - b.5 Square Occassional Table
Description:	Square occassional table with wood top and sides and stainless steel frame 21"W x 21"D x 20"H
Finish:	Hardwood Top and Sides Stainless Steel Frame Anigre Veneer, Quarter Cut, Slip Matched 866 Maple
Options:	N/A
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Select Offices on the 7th Floor
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: T14

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Project Name: KSC Central Campus - Replacement Headquarters Building
Location: Kennedy Space Center, Florida
HB Project No.: 12070.00
Date: 12.16.13

HuntonBrady ARCHITECTS

FURNITURE SPECIFICATION

Code:	TC1
Item:	Outdoor Table and Chairs
Manufacturer:	Global Industrial or Approved Equal
Model #:	WG277150BK - Round Expanded Metal Picnic Table
Description:	One-Piece Round Table with (4) Attached Benches, No Arms, Size 46" Round Table with 46" L Benches
Finish:	Powder Coated Steel with Perforations - Black
Options:	TBD
Quantity:	TBD
Fabric(s):	N/A
MFR:	N/A
Name:	N/A
Number:	N/A
Color:	N/A
Location:	Outdoor Café
Remarks:	Refer to A700 Series, Furniture Plans
Image:	

Code: TC1

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