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TECHNICAL SPECIFICATIONS FOR DRAWING 79K38699 REV B

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING DRAFTSMAN / CHECKER	REVITALIZE KSC WATER SYSTEMS, DESIGN PACKAGE 1 TECHNICAL SPECIFICATIONS	JOHN F. KENNEDY SPACE CENTER, NASA KENNEDY SPACE CENTER, FLORIDA
MATERIAL	TRACER / CHECKER ENGINEER / ENGINEER		
HEAT TREATMENT	SUBMITTED K. MILLER, TA-B3A 3/31/11	SCALE	DWG SIZE: A — 79K38700 REV B
FINAL PROTECTIVE FINISH	APPROVED P. YU, TA-B3A 3/31/2011	PCN 98814	SHEET 1 OF 789

KSC FORM 21-2 (REV 9/65) (C/G 7/97)

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SECTION 01 11 00

SUMMARY OF WORK

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 E 2114	(2008) Standard Terminology for Sustainability Relative to the Performance of Buildings

1.2 DEFINITIONS

Definitions pertaining to sustainable development are as defined in ASTM E 2114, Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION, 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. "Sustainability" is the balance of environmental, economic, and societal considerations.

1.3 SUBMITTALS

Not used.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

1.4.1 Project Description

1. The work includes the installation of replacement water mains and associated appurtenances in the Industrial Area and the VAB Area. The work includes installing new DI water mains into the existing water distribution system as well as abandoning the existing AC water mains in place.

2. Installation includes a check valve, a manual bypass valve, and associated piping, valves, appurtenances along D Avenue between NASA Causeway and 1st Street. The purpose is to provide additional availability of fire flow in the Industrial Area.

3. Installation includes a pressure control valve, a manual bypass valve, and associated piping, valves, at the north terminus of the 24-inch CI water main along Kennedy Parkway, north of the 16-inch water main branch to

Saturn V and south of the 12-inch water main branch to the SLF. The purpose is to re-circulate water flow through the SLF and Saturn V Area to reduce water age while maintaining fire flow requirements in the SLF and Saturn V Area.

4. Installation includes a Chlorine and Ammonia analyzer, a pre-engineered fiberglass structure, and associated piping, valves, and appurtenances in the vicinity of Schwartz Road and Kennedy Parkway.

5. Installation includes a new automated SCADA system with data accumulation systems to monitor and adjust water and wastewater parameters.

6. Installation includes parallel water mains and associated appurtenances between the Launch Control Center (LCC) and each Launch Pad. The work includes connecting the proposed PVC water mains to the water distribution system and connecting existing potable water mains and service lines between the LCC and the Launch Pads to the new water mains, as well as installing back flow preventers along the existing potable lines to convert them into non-potable fire lines.

7. Installation includes a W-5 Pump Station building with high service pumps and jockey pumps, an electrical substation, a 15,000-gallon hydropneumatic tank, a 500,000-gallon ground storage tank, and associated piping and valves in the vicinity of the VAB EST and the OPF Firex Tanks.

1.4.2 Location

The work shall be located at the Industrial Area and VAB Area, approximately as indicated on the drawings. The exact locations will be shown by the Contracting Officer.

1.5 CONTRACT DRAWINGS

The following drawings accompany this specification and are a part thereof.

Drawing No. 79K38699
Sheets 1 through 122

The publications of the issues of referenced documents in effect on the date of issuance of invitation for bids form a part of this specification and, where referred to herein by basic designation only, are applicable to the extent indicated by the references thereto. In the event of difference between this specification or its accompanying drawings and the referenced document, this specification and its accompanying drawings must govern to the extent of such difference.

1.6 EPA DESIGNATED ITEMS INCORPORATED IN THE WORK

Various sections of the specifications contain requirements for materials that have been designated by EPA as being products which are or can be made with recovered recycled materials. These items, when incorporated into the work under this contract, must contain at least the specified percentage of recycled or recovered material.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

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SECTION 01 33 00

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PART 2 PRODUCTS

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-- End of Section Table of Contents --

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections.

Units of weights and measures used on all submittals are to be the same as those used in the contract drawings.

Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

Contractor's Quality Control (CQC) System Manager and the Designer of Record, if applicable, to check and approve all items prior to submittal and stamp, sign, and date indicating action taken. Proposed deviations from the contract requirements are to be clearly identified. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals.

Submittals requiring Government approval are to be scheduled and made prior to the acquisition of the material or equipment covered thereby. Picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations samples remaining upon completion of the work.

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 a notice to proceed commencing work on site. Submittals required prior to the start of the next major phase of the construction on a multi-phase contract. Schedules or tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work, submitted prior to contract notice to proceed or next major phase of construction.

Certificates of insurance
Surety bonds
List of proposed subcontractors
List of proposed products
Construction Progress Schedule
Network Analysis Schedule (NAS)

Submittal register
Schedule of prices
Safety and health 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.

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.

Confined space entry permits.

Text of posted operating instructions.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and Material Safety Data sheets 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.

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

Not used.

1.3 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.3.1 Government Approved

Government approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Government approval is required for any deviations from the Solicitation or Accepted Proposal and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.3.2 Information Only

Submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.4 FORWARDING SUBMITTALS REQUIRING GOVERNMENT APPROVAL

1.4.1 Submittals Required from the Contractor

As soon as practical after award of contract, and before procurement of fabrication, forward to the Contracting Officer, submittals required in the technical sections of this specification, including shop drawings, product data and samples.

The Government will review and approve for the Contracting Officer those submittals reserved for Contracting Officer approval to verify submittals

comply with the contract requirements.

1.4.1.1 O&M Data

The Government will review and approve for the Contracting Officer O&M Data to verify the submittals comply with the contract requirements; submit data specified for a given item within 30 calendar days after the item is delivered to the contract site.

a. In the event the Contractor fails to deliver O&M Data within the time limits specified, the Contracting Officer may withhold from progress payments 50 percent of the price of the item with which such O&M Data are applicable.

1.5 PREPARATION

1.5.1 Transmittal Form

Transmit each submittal, except sample installations and sample panels to office of approving authority. Transmit submittals with transmittal form prescribed by Contracting Officer and standard for project. On the transmittal form identify Contractor, indicate date of submittal, and include information prescribed by transmittal form and required in paragraph entitled "Identifying Submittals." Process transmittal forms to record actions regarding sample installations.

1.5.2 Identifying Submittals

When submittals are provided by a Subcontractor, the Prime Contractor is to prepare, review and stamp with Contractor's approval all specified submittals prior to submitting for Government approval.

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.

1.5.3 Format for SD-02 Shop Drawings

a. 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.

b. Present A4 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.

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

d. Number drawings in a logical sequence. Contractors may use their own number system. 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.

e. Reserve a blank space, no smaller than 4 inches on the right hand side of each sheet for the Government disposition stamp.

f. 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.

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

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

a. 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.

b. Indicate, by prominent notation, each product which is being submitted; indicate specification section number and paragraph number to which it pertains.

c. 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.

d. Provide product data in metric dimensions. Where product data are included in preprinted catalogs with English units only, submit metric dimensions on separate sheet.

e. 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.

f. 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.

g. 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.

h. Submit manufacturer's instructions prior to installation.

1.5.5 Format of SD-04 Samples

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

(1) Sample of Equipment or Device: Full size.

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

(3) 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.

(4) 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.

1.5.6 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.

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

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

b. Indicate by prominent notation, each report in the submittal.

Indicate specification number and paragraph number to which it pertains.

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

Comply with the requirements specified in Section 01 78 00 CLOSEOUT SUBMITTALS for O&M Data format.

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

a. 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.

1.6 INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. Approval of the Contracting Officer is not required on information only submittals. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

1.7 VARIATIONS / SUBSTITUTION REQUESTS

Variations from contract requirements require Government approval pursuant to contract Clause FAR 52.236-21 and will be considered where advantageous to Government.

1.7.1 Considering Variations

Discussion with Contracting Officer prior to submission, will help ensure functional and quality requirements are met and minimize rejections and re-submittals. When contemplating a variation which results in lower cost, consider submission of the variation as a Value Engineering Change Proposal (VECP).

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.

1.7.2 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. 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.

1.7.3 Warranting That Variations Are Compatible

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

1.7.4 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.

1.8 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. For submittals requiring review by fire protection engineer, allow review period, beginning when Government receives submittal from the Contractor, of 21 working days for return of submittal to the Contractor.

c. Period of review for each resubmittal is the same as for initial submittal.

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).

1.8.1 Reviewing, Certifying, Approving Authority

The Contractor is responsible for reviewing and certifying that submittals are in compliance with contract requirements. At each "Submittal" paragraph in individual specification sections, a notation "G," following a submittal item, indicates Contracting Officer is approving authority for that submittal item.

1.8.2 Constraints

a. Conform to provisions of this section, unless explicitly stated otherwise for submittals listed or specified in this contract.

b. Submit complete submittals for each definable feature of work. Submit at the same time components of definable feature interrelated as a system.

c. When acceptability of a submittal is dependent on conditions, items, or materials included in separate subsequent submittals, submittal will be returned without review.

d. Approval of a separate material, product, or component does not imply approval of assembly in which item functions.

1.9 GOVERNMENT APPROVING AUTHORITY

When approving authority is Contracting Officer, the Government will:

a. Note date on which submittal was received from the Contractor.

b. Review submittals for approval within scheduling period specified and only for conformance with project design concepts and compliance with contract documents.

c. Identify returned submittals with one of the actions defined in paragraph entitled "Review Notations" and with markings appropriate for action indicated.

Upon completion of review of submittals requiring Government approval, stamp and date approved submittals.

1.9.1 Review Notations

Contracting Officer review will be completed within 14 calendar days after date of submission. Submittals will be returned to the Contractor with the following notations:

a. Submittals marked "approved" or "accepted" authorize the Contractor to proceed with the work covered.

b. Submittals marked "approved as noted" "or approved except as noted, resubmittal not required," authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections.

c. Submittals marked "not approved" or "disapproved," or "revise and resubmit," indicate noncompliance with the contract requirements or design concept, or that submittal is incomplete. Resubmit with appropriate changes. No work shall proceed for this item until resubmittal is approved.

d. Submittals marked "not reviewed" will indicate submittal has been previously reviewed and approved, is not required , does not have evidence of being reviewed and approved by Contractor, or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals returned for lack of review by Contractor or for being

incomplete, with appropriate action, coordination, or change.

1.10 DISAPPROVED SUBMITTALS

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.

1.11 APPROVED SUBMITTALS

The Contracting Officer's approval or acceptance of submittals is not be construed as a complete check, and indicates only that the general method of construction, materials, detailing and other information are satisfactory design, general method of construction, materials, detailing and other information appear to meet the Solicitation and Accepted Proposal. Approval or acceptance will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work. 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.

1.12 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.

1.13 STATUS REPORT ON MATERIALS ORDERS

Within 30 calendar days after notice to proceed, submit, for approval by the Contracting Officer, an initial material status report on all materials

orders. This report will be updated and re-submitted every 30 calendar days as the status on material orders changes.

Report to include list, in chronological order by need date, materials orders necessary for completion of the contract. The following information will be required for each material order listed:

a. Material name, supplier, and invoice number.

b. Bar chart line item or CPM activity number affected by the order.

c. Delivery date needed to allow directly and indirectly related work to be completed within the contract performance period.

d. Current delivery date agreed on by supplier.

e. When item d exceeds item c, the effect that delayed delivery date will have on contract completion date.

f. When item d exceeds item c, a summary of efforts made by the Contractor to expedite the delayed delivery date to bring it in line with the needed delivery date, including efforts made to place the order (or subcontract) with other suppliers.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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GOVERNMENTAL SAFETY REQUIREMENTS

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 B30.22	(2005) Articulating Boom Cranes
ASME B30.3	(2009) Construction Tower Cranes
ASME B30.5	(2007) Mobile and Locomotive Cranes

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA NPG 8621.1	(2004a) NASA Mishap Reporting, Investigating and Record Keeping Policy
NASA NSS 1740.12	(1993) NASA Safety Standard For Explosives, Propellants and Pyrotechnics

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 10	(2007; Errata 2007; AMD 1 2007) Standard for Portable Fire Extinguishers
NFPA 51B	(2009) Standard for Fire Prevention During Welding, Cutting, and Other Hot Work
NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 70E	(2009; Errata 2009) Standard for Electrical Safety in the Workplace

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

29 CFR 1910.146	Permit-required Confined Spaces
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.500	Fall Protection

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:

Government acceptance is required for submittals with a "G" designation.

SD-01 Preconstruction Submittals

Safety and Health Plan; G

Proof of qualification for Crane Operators; G

SD-06 Test Reports

Reports

Submit reports as their incidence occurs, in accordance with the requirements of the paragraph entitled, "Reports."

Accident Reports

Crane Reports

SD-07 Certificates

Confined Space Entry Permit

Hot work permit

Certificate of Compliance (Crane)

1.3 DEFINITIONS

a. Competent Person for Fall Protection. A person who is capable of identifying hazardous or dangerous conditions in the personal fall arrest system or any component thereof, as well as their application and use with related equipment, and has the authority to take prompt corrective measures to eliminate the hazards of falling.

b. High Visibility Accident. Any mishap which may generate publicity and/or high visibility.

c. Medical Treatment. Treatment administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does not include first aid treatment even through provided by a physician or registered personnel.

d. Operating Envelope. The area surrounding any crane. Inside this "envelope" is the crane, the operator, riggers and crane walkers, rigging gear between the hook and the load, the load and the crane's supporting structure (ground, rail, etc.).

e. Qualified Person for Fall Protection. A person with a recognized degree or professional certificate, and with extensive knowledge, training and experience in the field of fall protection; who is capable of performing design, analysis, and evaluation of fall protection systems and equipment.

f. Recordable Injuries or Illnesses. Any work-related injury or illness that results in:

(1) Death, regardless of the time between the injury and death, or the length of the illness;

(2) Days away from work (any time lost after day of injury/illness onset);

(3) Restricted work;

(4) Transfer to another job;

(5) Medical treatment beyond first aid;

(6) Loss of consciousness; or

(7) A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (1) through (6) above.

h. Weight Handling Equipment (WHE) Accident. A WHE accident occurs when any one or more of the six elements in the operating envelope fails to perform correctly during operation, including operation during maintenance or testing resulting in personnel injury or death; material or equipment damage; dropped load; derailment; two-blocking; overload; and/or collision, including unplanned contact between the load, crane, and/or other objects. A dropped load, derailment, two-blocking, overload and collision are considered accidents even though no material damage or injury occurs. A component failure (e.g., motor burnout, gear tooth failure, bearing failure) is not considered an accident solely due to material or equipment damage unless the component failure results in damage to other components (e.g., dropped boom, dropped load, roll over, etc.)

1.4 REGULATORY REQUIREMENTS

In addition to the detailed requirements included in the provisions of this contract, comply with the most recent addition of federal, state, and local laws, ordinances, criteria, rules and regulations. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements govern.

1.5 SITE QUALIFICATIONS, DUTIES AND MEETINGS

1.5.1 Personnel Qualifications

1.5.1.1 Site Safety and Health Officer (SSHO)

The contractor shall provide a Safety oversight team that includes a minimum of one (1) Competent Person at each project site to function as the Site Safety and Health Officer (SSHO). The SSHO shall be at the work site at all times, unless specified differently in the contract, to perform safety and occupational health management, surveillance, inspections, and safety enforcement for the Contractor, and their training, experience, and qualifications shall be as required. A Competent Personal shall be provided for all of the hazards identified in the Contractor's Safety and Health Program in accordance with the accepted Accident Prevention Plan, and shall be on-site at all times when the work that presents the hazards associated with their professional expertise is being performed. The

credentials of the Competent Persons(s) shall be approved by the Contracting Officer in consultation with the Safety Office.

1.5.1.2 Construction Safety Hazard Awareness Training

The training requirements for the Site Safety and Health Officer (SSHO) must include the successful completion of the course entitled "Construction Safety Hazard Awareness Training for Contractors". If the SSHO does not have a current certification, they must obtain the course certification within sixty (60) calendar days from award.

1.5.1.3 Competent Person for Confined Space Entry

Provide a competent person for confined space.

1.5.1.4 Crane Operators

For mobile cranes with Original Equipment Manufacturer (OEM) rated capacitates of 50,000 pounds or greater, designate crane operators as qualified by a source that qualifies crane operators (i.e., union, a government agency, or and organization that tests and qualifies crane operators). Provide proof of current qualification.

1.5.2 Personnel Duties

1.5.2.1 Site Safety and Health Officer (SSHO)

a. Conduct daily safety and health inspections and maintain a written log which includes area/operation inspected, date of inspection, identified hazards, recommended corrective actions, estimated and actual dates of corrections. Attach safety inspection logs to the Contractors' daily production report.

b. Conduct mishap investigations and complete required reports. Maintain the OSHA Form 300 and Daily Production reports for prime and sub-contractors.

c. Maintain applicable safety reference material on the job site.

d. Attend the pre-construction conference, pre-work meetings including preparatory inspection meeting, and periodic in-progress meetings.

e. Implement and enforce accepted APPS and AHAs.

f. Maintain a safety and health deficiency tracking system that monitors outstanding deficiencies until resolution. Post a list of unresolved safety and health deficiencies on the safety bulletin board.

g. Ensure sub-contractor compliance with safety and health requirements.

Failure to perform the above duties will result in dismissal of the superintendent, QC Manager, and/or SSHO, and a project work stoppage. The project work stoppage will remain in effect pending approval of a suitable replacement.

h. Maintain a list of hazardous chemicals on site and their material safety data sheets.

1.5.3 Meetings

1.5.3.1 Preconstruction Conference

a. Contractor representatives who have a responsibility or significant role in accident prevention on the project shall attend the preconstruction conference. This includes the project superintendent, site safety and health officer, or any other assigned safety and health professionals who participated in the development of the APP Safety and Health Plan.

b. Discuss the details of the submitted Safety and Health Plan.

c. Deficiencies in the submitted Safety and Health Plan will be brought to the attention of the Contractor at the preconstruction conference, and the Contractor shall revise the plan to correct deficiencies and re-submit it for acceptance. Do not begin work until there is an accepted Safety and Health Plan.

1.5.3.2 Safety Meetings

Conduct and document meetings daily as required. Attach minutes showing contract title, signatures of attendees and a list of topics discussed to the Contractors' daily production report.

1.6 DISPLAY OF SAFETY INFORMATION

Within 1 calendar days after commencement of work, erect a safety bulletin board at the job site. Where size, duration, or logistics of project do not facilitate a bulletin board, an alternative method, acceptable to the Contracting Officer, that is accessible and includes all mandatory information for employee and visitor review, shall be deemed as meeting the requirement for a bulletin board. Additional items required to be posted include:

a. Confined space entry permit.

b. Hot work permit.

1.7 SITE SAFETY REFERENCE MATERIALS

Maintain safety-related references applicable to the project, including those listed in the article "References." Maintain applicable equipment manufacturer's manuals.

1.8 EMERGENCY MEDICAL TREATMENT

Emergency medical treatment is available to the Contractor by calling 321-867-7911. Medical facilities are located in the VAB area and Industrial Area as shown below.

Medical	
Occupational Health Facility 2nd and C Avenue Hours: 7:00 a.m. to 5:00 p.m., Mon-Fri	321-867-3346

Medical	
LC 39 Area Clinic Utility Road and VAB Road Hours: 7:00 a.m. to 3:30 p.m., Mon-Fri	321-867-3360

1.9 REPORTS

1.9.1 Accident Reports

a. Conduct an accident investigation for recordable injuries and illnesses, as defined in 1.3.h and property damage accidents resulting in at least $2,000 in damages, to establish the root cause(s) of the accident and provide the report to the Contracting Officer within 5 calendar day(s) of the accident. The Contracting Officer will provide copies of any required or special forms.

b. Conduct an accident investigation for any weight handling equipment accident (including rigging gear accidents) to establish the root cause(s) of the accident, complete the WHE Accident Report (Crane and Rigging Gear) form and provide the report to the Contracting Officer within 30 calendar days of the accident. Do not proceed with crane operations until cause is determined and corrective actions have been implemented to the satisfaction of the contracting officer. The Contracting Officer will provide a blank copy of the accident report form.

1.9.2 Accident Notification

Notify the Contracting Officer as soon as practical, but not later than four hours, after any accident meeting the definition of Recordable Injuries or Illnesses or High Visibility Accidents, property damage equal to or greater than $2,000, or any weight handling equipment accident in accordance with NASA NPG 8621.1. Within notification include contractor name; contract title; type of contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (to include type of construction equipment used, PPE used, etc.). Preserve the conditions and evidence on the accident site until the Government investigation team arrives on-site and Government investigation is conducted.

1.9.3 Crane Reports

Submit crane inspection reports as specified herein with Daily Reports of Inspections.

1.9.4 Certificate of Compliance

Provide a Certificate of Compliance for each crane entering an activity under this contract. State within the certificate that the crane and rigging gear meet applicable OSHA regulations (with the Contractor citing which OSHA regulations are applicable, e.g., cranes used in construction, demolition, or maintenance comply with 29 CFR 1926. Certify on the Certificate of Compliance that the crane operator(s) is qualified and trained in the operation of the crane to be used.

1.10 HOT WORK

Submit and obtain a written permit prior to performing "Hot Work" (welding, cutting, etc.) or operating other flame-producing/spark producing devices, from the Fire Division. A permit is required from the Explosives Safety Office for work in and around where explosives are processed, stored, or handled. CONTRACTORS ARE REQUIRED TO MEET ALL CRITERIA BEFORE A PERMIT IS ISSUED. The Contractor will provide at least two (2) twenty (20) pound 4A:20 BC rated extinguishers for normal "Hot Work". All extinguishers shall be current inspection tagged, approved safety pin and tamper resistant seal. It is also mandatory to have a designated FIRE WATCH for any "Hot Work" done at this activity. The Fire Watch shall be trained in accordance with NFPA 51B and remain on-site for a minimum of 30 minutes after completion of the task or as specified on the hot work permit.

When starting work in the facility, require personnel to familiarize themselves with the location of the nearest fire alarm boxes and place in memory the emergency Fire Division phone number. ANY FIRE, NO MATTER HOW SMALL, SHALL BE REPORTED IMMEDIATELY.

1.11 FACILITY OCCUPANCY CLOSURE

Streets, walks, and other facilities occupied and used by the Government shall not be closed or obstructed without written permission from the Contracting Officer.

1.12 WELDING

Toxic paint may exist on metals. Contractor shall require their employees to wear the proper PPE during welding activities.

1.13 HIGH NOISE LEVEL PROTECTION

Operations performed by the Contractor that involve the use of equipment with output of high noise levels (jackhammers, air compressors, and explosive-actuated devices) shall be scheduled with the Facility Manager. Use of any such equipment shall be approved in writing by the Contracting Officer prior to commencement of work.

1.14 SEVERE STORM PLAN

In the event of a severe storm warning, the Contractor must:

a. Secure outside equipment and materials and place materials that could be damaged in protected areas.

b. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.

c. Ensure that temporary erosion controls are adequate.

1.15 CONFINED SPACE ENTRY REQUIREMENTS

Contractors entering and working in confined spaces performing general industry work are required to follow the requirements of OSHA 29 CFR 1926.

PART 2 PRODUCTS

Not used.

2.1 CONFINED SPACE SIGNAGE

Provide permanent signs integral to or securely attached to access covers for new permit-required confined spaces. Signs wording: "DANGER--PERMIT-REQUIRED CONFINED SPACE - DO NOT ENTER -" in bold letters a minimum of one inch in height and constructed to be clearly legible with all paint removed. The signal word "DANGER" shall be red and readable from 5 feet.

2.2 FALL PROTECTION ANCHORAGE

Leave in place fall protection anchorage, conforming to 29 CFR 1926, installed under the supervision of a qualified person in fall protection, for continued customer use and so identified by signage stating the capacity of the anchorage (strength and number of persons who may be tied-off to it at any one time).

PART 3 EXECUTION

3.1 CONSTRUCTION AND/OR OTHER WORK

Comply with Federal and/or State OSHA regulations, and other related submittals and activity fire and safety regulations. The most stringent standard prevails.

3.2 PRE-OUTAGE COORDINATION MEETING

Contractors are required to apply for utility outages at least 14 days in advance. As a minimum, the request should include the location of the outage, utilities being affected, duration of outage and any necessary sketches. Special requirements for electrical outage requests are contained elsewhere in this specification section. Once approved, and prior to beginning work on the utility system requiring shut down, attend a pre-outage coordination meeting with the Contracting Officer to review the scope of work and the lock-out/tag-out procedures for worker protection. No work will be performed on energized electrical circuits unless proof is provided that no other means exist.

3.3 CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)

Contractor shall ensure that each employee is familiar with and complies with these procedures.

Contracting Officer will, at the Contractor's request, apply lockout/tagout tags and take other actions that, because of experience and knowledge, are known to be necessary to make the particular equipment safe to work on for government owned and operated systems.

No person, regardless of position or authority, shall operate any switch, valve, or equipment that has an official lockout/tagout tag attached to it, nor shall such tag be removed except as provided in this section. No person shall work on any energized equipment including, but not limited to activities such as erecting, installing, constructing, repairing, adjusting, inspecting, un-jamming, setting up, trouble shooting, testing, cleaning, dismantling, servicing and maintaining machines equipment of

processes until an evaluation has been conducted identifying the energy source and the procedures which will be taken to ensure the safety of personnel.

When work is to be performed on electrical circuits, only qualified personnel shall perform work on electrical circuits.

A supervisor who is required to enter an area protected by a lockout/tagout tag will be considered a member of the protected group provided he notifies the holder of the tag stub each time he enters and departs from the protected area.

Identification markings on building light and power distribution circuits shall not be relied on for established safe work conditions.

Before clearance will be given on any equipment other than electrical (generally referred to as mechanical apparatus), the apparatus, valves, or systems shall be secured in a passive condition with the appropriate vents, pins, and locks.

Pressurized or vacuum systems shall be vented to relieve differential pressure completely.

Vent valves shall be tagged open during the course of the work.

Where dangerous gas or fluid systems are involved, or in areas where the environment may be oxygen deficient, system or areas shall be purged, ventilated, or otherwise made safe prior to entry.

3.3.1 Tag Placement

Lockout/tagout tags shall be completed in accordance with the regulations printed on the back thereof and attached to any device which, if operated, could cause an unsafe condition to exist.

If more than one group is to work on any circuit or equipment, the employee in charge of each group shall have a separate set of lockout/tagout tags completed and properly attached.

When it is required that certain equipment be tagged, the Government will review the characteristics of the various systems involved that affect the safety of the operations and the work to be done; take the necessary actions, including voltage and pressure checks, grounding, and venting, to make the system and equipment safe to work on; and apply such lockout/tagout tags to those switches, valves, vents, or other mechanical devices needed to preserve the safety provided. This operation is referred to as "Providing Safety Clearance."

3.3.2 Tag Removal

When any individual or group has completed its part of the work and is clear of the circuits or equipment, the supervisor, project leader, or individual for whom the equipment was tagged shall turn in his signed lockout/tagout tag stub to the Contracting Officer. That group's or individual's lockout/tagout tags on equipment may then be removed on authorization by the Contracting Officer.

3.4 FALL HAZARD PROTECTION AND PREVENTION PROGRAM

Establish a fall protection and prevention program, for the protection of all employees exposed to fall hazards. Within the program include company policy, identify responsibilities, education and training requirements, fall hazard identification, prevention and control measures, inspection, storage, care and maintenance of fall protection equipment and rescue and evacuation procedures.

3.4.1 Training

Institute a fall protection training program. As part of the Fall Hazard Protection and Prevention Program, provide training for each employee who might be exposed to fall hazards. Provide training by a competent person for fall protection in accordance with 29 CFR 1926.

3.4.2 Fall Protection Equipment and Systems

Enforce use of the fall protection equipment and systems designated for each specific work activity in the Fall Protection and Prevention Plan at all times when an employee is exposed to a fall hazard. Protect employees from fall hazards as specified in 29 CFR 1926. Personal fall arrest systems are required when working from an articulating or extendible boom, swing stages, or suspended platform. In addition, personal fall arrest systems are required when operating other equipment such as scissor lifts if the work platform is capable of being positioned outside the wheelbase. The need for tying-off in such equipment is to prevent ejection of the employee from the equipment during raising, lowering, or travel. Fall protection must comply with 29 CFR 1926.500, Subpart M.

3.4.2.1 Personal Fall Arrest Equipment

Personal fall arrest equipment, systems, subsystems, and components shall meet 29 CFR 1926. Only a full-body harness with a shock-absorbing lanyard or self-retracting lanyard is an acceptable personal fall arrest body support device. Body belts may only be used as a positioning device system (for uses such as steel reinforcing assembly and in addition to an approved fall arrest system). Harnesses shall have a fall arrest attachment affixed to the body support (usually a Dorsal D-ring) and specifically designated for attachment to the rest of the system. Only locking snap hooks and carabiners shall be used. Webbing, straps, and ropes shall be made of synthetic fiber. The maximum free fall distance when using fall arrest equipment shall not exceed 6 feet. The total fall distance and any swinging of the worker (pendulum-like motion) that can occur during a fall shall always be taken into consideration when attaching a person to a fall arrest system.

3.4.3 Fall Protection for Roofing Work

Implement fall protection controls based on the type of roof being constructed and work being performed. Evaluate the roof area to be accessed for its structural integrity including weight-bearing capabilities for the projected loading.

a. Low Sloped Roofs:

(1) For work within 6 feet of an edge, on low-slope roofs, Protect personnel from falling by use of personal fall arrest systems, guardrails, or safety nets. A safety monitoring system is not

adequate fall protection and is not authorized.

(2) For work greater than 6 feet from an edge, erect and install warning lines in accordance with 29 CFR 1926.500.

b. Steep-Sloped Roofs: Work on steep-sloped roofs requires a personal fall arrest system, guardrails with toe-boards, or safety nets. This requirement also includes residential or housing type construction.

3.4.4 Existing Anchorage

Certified (or re-certified) by a qualified person for fall protection existing anchorages, to be used for attachment of personal fall arrest equipment in accordance with 29 CFR 1926. Exiting horizontal lifeline anchorages must be certified (or re-certified) by a registered professional engineer with experience in designing horizontal lifeline systems.

3.4.5 Horizontal Lifelines

Design, install, certify and use under the supervision of a qualified person horizontal lifelines for fall protection as part of a complete fall arrest system which maintains a safety factor of 2 (29 CFR 1926.500).

3.4.6 Guardrails and Safety Nets

Design, install and use guardrails and safety nets in accordance with 29 CFR 1926 Subpart M.

3.4.7 Rescue and Evacuation Procedures

When personal fall arrest systems are used, the contractor must ensure that the mishap victim can self-rescue or can be rescued promptly should a fall occur. Prepare a Rescue and Evacuation Plan and include a detailed discussion of the following: methods of rescue; methods of self-rescue; equipment used; training requirement; specialized training for the rescuers; procedures for requesting rescue and medical assistance; and transportation routes to a medical facility. Include the Rescue and Evacuation Plan within the Fall Protection and Prevention (FP&P) Plan and the Safety and Health Plan.

3.5 SCAFFOLDING

Provide employees with a safe means of access to the work area on the scaffold. Climbing of any scaffold braces or supports not specifically designed for access is prohibited. Access scaffold platforms greater than 20 feet maximum in height by use of a scaffold stair system. Do not use vertical ladders commonly provided by scaffold system manufacturers for accessing scaffold platforms greater than 20 feet maximum in height. The use of an adequate gate is required. Ensure that employees are qualified to perform scaffold erection and dismantling. Do not use scaffold without the capability of supporting at least four times the maximum intended load or without appropriate fall protection as delineated in the accepted fall protection and prevention plan. Stationary scaffolds must be attached to structural building components to safeguard against tipping forward or backward. Give special care to ensure scaffold systems are not overloaded. Side brackets used to extend scaffold platforms on self-supported scaffold systems for the storage of material is prohibited. The first tie-in shall be at the height equal to 4 times the width of the smallest dimension of the scaffold base. Place work platforms on mud

sills. Scaffold or work platform erectors shall have fall protection during the erection and dismantling of scaffolding or work platforms that are more than six feet. Delineate fall protection requirements when working above six feet or above dangerous operations in the Fall Protection and Prevention (FP&P) Plan and the Safety and Health Plan for the phase of work.

3.5.1 Stilts

The use of stilts for gaining additional height in construction, renovation, repair or maintenance work is prohibited.

3.6 EQUIPMENT

3.6.1 Material Handling Equipment

a. Material handling equipment such as forklifts shall not be modified with work platform attachments for supporting employees unless specifically delineated in the manufacturer's printed operating instructions.

b. The use of hooks on equipment for lifting of material must be in accordance with manufacturer's printed instructions.

c. Operators of forklifts or power industrial trucks shall be licensed in accordance with OSHA.

3.6.2 Weight Handling Equipment

a. Notify the Contracting Officer 15 days in advance of any cranes entering the activity so that necessary quality assurance spot checks can be coordinated. Contractor's operator shall remain with the crane during the spot check.

b. Comply with the crane manufacturer's specifications and limitations for erection and operation of cranes and hoists used in support of the work. Perform erection under the supervision of a designated person (as defined in ASME B30.5). Perform all testing in accordance with the manufacturer's recommended procedures.

c. Comply with ASME B30.5 for mobile and locomotive cranes, ASME B30.22 for articulating boom cranes, and ASME B30.3 for construction tower cranes.

d. Under no circumstance shall a Contractor make a lift at or above 90 percent of the cranes rated capacity in any configuration.

e. When operating in the vicinity of overhead transmission lines, operators and riggers shall be alert to this special hazard and follow the requirements of OSHA and ASME B30.5 or ASME B30.22 as applicable.

f. Do not crane suspended personnel work platforms (baskets) unless the Contractor proves that using any other access to the work location would provide a greater hazard to the workers or is impossible. Do not lift personnel with a line hoist or friction crane.

g. Inspect, maintain, and recharge portable fire extinguishers as specified in NFPA 10, Standard for Portable Fire Extinguishers.

h. All employees must keep clear of loads about to be lifted and of suspended loads.

i. Use cribbing when performing lifts on outriggers.

j. The crane hook/block must be positioned directly over the load. Side loading of the crane is prohibited.

k. A physical barricade must be positioned to prevent personnel from entering the counterweight swing (tail swing) area of the crane.

l. Certification records which include the date of inspection, signature of the person performing the inspection, and the serial number or other identifier of the crane that was inspected shall always be available for review by Contracting Officer personnel.

m. Written reports listing the load test procedures used along with any repairs or alterations performed on the crane shall be available for review by Contracting Officer personnel.

n. Certify that all crane operators have been trained in proper use of all safety devices (e.g. anti-two block devices).

o. Take steps to ensure that wind speed does not contribute to loss of control of the load during lifting operations. Prior to conducting lifting operations set a maximum wind speed at which a crane can be safely operated based on the equipment being used, the load being lifted, experience of operators and riggers, and hazards on the work site. This maximum wind speed determination shall be included as part of the activity hazard analysis plan for that operation.

3.6.3 Equipment and Mechanized Equipment

a. Proof of qualifications for operator shall be kept on the project site for review.

b. Manufacture specifications or owner's manual for the equipment shall be on-site and reviewed for additional safety precautions or requirements that are sometimes not identified by OSHA.

3.6.4 USE OF EXPLOSIVES

Explosives shall not be used or brought to the project site without prior written approval from the Contracting Officer. Such approval shall not relieve the Contractor of responsibility for injury to persons or for damage to property due to blasting operations.

Storage of explosives, when permitted on Government property, shall be only where directed and in approved storage facilities. These facilities shall be kept locked at all times except for inspection, delivery, and withdrawal of explosives.

Explosive work shall be performed in accordance with NASA NSS 1740.12. This document is available at:

http://www.hq.nasa.gov/office/codeq/doctree/871912.htm

3.7 EXCAVATIONS

Perform soil classification by a competent person in accordance with 29 CFR 1926.

3.7.1 Utility Locations

Prior to digging, the appropriate digging permit must be obtained. All underground utilities in the work area must be positively identified by a private utility locating service in addition to any station locating service and coordinated with the station utility department. Any markings made during the utility investigation must be maintained throughout the contract.

3.7.2 Utility Location Verification

The Contractor must physically verify underground utility locations by hand digging using wood or fiberglass handled tools when any adjacent construction work is expected to come within three feet of the underground system. Digging within 2 feet of a known utility must not be performed by means of mechanical equipment; hand digging shall be used. If construction is parallel to an existing utility expose the utility by hand digging every 100 feet if parallel within 5 feet of the excavation.

3.7.3 Shoring Systems

Trench and shoring systems must be identified in the accepted safety plan. Manufacture tabulated data and specifications or registered engineer tabulated data for shoring or benching systems shall be readily available on-site for review. Job-made shoring or shielding must have the registered professional engineer stamp, specifications, and tabulated data. Extreme care must be used when excavating near direct burial electric underground cables.

3.7.4 Trenching Machinery

Operate trenching machines with digging chain drives only when the spotters/laborers are in plain view of the operator. Provide operator and spotters/laborers training on the hazards of the digging chain drives with emphasis on the distance that needs to be maintained when the digging chain is operating. Keep documentation of the training on file at the project site.

3.8 UTILITIES WITHIN CONCRETE SLABS

Utilities located within concrete slabs are extremely difficult to identify due to the reinforcing steel used in the construction of these structures. Whenever contract work involves concrete chipping, saw cutting, or core drilling, the existing utility location must be coordinated with utility departments. Outages to isolate utility systems must be used in circumstances where utilities are unable to be positively identified. The use of historical drawings does not alleviate the contractor from meeting this requirement.

3.9 ELECTRICAL

3.9.1 Conduct of Electrical Work

Underground electrical spaces must be certified safe for entry before

entering to conduct work. Cables that will be cut must be positively identified and de-energized prior to performing each cut. Positive cable identification must be made prior to submitting any outage request for electrical systems. Arrangements are to be coordinated with the Contracting Officer and Station Utilities for identification. The Contracting Officer will not accept an outage request until the Contractor satisfactorily documents that the circuits have been clearly identified. Perform all high voltage cable cutting remotely using hydraulic cutting tool. When racking in or live switching of circuit breakers, no additional person other than the switch operator will be allowed in the space during the actual operation. Plan so that work near energized parts is minimized to the fullest extent possible. Use of electrical outages clear of any energized electrical sources is the preferred method. When working in energized substations, only qualified electrical workers will be permitted to enter. When work requires the Contractor to work near energized circuits as defined by the NFPA 70, high voltage personnel must use personal protective equipment that includes, as a minimum, electrical hard hat, safety shoes, insulating gloves with leather protective sleeves, fire retarding shirts, coveralls, face shields, and safety glasses. In addition, provide electrical arc flash protection for personnel as required by NFPA 70E. Insulating blankets, hearing protection, and switching suits may also be required, depending on the specific job and as delineated in the Contractor's Safety and Health Plan.

3.9.2 Portable Extension Cords

Size portable extension cords in accordance with manufacturer ratings for the tool to be powered and protected from damage. Immediately removed from service all damaged extension cords. Portable extension cords shall meet the requirements of NFPA 70E and OSHA electrical standards.

3.10 WORK IN CONFINED SPACES

Comply with the requirements in OSHA 29 CFR 1910.146 and OSHA 29 CFR 1926.21(b)(6). Any potential for a hazard in the confined space requires a permit system to be used.

a. Entry Procedures. Prohibit entry into a confined space by personnel for any purpose, including hot work, until the qualified person has conducted appropriate tests to ensure the confined or enclosed space is safe for the work intended and that all potential hazards are controlled or eliminated and documented. All hazards pertaining to the space shall be reviewed with each employee during review of the Safety and Health Plan.

b. Forced air ventilation is required for all confined space entry operations and the minimum air exchange requirements must be maintained to ensure exposure to any hazardous atmosphere is kept below its' action level.

c. All underground structures require continuous atmosphere monitoring with audible alarm for toxic gas detection.

-- End of Section --

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SOURCES FOR REFERENCE PUBLICATIONS

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 B 564 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.

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Fax: 202-624-5806
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Internet: http://www.nema.org/

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ENVIRONMENTAL PROTECTION

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. 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 273	Standards For Universal Waste Management
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.

1.2.8 Universal Waste

Universal Waste means any of the following hazardous wastes that are managed under the universal waste requirements 40 CFR 273:

(1) Batteries as described in Sec. 273.2 of this chapter;
(2) Pesticides as described in Sec. 273.3 of this chapter;
(3) Thermostats as described in Sec. 273.4 of this chapter; and
(4) Lamps as described in Sec. 273.5 of this chapter.

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

The environmental protection plan.

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 the contract clause "Spills". 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 and disposal.

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 waste water management plan that identifies the methods and procedures for management and/or discharge of waste waters 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 waste water, 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 waste water. If disposal is to a sanitary sewer, the plan must include documentation that the Waste Water Treatment Plant Operator has approved the flow rate, volume, and type of discharge.

q. A historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on the project site: and/or identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in the area are discovered during construction. Include in the plan methods to assure the protection of known or discovered resources, identifying lines of communication between Contractor personnel and the Contracting Officer.

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 the Contract Clauses, 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 and as specified in Section 01 57 23 TEMPORARY STORM WATER POLLUTION CONTROL. 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, 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 the contract clause "Dewatering/Consumptive Use Permit (CUP)".

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 the contract clause "Landfill Operations/Solid Waste Removal".

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 the contract clause "Hazardous Waste".

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 the contract clause "Hazardous Waste". 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 the contract clause "Hazardous Waste".

3.4.5 Waste Water

Disposal of waste water will be as specified below.

a. Waste water 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 the contract clause "Concrete Wastewater".

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 the contract clause "Dewatering/Consumptive Use Permit (CUP)".

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.

3.4.6 PCB Management

Polychlorinated Biphenyl (PCB) wastes shall be managed in accordance with the contract clause "PCB Management".

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 the contract clause "Recycling and Salvaging Materials". 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 to the Environmental Program Branch through the Contracting Officer on the first working day after each fiscal year quarter, starting the first quarter that non-hazardous solid waste has been generated. Include the following in the report:

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 the contract clause "Historical, Architectural and Cultural Resources".

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. The Contractor shall comply with the contract clause "Biological Surveys".

3.9 SOLID WASTE MANAGEMENT UNIT (SWMU)

Portions of this project are located within the boundaries of various identified Solid Waste Management Unit (SWMU)/Potential Release Location (PRL) sites being managed by the Remediation Group of NASA Environmental. A SWMU/PRL designation means that the site has had historical operations which had the potential to impact the environment.

The systems being modified are located within various SWMU or PRL sites. These sites contain groundwater contamination, soil contamination, or both. Return soil excavated from the land surface to any depth to the area of excavation from which it was removed. Collect, containerize, sample, and dispose of excavated soil that cannot be returned to the area from which it was removed in accordance with the Process Waste Questionnaire (PWQ)/Technical Response Packet (TRP) process. Wear proper PPE when working in soil and groundwater. Use best management practices to prevent erosion and removal of soil from site.

Discharge dewatering effluent to grade upland of the excavated area and allow to percolate back into the pervious ground surface. Use best management practices to prevent dewatering effluent from entering surface waters. There is a potential that dewatering effluent from SWMU or PRL sites may not be discharged to grade. Coordinate with the Contracting Officer and NASA Environmental for approval of the Dewatering Plan within the boundary of a SWMU or PRL 12 days before the Notice to Proceed.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

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SECTION 01 57 23

TEMPORARY STORM WATER POLLUTION CONTROL

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 4439	(2004) Geosynthetics
ASTM D 4491	(1999a; R 2004e1) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D 4873	(2002) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 832-R-92-005	(1992) Storm Water Management for Construction Activities Developing Pollution Preventions and Plans and Best Management Practices

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

40 CFR 122.26	Storm Water Discharges (Applicable to State NPDES Programs, see section 123.25)

1.2 SYSTEM DESCRIPTION

The work consists of implementing the storm water pollution prevention measures to prevent sediment from entering streams or water bodies as specified in this Section in conformance with the requirements of Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION, and the requirements of the National Pollution Discharge Elimination System (NPDES) permit.

1.3 EROSION AND SEDIMENT CONTROLS

The controls and measures required of the Contractor are described below.

1.3.1 Stabilization Practices

The stabilization practices to be implemented include temporary seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, erosion control mats, protection of trees, preservation of mature vegetation, etc. On the Daily Report, record the dates when the major grading activities occur, (e.g., clearing, excavation, and grading); when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated. Except as provided in paragraphs UNSUITABLE CONDITIONS and NO ACTIVITY FOR LESS THAN 21 DAYS, stabilization practices must be initiated as soon as practicable, but no more than 14 days, in any portion of the site where construction activities have temporarily or permanently ceased.

1.3.1.1 Unsuitable Conditions

Where the initiation of stabilization measures by the fourteenth day after construction activity temporarily or permanently ceases or is precluded by unsuitable conditions caused by the weather, stabilization practices shall be initiated as soon as practicable after conditions become suitable.

1.3.1.2 No Activity for Less Than 21 Days

When the total time period in which construction activity is temporarily ceased on a portion of the site is 14 days minimum, stabilization practices do not have to be initiated on that portion of the site until 14 days have elapsed after construction activity temporarily ceased.

1.3.1.3 Burnoff

Burnoff of the ground cover is not permitted.

1.3.1.4 Protection of Erodible Soils

Immediately finish the earthwork brought to a final grade, as indicated or specified, and protect the side slopes and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize the duration of exposure of unprotected soils.

1.3.2 Erosion, Sediment and Stormwater Control

a. Storm Water Notice of Intent for Construction Activities

b. Submit a Storm Water Notice of Intent for NPDES coverage under the general permit for construction activities and a Storm Water Pollution Prevention Plan (SWPPP) for the project to the Contracting Officer prior to the commencement of work. The SWPPP shall meet the requirements of the State of Florida general permit for storm water discharges from construction sites. Submit the SWPPP along with any required Notice of Intents, Notice of Termination, and appropriate permit fees, via the Contracting Officer, to the appropriate State agency for approval, a minimum of 14 calendar days prior to the start of any land disturbing activities. Maintain an approved copy of the SWPPP at the construction on-site office, and continually update as regulations require, to reflect current site conditions. Include within the SWPPP:

(1) Identify potential sources of pollution which may be reasonably expected to affect the quality of storm water discharge

from the site.

(2) Describe and ensure implementation of practices which will be used to reduce the pollutants in storm water discharge from the site.

(3) Ensure compliance with terms of the State of Florida general permit for storm water discharge.

(4) Select applicable best management practices from EPA 832-R-92-005.

(5) Include a completed copy of the Registration Statement, BMP Inspection Report Template and Notice of Termination except for the effective date.

(6) Storm Water Pollution Prevention Measures and Notice of Intent 40 CFR 122.26, EPA 832-R-92-005. Provide an SWPPP for the project.

(7) Install, inspect, and maintain best management practices (BMPs) as required by the general permit. Prepare and submit to the Contracting Officer, BMP Inspection Reports as required by the general permit.

(8) Once construction is complete and the site has been stabilized with a final, sustainable cover, submit the Notice of Termination to the Contracting Officer and NASA Environmental within 30 days after all land disturbing activities end.

(9) At the time of submittal to the Contracting Officer, concurrently forward copies of the SWPPP, Registration Statement, BMP Inspection Reports, and Notice of Termination to the Contracting Officer and to NASA Environmental.

1.3.3 Stormwater Drainage

There will be no discharge of excavation ground water to the sanitary sewer, storm drains, or to the river without prior specific authorization from the Contracting Officer and NASA Environmental. Discharge of hazardous substances will not be permitted under any circumstances. Construction site runoff will be prevented from entering any storm drain or the river directly by the use of silt fence or other method suitable to the Contracting Officer and NASA Environmental. Provide erosion protection of the surrounding soils.

1.3.4 Structural Practices

Implement structural practices to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Implement structural practices in a timely manner, during the construction process, to minimize erosion and sediment runoff. Include the following devices; Location and details of installation and construction are shown on the drawings.

1.3.4.1 Silt Fences

Provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Properly install silt fences to effectively retain

sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing, excavation, and grading). Install silt fences in the locations indicated on the drawings. Obtain approval from the Contracting Officer prior to final removal of silt fence barriers.

1.3.5 Vegetation and Mulch

a. Provide temporary protection on sides and back slopes as soon as rough grading is completed or sufficient soil is exposed to require erosion protection. Protect slopes by accelerated growth of permanent vegetation, temporary vegetation, mulching, or netting. Stabilize slopes by hydroseeding, anchoring mulch in place, covering with anchored netting, sodding, or such combination of these and other methods necessary for effective erosion control.

b. Seeding: Provide new seeding where ground is disturbed. Include topsoil or nutriment during the seeding operation necessary to establish a suitable stand of grass.

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

Storm Water Pollution Prevention Plan
Storm Water Notice of Intent

Pollution prevention plan and Notice of intent for NPDES coverage under the general permit for construction activities

1.5 DELIVERY, STORAGE, AND HANDLING

Identify, store and handle filter fabric in accordance with ASTM D 4873.

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES

2.1.1 Filter Fabric

Provide geotextile that complies with the requirements of ASTM D 4439, and consists of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and contains stabilizers and/or inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure. Provide synthetic filter fabric that contains ultraviolet ray inhibitors and stabilizers to assure a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric shall meet the following requirements:

FILTER FABRIC FOR SILT SCREEN FENCE

PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT

Grab Tensile	ASTM D 4632	100 lbs. min.
Elongation (percent)		30 percent max.
Trapezoid Tear	ASTM D 4533	55 lbs. min.
Permittivity	ASTM D 4491	0.2 sec-1
AOS (U.S. Std Sieve)	ASTM D 4751	20-100

2.1.2 Silt Fence Stakes and Posts

Use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction, shall have a minimum cross section of 2 by 2 inches when oak is used and 4 by 4 inches when pine is used, and have a minimum length of 5 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, shall have a minimum weight of 1.33 pounds/linear foot and a minimum length of 5 feet.

PART 3 EXECUTION

3.1 INSTALLATION OF SILT FENCES

Extend silt fences a minimum of 16 inches above the ground surface without exceeding 34 inches above the ground surface. Provide filter fabric from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, splice together filter fabric at a support post, with a minimum 6 inch overlap, and securely sealed. Excavate trench approximately 4 inches wide and 4 inches deep on the upslope side of the location of the silt fence. The 4 by 4 inch trench shall be backfilled and the soil compacted over the filter fabric. Remove silt fences upon approval by the Contracting Officer.

3.2 FIELD QUALITY CONTROL

Maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. Use the following procedures to maintain the protective measures.

3.2.1 Silt Fence Maintenance

Inspect the silt fences in accordance with paragraph, titled "Inspections," of this section. Any required repairs shall be made promptly. Pay close attention to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, replace the fabric promptly. Remove sediment deposits when deposits reach one-third of the height of the barrier. Remove a silt fence when it is no longer required. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall receive erosion control.

3.3 INSPECTIONS

3.3.1 General

Inspect disturbed areas of the construction site, areas that have not been finally stabilized used for storage of materials exposed to precipitation, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Conduct inspections at least once every month where sites have been finally stabilized.

3.3.2 Inspections Details

Inspect disturbed areas and areas used for material storage that are exposed to precipitation for evidence of, or the potential for, pollutants entering the drainage system. Observe erosion and sediment control measures identified in the Storm Water Pollution Prevention Plan to ensure that they are operating correctly. Inspect discharge locations or points to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Inspect locations where vehicles exit the site for evidence of offsite sediment tracking.

3.3.3 Erosion and Sediment Control Inspection Reports

Prepare "Storm Water Pollution Prevention Plan (SWPPP) Inspection Reports" (form provided at the pre-construction conference) to the Contracting Officer once every 7 calendar days and within 24 hours of a storm event that produced 0.5 inch or more of rain, and submit reports monthly. A copy of the inspection report shall be maintained on the job site.

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CLOSEOUT SUBMITTALS

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 E 1971	(2005) Stewardship for the Cleaning of Commercial and Institutional Buildings

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

As-Built Record of Equipment and Materials

Two copies of the record listing the as-built materials and equipment incorporated into the construction of the project.

Warranty Management Plan

One set of the warranty management plan containing information relevant to the warranty of materials and equipment incorporated into the construction project, including the starting date of warranty of construction. Furnish with each warranty the name, address, and telephone number of each of the guarantor's representatives nearest to the project location.

Final Cleaning

Two copies of the listing of completed final clean-up items.

Spare Parts Data

Two copies of list that ndicates manufacturer's name, part number, nomenclature, and stock level recommended for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

SD-08 Manufacturer's Instructions

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

Define within the schedule 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. On each test feature; e.g., gpm, rpm, psi, provide a signoff blank for the Contractor and Contracting Officer. Within a remarks column of the testing validation procedure include references to operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Delineate procedures for preventative maintenance, condition monitoring (predictive testing) and inspection, adjustment, lubrication and cleaning necessary to prevent failure.

Posted Instructions

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with paragraph entitled, "Operation and Maintenance," of this section.

SD-11 Closeout Submittals

Record Drawings

Drawings showing final as-built conditions of the project. The final CADD record drawings must consist of one set of electronic CADD drawing files in the specified format, 2 sets of blue-line prints of the mylars, and one set of the approved working Record drawings.

1.3 PROJECT RECORD DOCUMENTS

1.3.1 Record Drawings

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 showning as-built conditions.

1.3.1.1 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 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 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 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. If borrow material for this project is from sources on Government property, or if Government property is used as a spoil area, furnish a contour map of the final borrow pit/spoil area elevations.

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

j. 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 Circle at the location of each deletion.

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

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

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

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

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

1.3.1.2 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 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.

1.3.2 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

1.3.3 Final Approved Shop Drawings

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

1.3.4 Construction Contract Specifications

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

1.3.5 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.

1.4 SPARE PARTS DATA

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.

Supply two items of each part for spare parts inventory. Provision of spare parts does not relieve the Contractor of responsibilities listed under the contract guarantee provisions.

1.5 PREVENTATIVE MAINTENANCE

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

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 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.

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.

1.6 WARRANTY MANAGEMENT

1.6.1 Warranty Management Plan

Develop a warranty management plan which contains information relevant to the clause Warranty of Construction. At least 30 days before the planned pre-warranty conference, submit the warranty management plan for Government approval. 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 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 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. Listing and status of delivery of all Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, valves, meters, pumps, motors, transformers, and for all commissioned systems such as alarm systems, lightning protection systems, etc.

c. 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. 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.

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

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

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

1.6.2 Performance Bond

The Contractor's Performance Bond must remain effective throughout the construction period.

1.6.3 Pre-Warranty Conference

Prior to contract completion, and at a time designated by the Contracting Officer, meet with the Contracting Officer 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 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 sbe 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.

1.6.4 Contractor's Response to Construction Warranty Service Requirements

Following oral or written notification by the Contracting Officer, respond to construction warranty service requirements in accordance with the "Construction Warranty Service Priority List" and the three categories of priorities listed below. Submit a report on any warranty item that has been repaired during the warranty period. Include within the report the cause of the problem, date reported, corrective action taken, and when the repair was completed. If the Contractor does not perform the construction warranty within the timeframes specified, the Government will perform the work and backcharge the construction warranty payment item established.

a. First Priority Code 1. Perform onsite inspection to evaluate situation, and determine course of action within 4 hours, initiate work within 6 hours and work continuously to completion or relief.

b. Second Priority Code 2. Perform onsite inspection to evaluate situation, and determine course of action within 8 hours, initiate work within 24 hours and work continuously to completion or relief.

c. Third Priority Code 3. All other work to be initiated within 3 work days and work continuously to completion or relief.

d. The "Construction Warranty Service Priority List" is as follows:

Code 1-Air Conditioning Systems
(1) Recreational support.
(2) Air conditioning leak in part of building, if causing damage.
(3) Air conditioning system not cooling properly.

Code 1-Doors
(1) Overhead doors not operational, causing a security, fire, or safety problem.
(2) Interior, exterior personnel doors or hardware, not functioning properly, causing a security, fire, or safety problem.

Code 3-Doors
(1) Overhead doors not operational.
(2) Interior/exterior personnel doors or hardware not functioning properly.

Code 1-Electrical
(1) Power failure (entire area or any building operational after 1600 hours).
(2) Security lights
(3) Smoke detectors

Code 2-Electrical
(1) Power failure (no power to a room or part of building).

(2) Receptacle and lights (in a room or part of building).

Code 3-Electrical
Street lights.

Code 1-Gas
(1) Leaks and breaks.
(2) No gas to family housing unit or cantonment area.

Code 1-Heat
(1). Area power failure affecting heat.
(2). Heater in unit not working.

Code 2-Kitchen Equipment
(1) Dishwasher not operating properly.
(2) All other equipment hampering preparation of a meal.

Code 1-Plumbing
(1) Hot water heater failure.
(2) Leaking water supply pipes.

Code 2-Plumbing
(1) Flush valves not operating properly.
(2) Fixture drain, supply line to commode, or any water pipe leaking.
(3) Commode leaking at base.

Code 3 -Plumbing
Leaky faucets.

Code 3-Interior
(1) Floors damaged.
(2) Paint chipping or peeling.
(3) Casework.

Code 1-Roof Leaks
Temporary repairs will be made where major damage to property is occurring.

Code 2-Roof Leaks
Where major damage to property is not occurring, check for location of leak during rain and complete repairs on a Code 2 basis.

Code 2-Water (Exterior)
No water to facility.

Code 2-Water (Hot)
No hot water in portion of building listed.

Code 3-All other work not listed above.

1.6.5 Warranty Tags

At the time of installation, tag each warranted item with a durable, oil and water resistant tag approved by the Contracting Officer. Attached each tag with a copper wire and spray with a silicone waterproof coating. 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.

a. Type of product/material_____.

b. Model number_____.

c. Serial number_____.

d. Contract number_____.

e. Warranty period_____from_____to_____.

f. Inspector's signature_____.

g. Construction Contractor_____.

Address_____.

Telephone number_____.

h. Warranty contact_____.

Address_____.

Telephone number_____.

i. Warranty response time priority code_____.

j. WARNING - PROJECT PERSONNEL TO PERFORM ONLY OPERATIONAL MAINTENANCE DURING THE WARRANTY PERIOD.

1.7 OPERATION AND MAINTENANCE MANUALS

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.

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 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.

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 CLEANUP

Provide final cleaning in accordance with ASTM E 1971. Leave premises "broom clean." Use only nonhazardous cleaning materials, including natural cleaning materials, in the final cleanup. Clean interior and exterior glass surfaces exposed to view; remove temporary labels, stains and foreign substances; polish transparent and glossy surfaces. Clean equipment and fixtures to a sanitary condition. Clean filters of operating equipment and comply with the Indoor Air Quality (IAQ) Management Plan. Clean debris from roofs, gutters, downspouts and drainage systems. Sweep paved areas and rake clean landscaped areas. Remove waste and surplus materials, rubbish and construction facilities from the site. Recycle, salvage, and return construction and demolition waste from project in accordance with the Waste Management Plan. Promptly and legally transport and dispose of any trash. Do not burn, bury, or otherwise dispose of trash on the project site.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

-- End of Section --

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SECTION 01 78 23

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PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

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SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

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 E 1971	(2005) Stewardship for the Cleaning of Commercial and Institutional Buildings

1.2 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 shall compile and prepare data and deliver to the Contractor prior to the training of Government personnel. The Contractor shall 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.

1.2.1 Package Quality

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

1.2.2 Package Content

Data package content shall be as shown in the paragraph titled "Schedule of Operation and Maintenance Data Packages." 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, except as follows. Commissioned items without a specified data package requirement in the individual technical sections shall use Data Package 3. Commissioned items with a Data Package 1 or 2 requirement shall use instead Data Package 3.

1.2.3 Changes to Submittals

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

1.2.4 Review and Approval

The Government's Commissioning Authority (CA) shall review the commissioned systems and equipment submittals for completeness and applicability. The Government shall 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. This work shall be in addition to the normal review procedures for O&M data.

1.2.5 O&M Database

Develop a database from the O&M manuals that contains the information required to start a preventative maintenance program.

1.3 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

1.3.1 Operating Instructions

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

1.3.1.1 Safety Precautions

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

1.3.1.2 Operator Prestart

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

1.3.1.3 Startup, Shutdown, and Post-Shutdown Procedures

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

1.3.1.4 Normal Operations

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

1.3.1.5 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.

1.3.1.6 Operator Service Requirements

Include instructions for services to be performed by the operator such as

lubrication, adjustment, inspection, and recording gage readings.

1.3.1.7 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.

1.3.2 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.

1.3.2.1 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.

1.3.2.2 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.

1.3.2.3 Cleaning Recommendations

Provide environmentally preferable cleaning recommendations in accordance with ASTM E 1971.

1.3.3 Corrective Maintenance (Repair)

Include manufacturer's recommended procedures and instructions for correcting problems and making repairs for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.3.3.1 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.

1.3.3.2 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.

1.3.3.3 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.

1.3.3.4 Removal and Replacement Instructions

Include step-by-step procedures and a list of 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.

1.3.3.5 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.

1.3.4 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.

1.3.5 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:

1.3.5.1 Product Submittal Data

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

1.3.5.2 Manufacturer's Instructions

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

1.3.5.3 O&M Submittal Data

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

1.3.5.4 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

1.3.5.5 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.

1.3.5.6 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.

1.3.5.7 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.

1.3.5.8 Testing and Performance Data

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

1.3.5.9 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.

1.4 TYPES OF INFORMATION REQUIRED IN CONTROLS O&M DATA PACKAGES

Include Data Package 5 and the following for control systems:

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 copy on disk or CD of the entire program for this facility.

h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

1.5 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:

1.5.1 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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

-- End of Section --

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-- End of Section Table of Contents --

SECTION 02 41 00

DEMOLITION AND DECONSTRUCTION

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 AND REFRIGERATION INSTITUTE (ARI)

ARI Guideline K	(2005) Guideline for Containers for Recovered Non-Flammable Fluorocarbon Refrigerants

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

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

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(Rev K; Change 1) Obstruction Marking and Lighting

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

40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 82	Protection of Stratospheric Ozone

1.2 GENERAL REQUIREMENTS

Do not begin demolition or deconstruction until authorization is received from the Contracting Officer. The work of this section is to be performed in a manner that maximizes salvage and recycling of materials. Remove rubbish and debris from the project site; do not allow accumulations inside or outside the buildings. The work includes demolition, deconstruction, salvage of identified items and materials, 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 OSHA, NASA/KSC Health and Safety Policies, and other applicable Sections.

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-01 Preconstruction Submittals

Existing Conditions; G
Demolition Plan; G
Notifications; G

Proposed salvage, demolition, deconstruction, and removal procedures for approval before work is started.

SD-07 Certificates

Certification of DBPR certified pollutant storage contractor; G

1.4 REGULATORY AND SAFETY REQUIREMENTS

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.

1.4.1 Notifications

1.4.1.1 General Requirements

Furnish timely notification of demolition and deconstruction projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. 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.

1.5 DUST AND DEBRIS CONTROL

Prevent the spread of dust and debris 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.

Contractor shall use best management control measures to prevent the release of paint chips to the environment.

Best management practices include, but are not limited to, the following:

a. Contractor shall contain demolition debris where possible to impermeable surfaces.

b. Contractor shall control stormwater runoff from the site with silt fencing.

c. Contractor shall conduct daily housekeeping to limit potential paint chip migration.

d. Contractor shall collect and remove all demolition debris from the project area.

e. Sediment collected adjacent to silt fence shall be containerized and disposed of appropriately.

f. Upon completion of demolition, the first 6 inches of top soil shall be removed from within and 6 feet beyond the project area and disposed of

in the KSC landfill.

1.6 PROTECTION

1.6.1 Traffic Control Signs

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

Contractor must provide a minimum of 2 aviation red or high intensity white obstruction lights on temporary structures (including cranes) over 100 feet above ground level. Light construction and installation must comply with FAA AC 70/7460-1. Lights must be operational during periods of reduced visibility, darkness, and as directed by the Contracting Officer. Maintain the temporary services during the period of construction and remove only after permanent services have been installed and tested and are in operation.

1.6.2 Existing Conditions Documentation

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. Digital 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.

1.6.3 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, deconstruction, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

1.6.4 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.

1.6.5 Weather Protection

For portions of the building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of existing roofing is necessary to accomplish work, have materials and workmen ready to provide adequate and temporary covering of exposed areas.

1.6.6 Trees.

Protect trees within the project site which might be damaged during demolition or deconstruction, 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.

1.6.7 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction 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.

1.6.8 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.

1.6.9 Protection of Personnel

Before, during and after the demolition and deconstruction work the Contractor shall continuously evaluate the condition of the structure being demolished and deconstructed and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.7 BURNING

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

1.8 RELOCATIONS

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

1.9 REQUIRED DATA

Prepare a Demolition Plan. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, and a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Identify components and materials to be salvaged for reuse or recycling with reference to paragraph Existing Facilities to be Removed. Append tracking forms for all removed materials indicating type, quantities, condition, destination, and end use. Coordinate with Waste Management Plan. Include statements affirming Contractor inspection of the existing roof deck and its suitability to perform as a safe working platform or if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the work. Submit certification of DBPR certified pollutant storage contractor for removal of underground storage tank. Provide procedures for safe conduct of the work in accordance with Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS. Plan shall be approved by Contracting Officer prior to work beginning.

1.10 ENVIRONMENTAL PROTECTION

Comply with the Environmental Protection Agency and NASA/KSC requirements specified.

Best Management Practices (BMPs) must be used to prevent releases of metal and/or PCB contaminated paint chips to the environment. The following are offered as suggested BMPs:

1. Where possible, demolish structures by collapsing walls inward onto facility foundation.

2. Where possible, limit heavy equipment use to paved surfaces.

3. Control stormwater runoff from paved areas by installing silt fencing and/or sediment barriers across stormwater flumes.

4. Drum or containerize, using appropriate PWQ/TRP listed containers, all paint chip contaminated sediments and submit debris for testing. Dispose of characterized sediment waste in accordance with KSC Waste Management Requirements following the PWQ/TRP process.

5. Maintain regular housekeeping on the construction site thus preventing significant stormwater runoff before it occurs.

1.11 USE OF EXPLOSIVES

Use of explosives will not be permitted.

PART 2 PRODUCTS

2.1 FILL MATERIAL

Comply with excavating, backfilling, and compacting procedures for soils used as backfill material to fill basements, voids, depressions or excavations resulting from demolition or deconstruction of structures. Fill material shall be waste products from demolition or deconstruction until all waste appropriate for this purpose is consumed.

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures on site 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 on site whenever possible.

3.1.1 Structures

a. Remove existing structures indicated to bottom of foundation walls. Interior walls, other than retaining walls and partitions, shall be removed below grade or to top of concrete slab on ground. Break up basement slabs to permit drainage. Remove sidewalks, curbs, gutters and street light bases as indicated.

b. Demolish structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each tier or floor before the supporting members on the lower level are disturbed. Demolish concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods as approved by the Contracting Officer.

c. Locate demolition and deconstruction equipment throughout the structure and remove materials so as to not impose excessive loads to supporting walls, floors, or framing.

d. Building, or the remaining portions thereof, not exceeding 80 feet in height may be demolished by the mechanical method of demolition.

3.1.2 Utilities and Related Equipment

3.1.2.1 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.

3.1.2.2 Disconnecting Existing Utilities

Remove existing utilities, as indicated and uncovered by work 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 that are not indicated on the drawings, the Contracting Officer shall be notified 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.

3.1.3 Paving and Slabs

Remove concrete and asphaltic concrete paving and slabs including aggregate base as indicated. Provide neat sawcuts at limits of pavement removal as indicated. Pavement and slabs designated to be recycled and utilized in this project shall be moved, ground and stored as directed by the Contracting Officer. Unpainted concrete shall be transported to DARCY in accordance with the contract clause "Landfill Operations/Solid Waste Removal".

3.1.4 Concrete

Salvage removed concrete.

3.1.5 Structural Steel

Dismantle structural steel at field connections and in a manner that will prevent bending or damage. Salvage for reuse or recycle structural steel, steel joists, girders, angles, plates, columns and shapes. Flame-cutting torches are permitted when other methods of dismantling are not practical. Where possible, hot work on painted/coated metal structures should be avoided. If hot work is necessary, affected paint/coating must be sampled for PCBs to determine if additional respiratory protection is required. Degradation of PCBs occur under moderate/extreme thermal conditions (such as torch work) causing PCB materials to degrade into dioxins and other by-product chemicals. The Contractor shall consult with its Industrial Hygiene representative prior to conducting hot work on any painted/coated surfaces.

3.1.6 Miscellaneous Metal

Salvage shop-fabricated items such as access doors and frames, steel gratings, metal ladders, wire mesh partitions, metal railings, metal windows and similar items as whole units. Salvage light-gage and cold-formed metal framing, such as steel studs, steel trusses, metal gutters, roofing and siding, metal toilet partitions, toilet accessories and similar items. Scrap metal shall become the Contractor's property. Recycle scrap metal as part of demolition and deconstruction operations. Provide separate containers to collect scrap metal and transport to a scrap metal collection or recycling facility, in accordance with the Waste Management Plan.

3.1.7 Carpentry

Salvage for reuse or recycle lumber, millwork items, and finished boards, and sort by type and size. Chip or shred and recycle salvaged wood unfit for reuse, except stained, painted, or treated wood.

3.1.8 Cylinders and Canisters

Remove all fire suppression system cylinders and canisters and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting

Substance (ODS)."

3.1.9 Mechanical Equipment and Fixtures

Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Mechanical equipment and fixtures must be disconnected at fittings. Remove service valves attached to the unit. Where indicated, salvage each item of equipment and fixtures as a whole unit; listed, indexed, tagged, and stored. Salvage each unit with its normal operating auxiliary equipment. Transport salvaged equipment and fixtures, including motors and machines, to a designated storage area as directed by the Contracting Officer. Do not remove equipment until approved. Do not offer low-efficiency equipment for reuse; provide to recycling service for disassembly and recycling of parts.

3.1.9.1 Preparation for Storage

Remove water, dirt, dust, and foreign matter from units; tanks, piping and fixtures shall be drained; interiors, if previously used to store flammable, explosive, or other dangerous liquids, must be steam cleaned. Seal openings with caps, plates, or plugs. Secure motors attached by flexible connections to the unit.

3.1.9.2 Piping

Disconnect piping at unions, flanges and valves, and fittings as required to reduce the pipe into straight lengths for practical storage. Store salvaged piping according to size and type. If the piping that remains can become pressurized due to upstream valve failure, end caps, blind flanges, or other types of plugs or fittings with a pressure gage and bleed valve shall be attached to the open end of the pipe to ensure positive leak control. Carefully dismantle piping that previously contained gas, gasoline, oil, or other dangerous fluids, with precautions taken to prevent injury to persons and property. Store piping outdoors until all fumes and residues are removed. Box prefabricated supports, hangers, plates, valves, and specialty items according to size and type. Wrap sprinkler heads individually in plastic bags before boxing. Classify piping not designated for salvage, or not reusable, as scrap metal.

3.1.10 Electrical Equipment and Fixtures

Where indicated, salvage motors, motor controllers, and operating and control equipment that are attached to the driven equipment. Salvage wiring systems and components. Box loose items and tag for identification. Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.

3.1.10.1 Fixtures

Remove and salvage electrical fixtures. Salvage unprotected glassware from the fixture and salvage separately. Salvage incandescent, mercury-vapor, and fluorescent lamps and fluorescent ballasts manufactured prior to 1978, boxed and tagged for identification, and protected from breakage. Note: Ballasts that cannot be identified as being PCB-free shall be managed as if they are PCB-contaminated.

3.1.10.2 Electrical Devices

Remove and salvage switches, switchgear, transformers, conductors including

wire and nonmetallic sheathed and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. Box and tag these items for identification according to type and size.

3.1.10.3 Wiring Ducts or Troughs

Remove and salvage wiring ducts or troughs. Dismantle plug-in ducts and wiring troughs into unit lengths. Remove plug-in or disconnecting devices from the busway and store separately.

3.1.10.4 Conduit and Miscellaneous Items

Salvage conduit except where embedded in concrete or masonry. Consider corroded, bent, or damaged conduit as scrap metal. Sort straight and undamaged lengths of conduit according to size and type. Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed.

3.1.11 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 or deconstruction work in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction in the area has been completed and debris removed. Fill holes, open basements 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, deconstruction, and removal procedures, and authorization by the Contracting Officer to begin demolition and deconstruction. 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.

3.3.2 Export Control

The Contractor shall comply with U.S. Export Control Laws. All facilities and associated equipment shall be deconstructed so that they can neither be reassembled nor recognized. The Contractor shall render unrecognizable all NASA and Contractor tags.

3.3.3 Reuse of Materials and Equipment

Remove and store materials and equipment listed in the Demolition Plan or as indicated by the Contracting Officer to be reused or relocated to prevent damage, and reinstall as the work progresses.

3.3.4 Salvaged Materials and Equipment

Remove materials and equipment that are listed in the Demolition Plan and specified to be removed by the Contractor and that are to remain the property of the Government, and deliver to the Reutilization, Recycling and Marketing Facility (RRMF).

a. Salvage items and material to the maximum extent possible.

b. Store all materials salvaged for the Contractor as approved by the Contracting Officer and remove from Government property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

c. Remove salvaged items to remain the property of the Government in a manner to prevent damage, and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage must be repaired or replaced to match existing items. Properly identify the contents of containers.

d. Remove historical items in a manner to prevent damage.

e. Remove and capture all Class I ODS refrigerants in accordance with the Clean Air Act Amendment of 1990.

3.3.5 Recycling

The Contractor must make every practical effort to reclaim and segregate materials that have the ability to be recycled. All reclaimed concrete must be segregated from other wastes and transported to the KSC Landfill (L7-0071) on Schwartz Road. All unpainted concrete must be transported to the Diverted Aggregate Reclamation and Collection Yard (DARCY). All reclaimed scrap metal, not being recycled by Contractor outside KSC, must be transported to the Reutilization, Recycling and Marketing Facility (RRMF) with a KSC Form 7-49. Please turn these items and the KSC Form 7-49 into RRMF personnel to ensure the proper disposition of the materials prior to leaving the recycling area. For any other information regarding what materials can be recycled or other general information regarding recycling policies at KSC, please contact NASA Environmental.

3.3.6 Disposal of Ozone Depleting Substance (ODS)

Class I and Class II ODS are defined in Section, 602(a) and (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting ARI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling. Recovered ODS shall be turned over to the Contracting Officer. Products, equipment and appliances containing ODS in a sealed, self-contained system (e.g. residential refrigerators and window air conditioners) shall be disposed of in accordance with 40 CFR 82.

3.3.6.1 Special Instructions

No more than one type of ODS is permitted in each container. A warning/hazardous label shall be applied to the containers in accordance with the contract clause "Hazardous Waste". All cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS shall have a tag with the following information:

a. Activity name and unit identification code

b. Activity point of contact and phone number

c. Type of ODS and pounds of ODS contained

d. Date of shipment

3.3.6.2 Fire Suppression Containers

Deactivate fire suppression system cylinders and canisters with electrical charges or initiators prior to shipment. Also, safety caps must be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.3.7 Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable noncombustible material in the KSC Class III landfill located on Schwartz Road in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

3.4 CLEANUP

Remove debris and rubbish from excavations. Remove and transport them 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 removal operations with all applicable federal, state and local regulations as contractually specified in the Waste Management Plan and Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION. Storage of removed materials on the project site is prohibited, unless otherwise specified on the drawings.

3.5.2 Burning on Government Property

Burning of materials removed from demolished and deconstructed structures will not be permitted on Government property.

3.5.3 Removal to Spoil Areas on Government Property

Transport noncombustible materials removed from demolition and deconstruction structures to designated spoil areas on Government property.

3.5.4 Removal from Government Property

Transport waste materials removed from demolished and deconstructed

structures, except waste soil, from Government property for legal disposal. Dispose of waste soil as directed.

3.6 REUSE OF SALVAGED ITEMS

Recondition salvaged materials and equipment designated for reuse before installation. Replace items damaged during removal and salvage operations or restore them as necessary to usable condition.

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ASBESTOS ABATEMENT

PART 1 GENERAL

1.1 SUMMARY

This section specifies the asbestos abatement requirements and the Contractor's applicable asbestos procedures, which include demolition or salvage of structures where asbestos is present, removal or encapsulation of materials containing asbestos, construction, alteration, repair, maintenance, or renovation of structures, substrates, or portions thereof, that contain asbestos, installation of products containing asbestos, asbestos spill/emergency cleanup, transportation, disposal, storage, containment of and housekeeping activities involving asbestos or products containing asbestos, on the site or location at which construction activities are performed.

Under OSHA, Asbestos Abatement work is categorized into four classes:

Class I Work: Activities involving the removal of Thermal System Insulation (TSI) and surfacing Asbestos Containing Materials (ACM) and Presumed Asbestos Containing Material (PACM).

Class II Work: Activities involving the removal of ACM that is not TSI or surfacing material. This includes wallboard, floor tile and sheeting, roofing, siding, shingles, and construction mastics.

Class III Work: Repair and Maintenance operations, where ACM, including TSI and surfacing ACM and PACM, is likely to be disturbed.

Class IV Work: Maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean up dust, waste, and debris from Class I,II, and III activities.

Conduct abatement work in accordance with the Class I, II, III, or IV Methods of Compliance as required by 29 CFR 1910,29 CFR 1926, 40 CFR 61-SUBPART M, 49 CFR 171, 49 CFR 172, FAC CHAPTER 62-257, and FL-STAT 469. Submit all required training certifications prior to commencement of work.

1.2 DEFINITIONS

FLAC - Florida Licensed Asbestos Consultant as defined within the FL-STAT 469 ASBESTOS ABATEMENT.

IH - Kennedy Space Center Industrial Hygienist. This person can be either a Government Civil Servant or an authorized Government Contractor. This person is responsible for the oversight, approval of the abatement procedures and the health, safety, and welfare of those who it effects.

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.

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7.1	(2004) Commodity Specification for Air

FLORIDA ADMINISTRATIVE CODE (FAC)

FAC CHAPTER 62-257	Florida Administrative Code, Asbestos Program

FLORIDA STATUTES (FL-STAT)

FL-STAT 469	Asbestos Abatement

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 8500.1	KSC Environmental Requirements
KNPR 1840.19	KSC Industrial Hygiene Programs
KNPR 8715.3	KSC Safety Practices Procedural Requirements

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 7400	(1994) Standard Test Method for Asbestos and Other Fibers by PCM
NIOSH 94-113	(1994; 4th Ed) NIOSH Manual of Analytical Methods

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

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction
40 CFR 61-SUBPART M	National Emission Standard for Asbestos
40 CFR 763	Asbestos
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements

1.4 DESCRIPTION OF WORK

Abate materials containing asbestos as indicated on the drawings in accordance with the contract clause "Asbestos Abatement."

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

Submit Work Schedule; G in accordance with the paragraph entitled, "Worker Protection," of this section.

Notification of Demolition/Renovation; G

SD-02 Shop Drawings

Submit items in accordance with the paragraph entitled, "Implementation Plan," of this section.

Coordination Drawings; G

Detailed Drawings

SD-06 Test Reports

Submit the following:

Initial Exposure Assessments in accordance with 29 CFR 1926

Submit Air Monitoring Reports in accordance with paragraph entitled, "Air Monitoring Report," of this section.

Maintain Work Site entry logs of all personnel entering and leaving the regulated work area by the on-site competent person indicating the date and time of entry and egress.

Maintain Daily Site Inspection Logs by the on-site competent person indicating the date, time and results of the work area daily site inspections.

Maintain Waste Inventory of all generated waste drums or containers indicating the location and approximate quantity of material in each container.

SD-07 Certificates

Submit the following certificates:

Asbestos Consultant's License from the State of Florida, Department of Business and Professional Regulation (DBPR)

Asbestos Contractor's License; G or other Contractor license approval from the State of Florida, Department of Business and Professional Regulation (DBPR).

Training Certifications; G, and experience of Contractor's "Competent Person", Supervisor, and workers.

Proficiency Analytical Test Certification

SD-08 Manufacturer's Instructions

Submit Material Safety Data Sheets in accordance with the paragraph entitled, "Licenses Permits, and Notices," of this section.

Submit Implementation Plan; G as identified in paragraph entitled, "Implementation Plan," prior to initial site set-ups or start of work.

SD-11 Closeout Submittals

Within 10 days after the completion of work, submit to the Contracts Administrator a written summary and copies of the following items:

Notification of Demolition/Renovation.

Waste Disposal Permit and all Disposal Shipping Manifests and Tickets.

Daily site inspection logs, negative pressure logs and other OSHA compliance inspection records.

Air Monitoring Reports conducted during the abatement.

Calibration Records; G for sampling equipment taken before and after each air sample.

Entry logs and Waste Stream Inventory maintained during the abatement task.

1.6 LICENSES PERMITS, AND NOTICES

Ensure that the FLAC possesses a current license and comply with all Federal, State and Local Regulations. Only those consultants who are certified and licensed by DBPR are permitted to perform Asbestos Surveys or abatement specifications and plans as per Florida Statute 469.

Contractor's possession of a current Asbestos Contractor's License is mandatory, as well as securing all necessary licenses and permits associated with asbestos removal, transportation, and disposal as may be required by Federal, State, and local regulations. Only those Contractors who are certified and licensed by the State of Florida DBPR will be permitted to perform asbestos abatement activities at Kennedy Space Center.

A Waste Disposal Permit and all Disposal Shipping Manifests and Tickets are to be obtained.

Submit the following certificates:

Certification of participation in a Proficiency Analytical Test (PAT) program such as or equivalent to the American Industrial Hygiene Association PAT or Asbestos Analytical Registry (AAR) accreditation certificate and Interlab QA/QC Program participation for the independent air monitoring agency selected by the Contractor before starting work.

Training Certifications and accreditation certificates for the independent air monitoring agency's on-site personnel and a copy of independent air monitoring agency's Quality Control Program.

Certification documents by the Contractor verifying that employees have been provided current respirator fit test, training, and medical examinations in compliance with 29 CFR 1926.

Material safety data sheets as required for materials to be used on the specified project.

1.6.1 Notification

When applicable, submit Florida Department of Environmental Protection (DEP) "Notice of Demolition or Asbestos Renovation" (DEP Form 62-257.900(1)) to DEP District Office. A copy of the notification is to be provided to the Government as part of the Implementation Plan.

1.7 IMPLEMENTATION PLAN

Prepare and submit a detailed, written Implementation Plan created, signed and sealed by a FLAC to the Government for approval, prior to the start of work, that includes the following:

Coordination drawings including site specific drawings of proposed work areas, clean room/change areas, mini-enclosures, shower, equipment room, waste loading/staging areas, locations of High Efficiency Particulate Air (HEPA) filtered negative pressure devices and exhaust points, work areas, emergency egress, and areas to be modified.

Detailed drawings for asbestos abatement systems consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents.

A copy of the applicable DEP Notification of Demolition/Renovation (DEP Form 62-257.900(1)).

Plan of Action, including proposed procedures to be used in complying with the requirements of this specification, 29 CFR 1926,and other applicable regulatory requirements, sequence of asbestos abatement work, the interfaces of trades involved in the performance of work, posting of licenses, permits, etc., methods to be used to assure the safety of building occupants and visitors to the site, disposal plan including location of approved disposal site, a detailed description of the methods employed to control pollution, and a detailed work schedule. Expand upon the method for removal of ACM, the use of portable HEPA ventilation systems, closing out of the buildings HVAC system, method of removal to prohibit visible emissions in the work area, and packaging of removed debris.

Details of the decontamination areas and procedures, locations of staging areas, posting of warning signs, and details of negative air system to be used in the work area.

Sketch(s) or drawing(s) of complete contract area(s) showing the shower room, clean room, drum staging area, decontamination and containment areas, the negative air system, and exits. Indicate designation of the "Competent

Person" (CP), and Site Supervisor.

Provide a written Air Monitoring Plan to be prepared under the direction of and signed/stamped by a Certified Industrial Hygienist (C.I.H.)or FLAC specifying the air monitoring criteria and an action plan for implementation by the Competent Person. Identify in the plan the Competent Person to be on site at all times (unless otherwise authorized by the Contracts Administrator) during asbestos abatement operations. The FLAC or his/her representative/competent person is responsible for ensuring applicable regulatory compliance during all phases of the asbestos abatement activities. The competent person has the authority to stop work for unsafe conditions and for not adhering to applicable regulations. Provide a qualified back-up person in the event that the Competent Person is absent from job site.

Provide certification that the Contractor, his staff, and abatement workers (including Supervisors) have attended and successfully completed (an) asbestos abatement course(s) including refresher courses as set forth in FL-STAT 469 and in accordance with 29 CFR 1926 and 40 CFR 763.

Provide a Respiratory Protection Program in accordance with 29 CFR 1910 including training in the care, use, and maintenance of respirators and fit test certification.

Provide a written description of respiratory equipment (name, type, model number) and protective clothing provided to the abatement workers.

Provide documentation that all personnel assigned to the abatement project have been examined annually by a physician. Submit the physician's written opinion containing the results of the employee's medical examination in compliance with 29 CFR 1926. Establish, maintain, and make readily available for review all Work site entry logs.

Provide Procedures for enforcement of Personal Hygiene Practices.

Prepare and submit a Contingency Plan for emergencies including fire, accident, power failure, heating or cooling, negative air system failure, respirator supplied air system failure, or any other event that may require modification of the work area isolation procedures. Include in the plan specific procedures for decontamination or work area isolation, safe exiting, and the need for medical attention in the event of an emergency.

Submit any additional procedures (fall protection, confined space, etc.) and policies that are in effect to ensure worker safety and environmental, KNPR 8500.1 and KNPR 8715.3) requirements are met.

Submit the Implementation Plan to the Government for review and approval. Commencement of work will not be permitted until the Implementation Plan is given final approval.

1.8 AIR MONITORING REPORTS

Obtain the services of an independent Air Monitoring Agency accredited by the American Industrial Hygiene Association (AIHA), for analysis of airborne asbestos concentration levels. Provide a copy of the monitoring agency's Quality Control Program to Contracts Administrator prior to commencement of the abatement activities. Ensure the individual performing the on-site air monitoring meets the requirements as set forth in FL-STAT 469 and 40 CFR 763, and performs sample collections in accordance

with the approved Air Monitoring Plan.

Perform all Air Monitoring under the direction of the FLAC using an independent Air Monitoring Contractor, in compliance with Florida Statute 469 requirements.

Calibrate pumps before and after each air sample and submit calibration records to the Government.

Submit daily Air Monitoring Reports. Include in the Air Monitoring Report the following information for each sample:

Sample identification, Sample location,

Employee Name, Social Security Number,

Description of task being monitored,

Exposure level results in (f/cc),

Monitoring instrument identification number,

Pre-calibration, post calibration, and average flow rate of each sample,

Sample date, start and stop times,

Type of protective devices worn (if any),

Project identification number, Facility number and name,

Sampling and Analytical Methods used,

Contact name and company, and name of individual performing the sampling.

1.8.1 Air Sample Analytical Method

Airborne fiber sampling and analytical procedures are to be analyzed by Phase Contrast Microscopy (PCM) in accordance with 29 CFR 1926 and NIOSH 94-113 7400 method.

1.8.2 Air Sampling Rate, Volumes and Frequency

Conduct daily monitoring utilizing sample rates, volumes and frequency in accordance with 29 CFR 1926 and retain for final submittal at closeout. The minimum number of samples or sample volumes may not be less than those specified below:

Type of Sample	Volume	Minimum No. Samples	Location
Prior to set-up (within 24 hrs)	1200L	2	Regulated Area
Personal, During work	400L	2	Personal B.Z.
Area samples, Adjacent to work area.	1200L	2	Regulated Area
Area samples at Negative	1200L	1	In area of outlets

Type of Sample	Volume	Minimum No. Samples	Location
Air Unit Exhaust.			

NOTE: The KSC IH will perform air sampling outside the regulated work area.

1.9 WORKER PROTECTION

Perform Initial Exposure Assessments and Employee Exposure Monitoring in accordance with 29 CFR 1926, part 1926.1101, with input and approval of the FLAC.

Select and provide respiratory protection to employees and ensure they are utilized in accordance with 29 CFR 1926.

Submit the Work schedule indicating the work days, hours, and the number of workers per shift. Include a bar chart to identify the individual milestones through to the completion of the project (i.e., number of days to complete work site preparation, number of days to complete ACM removal, number of days to complete final cleaning and lockdown, etc.).

Submit the OSHA compliance inspection records as part of the closeout documents.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES AND SERVICES

The Government will make available at the work site, water at hose bibs and 120 Volt AC at receptacles for the Contractor's use. Provide water proof safety lighting where necessary for safe, adequate illumination.

Ensure all electrical equipment to be used inside the work areas is powered from an Underwriters Laboratory (UL) approved Ground Fault Circuit Interrupter (GFCI). Do not exceed the manufacturers limits per GFCI. Make all necessary connections and restore the site connections to their original condition or better, prior to project completion.

Ensure all energized or pressurized systems inside the work area have been locked out, tagged out or otherwise rendered safe.

Provide temporary water from the existing building water source to control the generation of airborne dust, to allow for area, personnel, and equipment decontamination, and to supply decontamination unit needs. Also provide a backflow preventer at the source.

Provide temporary sanitary drainage piping to the decontamination unit sump and to the shower unit at a minimum slope of 2.0 percent, and temporary drainage piping to waste water pump and existing drain in accordance with local standards and as approved by the Contracts Administrator. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Discharge only clean water to the sanitary system.

3.2 WORK AREA PREPARATION

The Government will re-arrange equipment and storage areas to the extent of providing a direct and unobstructed path to the work area(s). During ACM removal, confine equipment and employees to the designated work area(s).

Unless otherwise directed by the Contracts Administrator, the Contractor is to establish and maintain a 25-foot access control barrier zone(s) around the designated work area(s). Interference with the functional operation of the building occupants outside these areas is not permitted.

Ensure all building supply and return air ducts from the mechanical system are isolated to eliminate air flow into or out of containment area(s).

3.2.1 Pre-Cleaning

Shut down HVAC systems and seal all critical barriers prior to initiating pre-cleaning actions. Seal, with 6 mil minimum thickness plastic sheeting, all openings, including but not limited to, windows, corridors, doorways, elevator openings, skylights, ducts, grilles, diffusers, and any other penetrations between the contaminated work areas and uncontaminated areas.

Pre-clean all movable objects identified as contaminated by the Contracts Administrator or his/her representative within the work area using a HEPA filtered vacuum and wet cleaning methods as appropriate. Remove these objects after cleaning and store in a protected area.

Pre-clean all surfaces in the work area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Methods that would raise dust, such as dry sweeping or vacuuming with equipment not equipped with HEPA filters, are PROHIBITED. Pay detailed attention to machinery or areas behind grilles and gratings.

Do not remove or otherwise disturb asbestos containing building materials during the pre-cleaning phase.

3.2.2 Work Area(s)

Inform all other Contractors and personnel on the site of the abatement work of the nature of the Contractor's work with ACM and/or PACM, of the existence of and requirements pertaining to regulated areas, and the measures taken to ensure that employees of such other Contractor employers are not exposed to asbestos in accordance with 29 CFR 1926.

Use industry controls and work practice methods in accordance with 29 CFR 1926. Ensure daily site inspection logs are posted at the jobsite by the on-site competent person.

Use flame resistant, 6 mil polyethylene sheeting when constructing Negative Pressure Enclosures (NPE) or decontamination areas.

3.3 WASTE LOAD-OUT UNIT

Establish a waste load-out unit to provide for interim secure storage. Include an equipment room for storage of asbestos-contaminated items (drums, tools, equipment). Decontaminate all equipment and waste containers prior to being taken out of the work area(s).

All asbestos-containing waste material is to be sealed in leak-tight

disposal containers or bags. Thoroughly wet all waste within the disposal containers. Maintain proper labeling protocols for all running and final inventory of filled disposable containers.

3.4 SIGNS AND MARKINGS

Post signs prior to commencing asbestos work as required in 29 CFR 1926. Post signs at the perimeter of the asbestos work areas, along the route of the temporary waste material holding (Drum Staging) area, and at all entrances to asbestos work areas. Ensure signs are conspicuous and legible.

Post telephone numbers and locations of emergency services including, but not limited to, fire, ambulance, doctor, and hospital, at the regulated area.

Post one copy of all permits at the work site perimeter in a accessible location outside the regulated area.

Post one copy of the Abatement Contractors current license at the work site perimeter in a accessible location outside the regulated area.

Post hazard communication notification signs in accordance with KNPR 1840.19 requirements.

3.5 NEGATIVE AIR SYSTEM

Construct Negative Pressure Enclosures (NPE's) as required by 29 CFR 1926.

Duct each of the negative air units through the containment barrier walls to the outside of the work area(s). When the building is occupied, ensure that the ducts exhaust into the outside air; otherwise, they may exhaust into an area of the building beyond the critical barriers. Never exhaust the units into the work area(s).

Provide each unit with temporary back-up electrical power (120 Volt AC) in the event of power failures or outages.

3.5.1 Testing

Design the negative air system to provide a minimum of four (4) air changes per hour and test before any work is begun. After the work area has been prepared, the decontamination unit set up, and the negative air units(s) installed, test the system. Prior to beginning abatement activities, an Asbestos Abatement Pre-Work Inspection checklist (KSC Form 28-1230NS) will be completed by the KSC IH to verify the adequacy of the containment system and work area. Once activated, ensure the negative air exhaust unit(s) remain in operation until final clearance air monitoring has been performed and the KSC IH has approved their shutdown/removal. Maintain daily negative pressure logs for review by the FLAC.

Install a differential pressure meter or manometer to continuously measure pressure differential between inside and outside the work area for all Class I activities which utilize a NPE. Maintain a minimum pressure differential of 0.02 inch of water column.

3.6 RESPIRATORY PROTECTION

Instruct and train each worker involved in asbestos abatement in proper respirator use and care. Fit all respirators by approved qualitative or

quantitative test. Use respiratory protection appropriate for the fiber level encountered in the Work Area and as specified herein, or as required for other situations encountered.

3.6.1 Air Quality for Supplied Air Respiratory Systems

The Contractor is to provide air used for breathing in Type "C" supplied air respiratory systems that meets or exceeds CGA G-7.1, standards for Grade D air.

3.7 REMOVAL OF ASBESTOS

Use industry controls and work practices for all operations in accordance with 29 CFR 1926 Methods of Compliance for Class I, II, III, or IV asbestos work. The FLAC or his/her representative are responsible for these practices.

Ensure all Class I, II, III and IV work is supervised by an on site Competent Person at all times that work is in progress.

Following removal of contaminated items and asbestos material, seal the edges of adjacent surfaces, which were exposed when asbestos was removed, with an asbestos bridging sealant/encapsulant.

3.8 DAILY HOUSEKEEPING

Maintain a clean work area in accordance with 29 CFR 1926. Perform the following housekeeping functions at the end of each shift or prior to leaving the work site unattended:

a. Prepare contaminated waste for disposal by packaging the waste and removing it from the work area.

b. HEPA vacuum the work area.

c. Visually inspect polyethylene in the work area and other high traffic areas.

3.9 CLEANING PROCEDURES

Clean the work area at the end of each day's abatement activities. Designate a separate, secured area within the work area for storage of debris until it can be properly disposed. Secure the work area after termination of the work day to prevent entry. Regularly dispose and replace disposable supplies, such as mop heads, sponges, and rags. Clean all equipment by HEPA vacuuming and wet wiping.

Clean all work areas in which abatement operations have been completed, starting at the ceiling and working down to the floors, by HEPA vacuuming and wet wiping. Prior to removal of worksite access controls and re-occupancy inspection by the Government, and upon satisfactory final clearance air sampling, and removal of polyethylene sheeting, perform a final cleaning (wet wipe) of all surfaces within the work area.

3.10 INSPECTION

Do not commence removal of asbestos materials prior to satisfactory KSC IH, concurrence to proceed on the Asbestos Abatement Pre-Work Inspection (checklist KSC Form 28-1230NS).

3.10.1 Initial Inspection

The Contractor and the KSC IH will conduct a walk-through of the work area prior to beginning the abatement work to review existing conditions and ensure safe and practical conditions for the work to be implemented. Any damage to structures, surfaces, and equipment, which could be misconstrued as damage resulting from work, is to be documented by the Contractor and immediately submitted to the Contracts Administrator.

Perform background sampling for work areas in accordance with 29 CFR 1926 prior to beginning the abatement work.

3.10.2 Daily Inspection

Maintain a work site entry log of all personnel who enter the regulated work area. Through continuous surveillance and inspections of the worksite, ensure the integrity of containment, proper function of the negative pressure system, and posting of signs and labels. Also ensure, through frequent inspections during each work shift, that negative pressure is maintained, appropriate work practices are followed, appropriate protective clothing and equipment are used, and worker decontamination procedures are being followed.

Ensure that critical barriers and negative pressure enclosures remain effectively sealed and taped. Take immediate action to remedy defects immediately upon discovery. Details of the inspections are to be included in the Contractor's daily inspection log and posted in an accessible location outside the regulated area.

Provide updated copies of the Air Monitoring Reports, Daily Site Inspection Logs and Waste Stream Inventory to the Contracts Administrator at the end of each week of the abatement work.

NASA/Kennedy Space Center reserves the right to conduct periodic inspections and air monitoring in the work area(s). If the work area is unsafe as determined by the Contracts Administrator for KSC IH, the Contracts Administrator, will require the Contractor to stop work until the unsafe conditions are corrected.

3.10.3 Final Inspection

The thoroughness of asbestos removal is to be evaluated by visually inspecting the affected surfaces for residual asbestos material and accumulated dust followed by air sampling. Evidence of residual asbestos or asbestos debris on any adjacent surfaces upon completion of the work is not acceptable.

Upon completion of the work, conduct a thorough visual inspection of the work area by the Abatement Contractor and by the KSC IH to ensure no residual asbestos material, dust or debris remains. Document final inspections on the Asbestos Abatement Clearance Inspection Checklist (KSC Form 28-1231NS), which will be completed by KSC IH.

If applicable, final aggressive air sampling is to be performed by the KSC IH for each NPE work area after completion of a satisfactory visual inspection. The clearance criteria is 0.01 fibers per cubic centimeter (f/cc) of air as determined by PCM. Satisfactory fiber counts from all final samples are to be less than 0.01 f/cc. If any of the final air

samples contain greater than 0.01 f/cc, repeat the final cleaning operation and re-test the area until satisfactory clearance levels are obtained.

Collect five (5) PCM final air samples for the first 5,000 square feet of containment plus one (1) additional PCM final air sample for each additional 5,000 square feet or one (1) air sample per room, whichever is greater. The number of final air samples may be reduced for small enclosures of less than approximately 2500 square feet. In no case may fewer than two (2) final samples be collected for any enclosure.

Ensure clearance air sample volumes meet the minimum volumes as indicated for analysis by NIOSH 7400 method.

3.11 ASBESTOS WASTE AND CONTAMINATED MATERIALS

3.11.1 Removal of Asbestos Waste Materials

For purposes of this paragraph, asbestos waste materials are defined as those materials which contain or have been contaminated by asbestos and are not planned to be encapsulated and remain at the job site. They are primarily removed asbestos, disposable clothing and safety equipment, polyethylene sheeting, contaminated amended water, vacuum cleaner contents, and filtration media.

Contain all asbestos waste material in two (2) 6 mil polyethylene disposal bags, or two (2) 6 mil disposal bags and a sealed leak-tight container such as, but not limited to, a steel or fiberboard drum. Pack the asbestos waste material while still wet. Clean the external surface of the waste containers by HEPA vacuuming and wet wiping before moving from the work area. Protect the interior of truck or dumpster with two layers of polyethylene sheeting.

3.11.1.1 Waste Inventory

Label and clearly mark all disposal containers, dumpsters, and trucks, in accordance with 40 CFR 61-SUBPART M, 29 CFR 1910 of OSHA's Hazard Communications Standard, and 49 CFR 171 and 49 CFR 172, Hazardous Substances.

Provide conspicuous, legible labels, affixed to plastic bags and drums indicating the name of the waste generator and the location (facility name and number) where the waste was generated.

For non-friable asbestos that will be disposed at the KSC/Schwartz Road Landfill, provide a completed landfill disposal verification form (KSC Form 28-1064NS) send to Contracts Administration. NOTE: Regulated ACM is not permitted for disposal at KSC/Schwartz Road Landfill.

Provide a Waste Shipment Record (WSR) to the Contracting Officer in accordance with the instructions in 40 CFR 61-SUBPART M.

3.11.2 Work Area Disposal

After final inspection has been completed and the work area is released for occupancy, shut off and remove the Negative Air System units. Unseal all entrances and exits. Dispose of all plastic sheeting, tape, and any other trash and debris, except for critical barriers, in sealable plastic bags, or in drums and moved to the staging area. After final wet wipe of the work area and satisfactory clearance air sampling, dismantle critical

barriers and the decontamination unit.

3.11.3 Decontamination Area And Support Area Disposal

Dismantle the decontamination area after the work area is released by the KSC IH for re-occupancy. Vacuum all surfaces of the decontamination unit before it is disassembled.

3.12 WASTE TRANSPORTATION AND DISPOSAL

Transport and dispose of asbestos waste in full compliance with 40 CFR 61-SUBPART M, SUBPART A, 49 CFR 171 and 49 CFR 172.

3.13 ASBESTOS ABATEMENT NOTICE AND CHECKLIST

An Asbestos Abatement Pre-Work Inspection form (KSC Form 28-1230NS) and an Asbestos Abatement Clearance Checklist (KSC Form 28-1231NS) will be provided by the KSC IH. Send copies to the Contracting Officer upon satisfactory completion of the work. Notify KSC IH and the Contracting Officer at least three days prior to the planned commencement of work. Coordinate and schedule all Pre-Work and Clearance Site inspections with KSC IH. The completed forms are to be used to establish approval of the containment, work practices and final acceptance/re-occupancy of the work area(s).

3.14 FINAL ACCEPTANCE

The work will not be considered complete until the asbestos materials identified herein have been abated, the areas cleaned, satisfactory clearance air monitoring completed, all asbestos contaminated waste has been properly disposed of, and all project close out documents have been received and approved by the Contracting Officer.

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SECTION 03 01 30.71

CONCRETE REHABILITATION

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 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 C 144	(2004) Standard Specification for Aggregate for Masonry Mortar
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 39/C 39M	(2005e1e2) 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 used in the repair of spalling along joints or cracks, small surface spalls or "popouts."

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 into structural cracks in walls or pavements.

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-06 Test Reports

Sieve analysis test for aggregate

SD-07 Certificates

Epoxy resin binder

Epoxy grout

SD-08 Manufacturer's Instructions

Epoxy repair material

Submit for mixing and applying.

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 TRAFFIC CONTROL

Do not permit vehicular or heavy equipment traffic on the pavement in the work area during the curing period. At the end of the curing period, light local traffic may be permitted on the pavement if approved by the Contracting Officer.

1.8 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.

2.1.2 Aggregate

For material passing No. 200 sieve provide a non-plastic material composed of a minimum of 75 percent limestone dust, talc or silica inert filler. Provide dry aggregate.

a. For epoxy concrete: ASTM C 33/C 33M, maximum size 1/2 inch. Conform to the following requirements:

Sieve Designation	Percent Passing by Weight
1/2 in.	100
3/8 in.	93-100
No. 4	70-80
No. 8	50-65
No. 16	37-53
No. 30	20-37
No. 50	10-20
No. 100	5-10
No. 200	3-5

b. For epoxy mortar: ASTM C 144, maximum size No. 40 sieve.

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

Apply epoxy mortar to newly exposed loose and 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

Apply grout to newly exposed concrete free of loose and 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 Testing

At the discretion of the Contracting Officer, samples provided may be tested by the Government for verification. Test samples by an approved laboratory. If a sample fails to meet specification requirements after two tests, replace the batch represented by the samples tested and retest. Test aggregates in accordance with ASTM C 117 and ASTM C 136.

3.5.3 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.

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SECTION 03 30 00

CAST-IN-PLACE CONCRETE

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.

ACI INTERNATIONAL (ACI)

ACI/MCP-1	(2009) Manual of Concrete Practice Part 1: ACI 104-71R-97 to 223-98
ACI/MCP-2	(2009) Manual of Concrete Practice Part 2 - ACI 224R-01 to ACI 313R-97
ACI/MCP-3	(2009) Manual of Concrete Practice Part 3 - ACI 315-99 to ACI 343R-95
ACI/MCP-4	(2009) Manual of Concrete Practice Part 4 - ACI 345R-05 to 355.2R-04

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	(2009) 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	(2006a) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars or 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	(2007) Standard Specification for Portland Cement
ASTM C 156	(2005) 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 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 311	(2007) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C 33	(2007) Standard Specification for Concrete Aggregates
ASTM C 39/C 39M	(2005e1e2) 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	(2009) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2009a) Standard Specification for Ground Granulated Blast-Furnace Slag 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 1190	(1997) Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type
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) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 4397	(2002) 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 E 1155	(1996; R 2008) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E 329	(2008) Standard Specification for Agencies Engaged in the Testing and/or Inspection

of Materials Used in Construction

ASTM E 648 (2008) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP (2001; 27Ed) Manual of Standard Practice

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS MMM-A-001993 (1978) Adhesive, Epoxy, Flexible, Filled (For Binding, Sealing, and Grouting)

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

Fabrication Drawings for concrete must be submitted by the Contractor in accordance with paragraph entitled, "Shop Drawings," of this section, to include the following:

Reinforcing Steel; G

Reproductions of contract drawings are unacceptable.

SD-03 Product Data

Materials for curing concrete
Joint sealants

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.

Joint filler
Cement
Portland Cement
Ready-Mix Concrete
Curing Concrete Elements
Pumping Concrete

Vapor barrier

Waterstops

Submit documentation indicating type of biobased material in product and biobased content.

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 Control Submittals

1.6.2.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.6.2.2 Pumping Concrete

Submit proposed materials and methods for pumping concrete.

1.6.3 Test Reports

1.6.3.1 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 Contractor-Furnished Mix Design

ACI/MCP-1, ACI/MCP-2, and ACI/MCP-3 except as otherwise specified. Indicate the compressive strength (f'c) of the concrete for each portion of the structure(s) and as specified below.

Location	f'c (Min. 28-Day Comp. Strength) (psi)	ASTM C 33 Maximum Nominal Aggregate (Size No.)	Range of Slump (inches)	Maximum Water-Cement Ratio (by weight)	Air Entr. (percent)
Concrete exposed to weather	4000	57	1 to 4	0.45	6

2.1.1.1 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 C 192/C 192M and tested in accordance with ASTM C 39/C 39M. 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/MCP-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 C 192/C 192M and tested in accordance with ASTM C 39/C 39M 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.

2.1.1.2 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/MCP-2. 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/MCP-2. 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/MCP-2 requirements.

2.1.2 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C 94/C 94M.

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 C 94/C 94M:

Type and brand cement

Cement content in 95-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

2.1.3 Concrete Curing Materials

2.1.3.1 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.

2.1.3.2 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, Type I or II blended cement except as modified herein. Provide blended cement that consists of a mixture of ASTM C 150, 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, 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 + 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, 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 1190 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 1190.

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 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 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 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

MAXIMUM SIZE OF AGGREGATE	ASTM C 33 SIZE NUMBER	TYPE OF CONSTRUCTION
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 Contracting 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 and 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, 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 joints 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 and ACI/MCP-3.

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-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-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 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 the ACI/MCP-3.

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-4, ASTM E 648,and ACI/MCP-3.

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 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.

3.8.6 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 inch in 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.

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PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION

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.

ACI 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	(1999; Errata 2006) Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 318	(2008; Errata 2008; Errata 2009; Errata 2009; Errata 2009; Errata 2009; Errata 2009) 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	(2008; Errata 2009) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2005; Errata 2005) 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 A 615/A 615M	(2009) 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	(2008a) 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 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	(2005e1e2) 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 494/C 494M	(2008a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 595/C 595M	(2008a) 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 891	(1990; R 2003) Installation of Underground Precast Concrete Utility Structures
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 Ground Granulated Blast-Furnace Slag 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

CANADIAN STANDARDS ASSOCIATION (CSA)

CAN/CSA A23.4	(2005) Precast Concrete - Materials and

Construction

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

NPCA QC Manual (2005; R 2006) Quality Control Manual for Precast Plants

1.2 SYSTEM DESCRIPTION

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. At a minimum of thirty days prior to precast concrete unit manufacturing, the precast concrete producer will submit a mix design for each strength and type of concrete that will be used. Furnish a complete list of materials, including quantity, type, brand and applicable data sheets for all mix design constituents as well as applicable reference specifications. 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-02 Shop Drawings

Standard Precast Units; G

Drawings for standard precast concrete units furnished by the precast concrete producer for approval by the Contracting Officer. These drawings shall demonstrate that the applicable industry design standards have been met. Include installation and construction information on shop drawings. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings.

SD-03 Product Data

Standard Precast Units

Cut sheets, for standard precast concrete units, showing conformance to project drawings and requirements, and to applicable industry design standards listed in this specification.

Proprietary Precast Units

Standard plans or informative literature, for proprietary precast concrete units. Make available supporting calculations and design details upon request. Provide sufficient information as to demonstrate that such products will perform the intended task.

Embedded Items

Product data sheets and proper installation instruction for anchors, lifting inserts and other devices. Clearly indicate the products dimensions and safe working load.

Accessories

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.

SD-05 Design Data

Concrete Mix Proportions

Precast concrete unit design calculations, and concrete mix proportions.

SD-06 Test Reports

Test Reports

SD-07 Certificates

Quality Control Procedures

Quality control procedures established in accordance with NPCA QC Manual and/or ACPA QPC.

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 00 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

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.

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

Do not subject concrete to steam or hot air until after the concrete has attained its initial set. Apply steam, if used, within a suitable enclosure, which permits free circulation of the steam in accordance with CAN/CSA A23.4. If hot air is used for curing, take precautions to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 150 degrees F. These requirements do not apply to products cured with steam under pressure in an autoclave.

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 General Requirements

a. Install precast concrete products to the lines and grades shown in the contract documents or otherwise specified.

b. Lift products by suitable lifting devices at points provided by the precast concrete producer.

c. Install products in accordance with the precast concrete producer's instructions. In the absence of such instructions, install underground

utility structures in accordance with ASTM C 891. Install pipe and manhole sections in accordance with the procedures outlined by the American Concrete Pipe Association.

d. Field modifications to the product will relieve the precast producer of liability even if such modifications result in the failure of the product.

3.3.3 Water Tightness

Where water tightness is a necessary performance characteristic of the precast concrete product's end use, watertight joints, connectors and inserts should be used to ensure the integrity of the entire system.

3.4 FIELD QUALITY CONTROL

3.4.1 Site Tests

When water tightness testing is required for an underground product, use one of the following methods:

3.4.2 Vacuum Testing

Prior to backfill vacuum test system according to ASTM C 1244.

3.4.3 Water Testing

Perform water testing according to the drawings and precast concrete producer's recommendations.

-- End of Section --

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DIVISION 03 - CONCRETE

SECTION 03 63 00

GROUTING-NON-SHRINK EPOXY MACHINERY GROUT

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SECTION 03 63 00

GROUTING-NON-SHRINK EPOXY MACHINERY GROUT

PART 1 GENERAL

1.1 SCOPE OF WORK

This Section contains the requirements for grouting with non-shrink epoxy machinery grout.

The Contractor shall perform all work necessary to prepare metal base and concrete substrate surfaces and to mix, place, and protect non-shrink epoxy machinery grout.

1.2 DEFINITIONS

Non-shrink Epoxy Grout: A high-strength epoxy grout which does not shrink in the plastic state, is dimensionally stable in the hardened state, and bonds permanently to a clean metal machinery base and concrete substrate.

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.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; CORR 2009) Quality Management Systems- Requirements

ASTM INTERNATIONAL (ASTM)

ASTM C 579	(2001; R 2006) Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C 827	(2001a; R 2005) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
ASTM C 1181	(2005) Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts

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

Grouting Plan. The grouting plan shall be reviewed and accepted by the high-service pump manufacturer and by the non-shrink epoxy machinery grout manufacturer before being submitted to the Contracting Officer. This plan shall include grout installation drawings for the machinery to be grouted and shall list, provide a detailed description of, and present a timeline for all activities necessary to perform the complete work. Activities and items to be addressed shall include but not be limited to the following:

Surface preparation:

Curing and developed strength of concrete foundation.

Clean, roughen, and dry concrete surfaces.

Clean metal surfaces for optimum bond.

Formwork:

A List of materials to be used for forms, isolation joints, bond prevention, leak prevention/sealant, fasteners to concrete, etc.

Method to form chamfers and make formwork watertight.

Location and size of base anchor bolts and leveling components. Indicate whether each leveling component is to be retained/ encapsulated in the grout. For leveling components to be retained/encapsulated, indicate the minimum rounding radius required on all edges by the grout manufacturer to limit stress concentrations in the grout to acceptable levels and preclude grout cracking.

Location and protection for all surfaces not to be bonded to the grout.

Environmental protection:

Maintain a dry work area.

Shade from sun.

Ensure that clearances/dimensional requirements are met for the following:

Isolation joints and the extent of each pour.

Grout shouldering height, width, and chamfer angle.

Air vent holes and grout application holes.

Form height relative to machinery base.

Mixing

Placement procedures:

Normal, cold, or hot weather installation procedures, including multiple lifts and isolation joint material removal and subsequent

filling.

List equipment to be used and location/set-up during grouting.

Adequate grouting crew for continuous work.

Pouring

Finishing

Clean Up

Curing:

Curing and developed strength of the grout.

Anchor bolt torques and when such torques can be applied.

SD-07 Certificates

Certificates of Compliance

Documentation of Experience Level. Submit evidence that the Contractor's grouting crew meets the requirements as specified in the paragraph titled Qualifications.

SD-08 Manufacturer's Instructions

Submit the manufacturer's installation instructions/recommendations.

1.5 QUALITY ASSURANCE

The manufacturer of the non-shrink epoxy machinery grout shall have a quality management system in place and shall be ISO 9001 certified. A written Quality Assurance program shall be required to ensure the quality of their products package-to-package and lot-to-lot.

1.5.1 Qualifications

The non-shrink epoxy machinery grout manufacturer shall have been in the business of manufacturing similar products for over 10 years, maintain a strict quality assurance program, offer technical services, and provide a representative at the jobsite for product training before product installation.

The Contractor's grouting crew shall be qualified and experienced in working with non-shrink epoxy machinery grout. The grouting crew shall have successfully completed installation of the particular grout to be used at no fewer than two facilities having machinery and associated grouting of comparable size and complexity to that required under this project (e.g., the high-service pumps).

1.6 DELIVERY, STORAGE, AND HANDLING

Non-shrink epoxy machinery grout shall be delivered and stored in accordance with the manufacturer's recommendations.

The Contractor shall not use and shall remove from the job site epoxy grout aggregate that becomes damp or otherwise defective. Liquid components that

are found to be defective shall also be removed from the job site.

1.7 WARRANTY

The warranty shall extend for 24 months from the Date of Substantial Completion.

1.8 CERTIFICATION

Materials used in the grout do not contain metallic elements and corrosion-producing substances.

Materials meet specified shrinkage and compressive strength requirements.

The non-shrink epoxy machinery grout complies with the machinery manufacturer's (e.g., the high-service pump manufacturer's) requirements with respect to creep for the particular service application. Creep characteristics shall be based on ASTM C 1181 and long-term data. Coordinated certificates of compliance shall be provided by both the grout manufacturer and machinery manufacturer.

PART 2 PRODUCTS

2.1 GENERAL

The non-shrink epoxy machinery grout shall provide a highly effective bearing area, permanently maintain alignment of equipment or machinery, and provide proper load transfer to the foundation.

2.2 NON-SHRINK EPOXY MACHINERY GROUT

Epoxy Machinery Grout shall be non-shrink non-metallic type, 100 percent solids, three-component system consisting of resin, hardener, and aggregate. Grout shall have 0 percent shrinkage in the plastic form and 0 percent expansion in the hardened form in accordance with ASTM C 827. Compressive strength shall be 5,000 psi in 24 hours and 12,000 psi in 7 days, in accordance with ASTM C 579, Method B.

Grout shall be a proven product that has the ability to be poured or pumped into place to facilitate placement under the bases to be grouted.

Grout working time shall be at least 30 minutes.

The grout and the grout manufacturer shall be Five Star DP Epoxy Grout as manufactured by Five Star Products, Inc., Fairfield, CT.; or approved equal.

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall perform all grouting work in accordance with the non-shrink epoxy machinery grout manufacturer's written instructions/recommendations and preparation and placement procedures to achieve the installation as required by the drawings and as specified in this Section.

The Contractor shall have on hand all Material Safety Data Sheets (MSDS) for products being used. MSDS shall be quickly accessible before and during placement of grout for reference.

3.2 PREPARATION

3.2.1 Machinery Base

The Contractor shall clean metal surfaces as recommended by the non shrink epoxy machinery grout manufacturer.

Surfaces that are not to be bonded to the grout, such as base anchor bolts and equipment anchor bolts/screws, shall be coated/protected according to the non shrink epoxy machinery grout manufacturer's recommendations to prevent adherence of the grout.

3.2.2 Concrete

Concrete shall have developed acceptable strength as required by the non shrink epoxy machinery grout manufacturer before any grouting work.

Bonding surfaces shall be in accordance with the following:

Laitance shall be removed by chipping.

Surfaces shall be clean and free of loose particles, oil, and grease.

Surfaces shall be clean and dry immediately before grouting.

The Contractor shall follow all other recommendations by the non-shrink epoxy machinery grout manufacturer to achieve proper bonding.

3.3 INSTALLATION

3.3.1 Setting and Leveling:

The Contractor shall use leveling screws, nuts, wedges, or shims according to the machinery manufacturer's instructions to position and level the machinery at its proper height. Whether or not such components are to be retained/encapsulated in the grout shall be as specified in the machinery manufacturer's instructions.

Where leveling wedges or shims are to be retained after grouting, these components shall have full contact with and provide proper load transfer to the foundation. Such wedges and shims shall have edges rounded in accordance with the requirements specified in the Grouting Plan portion of this Section.

3.3.2 Placement of Grout

Grout temperature and surrounding environmental conditions shall be adjusted and controlled in accordance with the non-shrink epoxy machinery grout manufacturer's recommendations.

Formwork shall be placed in a manner to avoid entrapment of air and resulting voids. Joints shall be sealed to prevent leakage of non-shrink epoxy machinery grout.

All leveling wedges and shims which are to be retained shall be encapsulated with non-shrink epoxy machinery grout in accordance with the non-shrink epoxy machinery grout manufacturer's recommendations.

Leveling wedges, shims, and screws which are not to be retained shall be removed and the voids filled with non-shrink epoxy machinery grout.

No isolation joint materials shall be retained; all such materials shall be completely removed and the resulting spaces shall be filled with non-shrink epoxy machinery grout.

The completed grouting work shall be free of voids and shall provide full contact/bearing of the grout against the machinery base and the concrete substrate surfaces.

3.4 MANUFACTURER'S FIELD SERVICE

The manufacturer shall provide field service in accordance with the requirements in Division 1.

The high-service pump manufacturer's representative shall have certified the pump installation is ready for grouting before the pump base grouting can begin. The non-shrink epoxy machinery grout manufacturer's representative shall inspect and approve the work just before grouting, observe the placement of grout, and inspect and approve the completed work to ensure that the approved grouting plan has been followed and a proper grout installation has been provided.

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MASONRY

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.

ACI INTERNATIONAL (ACI)

ACI 318	(2008; Errata 2008; Errata 2009; Errata 2009; Errata 2009; Errata 2009; Errata 2009) Building Code Requirements for Structural Concrete and Commentary
ACI 530/530.1	(2008) Building Code Requirements and Specification for Masonry Structures; Containing Building Code Requirements for Masonry Structures, Specification for Masonry Structures and Companion Commentaries

ASTM INTERNATIONAL (ASTM)

ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 615/A 615M	(2009) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 641/A 641M	(2009a) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A 82/A 82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C 1019	(2009) Standard Test Method for Sampling and Testing Grout
ASTM C 1072	(2006) Standard Test Method for Measurement of Masonry Flexural Bond Strength
ASTM C 1142	(1995; R 2007) Standard Specification for Extended Life Mortar for Unit Masonry
ASTM C 129	(2006) Standard Specification for Nonloadbearing Concrete Masonry Units

ASTM C 144	(2004) Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 270	(2008a) Standard Specification for Mortar for Unit Masonry
ASTM C 476	(2008) Standard Specification for Grout for Masonry
ASTM C 494/C 494M	(2008a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 593	(2006) Fly Ash and Other Pozzolans for Use with Lime
ASTM C 641	(2007) Staining Materials in Lightweight Concrete Aggregates
ASTM C 67	(2008) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C 744	(2008) Prefaced Concrete and Calcium Silicate Masonry Units
ASTM C 780	(2008a) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C 803/C 803M	(2003) Penetration Resistance of Hardened Concrete
ASTM C 90	(2008) Loadbearing Concrete Masonry Units
ASTM C 91	(2005) Masonry Cement
ASTM C 94/C 94M	(2009) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2009a) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 2000	(2008) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 2240	(2005) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D 2287	(1996; R 2001) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E 514	(2008) Water Penetration and Leakage Through Masonry

1.2 SYSTEM DESCRIPTION

1.2.1 Design Requirements

1.2.1.1 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.

1.2.1.2 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.

1.2.2 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.

1.2.3 Metrication

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 Masonry Units (CMU); G
Cement; G
Water-Repellant Admixture; G

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.

SD-05 Design Data

Pre-mixed Mortar; G
Unit Strength Method; G

Pre-mixed mortar composition. Calculations and certifications of masonry unit and mortar strength.

SD-06 Test Reports

Field Testing of Mortar
Field Testing of Grout
Masonry Cement

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.

Masonry Inspector Qualifications; G

Copies of masonry inspector reports.

SD-07 Certificates

Concrete Masonry Units (CMU)
Control Joint Keys
Joint Reinforcement
Reinforcing Steel Bars and Rods
Masonry Cement
Precast Concrete Items
Admixtures for Masonry Mortar

Certificates of compliance stating that the materials meet the specified requirements.

1.4 QUALITY ASSURANCE

1.4.1 Appearance

Blend all brick to produce a uniform appearance when installed. An observable "banding" or "layering" of colors or textures caused by improperly mixed brick is unacceptable.

1.4.2 Contamination

When using bricks containing contaminated soil, supplier shall certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants will be released, or that the product is free from hazardous contaminants.

1.4.3 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 Contracting Officer reporting the quality of masonry construction.

1.5 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, 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.

1.5.1 Masonry Units

Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C 90. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.5.2 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.

1.5.3 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. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

1.6 PROJECT/SITE CONDITIONS

Conform to ACI 530/530.1 for hot and cold weather masonry erection.

1.6.1 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.

1.6.2 Cold Weather Installation

No erecting masonry is permitted when ambient temperature or mean daily air temperature falls below 40 degrees F or temperature of masonry units is below 40 degrees F.

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.

2.2 CONCRETE MASONRY UNITS (CMU)

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 20 percent post-industrial recycled content. 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 bond. Exterior concrete masonry units shall have water-repellant admixture added during manufacture.

a. Hollow Load-Bearing Units: ASTM C 90, made with lightweight or normal weight aggregate. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.

b. Hollow Non-Load-Bearing Units: ASTM C 129, made with lightweight or normal weight aggregate. Load-bearing units may be provided in lieu of non-load-bearing units.

2.2.1 Aggregates

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification. Use industrial waste by-products (air-cooled slag, cinders, or bottom ash), ground waste glass and concrete, granulated slag, and expanded slag in aggregates. Slag shall comply with ASTM C 989; Grade 80.

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.

2.3 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 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.

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 psi using 1/2 inch to No. 4 nominal-size coarse aggregate. Reinforcement shall conform to ASTM A 615/A 615M 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 Sills and Copings

Sills and copings shall be cast with washes. Sills for windows having mullions shall be cast in sections with head joints at mullions and a 1/4 inch allowance for mortar joints. The ends of sills, except a 3/4 inch wide margin at exposed surfaces, shall be roughened for bond. Treads of door sills shall have rounded nosings. Reinforce sills with not less than two No. 4 bars.

2.3.3 Splash Blocks

Splash blocks shall be as detailed. Reinforcement shall be the manufacturer's standard.

2.4 MORTAR FOR STRUCTURAL MASONRY

ASTM C 270, Type M or S. Strength (f'm) as indicated. Test in accordance with ASTM C 780. Use Type I or II portland cement. Use Masonry 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 C 593.

2.5 MASONRY MORTAR

Type M mortar shall conform to ASTM C 270 and shall be used for foundation walls. Mortar Type S shall conform to the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate. Type S mortar shall be used for non-load-bearing, non-shear-wall interior masonry and Type S for remaining masonry work except where higher compressive strength is indicated on structural drawings. When masonry cement ASTM C 91 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 C 780 and ASTM C 1072. 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 C 494/C 494M, Type C.

2.5.2 Cement

Portland cement shall conform to ASTM C 150, Type I or II. Masonry cement shall conform to ASTM C 91, Type N or 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. Additives shall conform to requirements in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.5.3 Pre-Mixed Mortar

Pre-mixed mortar shall conform to ASTM C 1142, Type RN or RS.

2.5.4 Sand and Water

Sand shall conform to ASTM C 144. 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 transmission. Construct panels of masonry units conforming to ASTM C 744 and mortar which contain the water-repellant admixture. When tested in accordance with ASTM C 1072, such panels shall have flexural strength not less than that specified or indicated. When tested in accordance with ASTM E 514, panels shall exhibit no water visible on back of test panel and no leaks through the panel after 24 hours, and not more than 25 percent of wall area shall be damp after 72 hours.

2.7 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C 476, fine. Cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 11 inches. Minimum grout strength shall be 2000 psi in 28 days, as tested by ASTM C 1019. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C 94/C 94M.

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 C 494/C 494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer.

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 A 153/A 153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A 82/A 82M. Wire ties or anchors in exterior walls shall conform to ASTM A 641/A 641M. Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A 641/A 641M; 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.

2.8.1 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 A 82/A 82M, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A 153/A 153M, 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.

2.10 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615/A 615M, 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 D 2000 or polyvinyl chloride conforming to ASTM D 2287. 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 D 2240.

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

Surfaces on which masonry is to be placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 1/8 inch. Sandblasting shall be used, 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 Wetting of Units

Wetting of clay, shale brick, or hollow brick units having an initial rate of absorption of more than 1 gram per minute per square inch of bed surface shall be in conformance with ASTM C 67. The method of wetting shall ensure that each unit is nearly saturated but surface dry when laid. Test clay or shale brick daily on the job, prior to laying, as follows: Using a wax pencil, draw a circle the size of a quarter on five randomly selected bricks. Apply 20 drops of water with a medicine dropper to the surface within the circle on each brick. If the average time that the water is completely absorbed in the five bricks is less than 1-1/2 minutes, wet bricks represented by the five bricks tested.

3.2.5 Hollow Units

Hollow units shall be laid as specified for concrete masonry units.

3.2.6 Tolerances

Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid 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

TOLERANCES	
In adjacent masonry units	1/8 inch
In 10 feet	1/4 inch
In 20 feet	3/8 inch
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

3.2.7 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.

3.2.8 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:

3.2.8.1 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.

3.2.8.2 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.

3.2.8.3 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.

3.2.9 Joint Widths

Joint widths shall be as follows:

3.2.9.1 Concrete Masonry Units

Concrete masonry units shall have 3/8 inch joints, except for prefaced concrete masonry units.

3.2.9.2 Prefaced Concrete Masonry Units

Prefaced concrete masonry units shall have a joint width of 3/8 inch wide on unfaced side and not less than 3/16 inch nor more than 1/4 inch wide on prefaced side.

3.2.10 Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses. Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

3.2.11 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Toothing

may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

3.2.12 Masonry Wall Intersections

Each course shall be masonry bonded 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.

3.3 MORTAR MIX

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2.5 hours after mixing shall be discarded.

3.4 REINFORCING STEEL

Reinforcement shall be cleaned 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.

3.4.1 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.

3.4.2 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.

3.5 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.

3.6 PLACING GROUT

Cells containing reinforcing bars shall be filled 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.

3.6.1 Vertical Grout Barriers for Fully Grouted Walls

Grout barriers shall be provided not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.6.2 Horizontal Grout Barriers

Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

3.6.3 Grout Holes and Cleanouts

3.6.3.1 Grout Holes

Grouting holes shall be provided in slabs, spandrel beams, and other in-place overhead construction. Holes shall be located over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Additional openings spaced not more than 16 inches on centers shall be provided 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, grouting holes shall be plugged and finished to match surrounding surfaces.

3.6.3.2 Cleanouts for Hollow Unit Masonry Construction

Cleanout holes shall be provided 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, cleanout courses shall be constructed using bond beam units in an inverted position to permit cleaning of all cells. Cleanout holes shall be provided at a maximum spacing of 32 inches where all cells are to be filled with grout. A new series of cleanouts shall be established 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, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.6.4 Grouting Equipment

3.6.4.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

3.6.4.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

3.6.5 Grout Placement

Masonry shall be laid to the top of a pour before placing grout. Grout shall not be placed 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.

3.6.5.1 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.

3.6.5.2 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

Maximum Grout Pour Height (feet) (4)	Grout Type	Grouting Procedure	Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (in.) (1,2) 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.

3.7 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.

3.8 CONTROL JOINTS

Control joints shall be provided as indicated and shall be constructed by using special control-joint units or sash jamb units with control joint key 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.

3.9 JOINTS SHOWN ON THE DRAWINGS

Joints will be located, detailed, and constructed as shown on the drawings. Keep joints free of mortar and other debris.

3.10 LINTELS

3.10.1 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.

3.10.2 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.

3.11 SILLS AND COPINGS

Sills and copings shall be set in a full bed of mortar with faces plumb and true.

3.12 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

3.12.1 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.

3.12.2 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.

3.13 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.

3.14 SPLASH BLOCKS

Splash blocks shall be located as shown.

3.15 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.

3.15.1 Dry-Brushing

a. Exposed concrete masonry unit

b. Exposed concrete brick surfaces

c. shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.15.2 Clay or Shale Brick Surfaces

Exposed clay or shale brick masonry surfaces shall be cleaned as necessary

to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. After cleaning, examine the sample panel of similar material for discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, change the method of cleaning to ensure that the masonry surfaces in the structure will not be adversely affected. The exposed masonry surfaces shall be water-soaked and then cleaned with a solution proportioned 1/2 cup trisodium phosphate and 1/2 cup laundry detergent to one gallon of water or cleaned with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay products manufacturer. The solution shall be applied with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Proprietary cleaning agents shall be used in conformance with the cleaning product manufacturer's printed recommendations. Efflorescence shall be removed in conformance with the brick manufacturer's recommendations.

3.16 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.

3.17 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.

3.18 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.

3.18.1 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 cavity fill at grade or underground utility pipe kickers 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.

3.18.2 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.

3.19 TEST REPORTS

3.19.1 Field Testing of Mortar

At least three specimens of mortar shall be taken each day. A layer of mortar 1/2 to 5/8 inch thick shall be spread on the masonry units and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 803/C 803M and for mortar consistency and properties with ASTM C 780.

3.19.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. 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.

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SECTION 05 12 00

STRUCTURAL STEEL

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 303	(2005) Code of Standard Practice for Steel Buildings and Bridges
AISC 317	(1992; Reprint 1999) ASD Manual of Steel Construction, Vol II: Connections
AISC 325	(2005) Manual of Steel Construction
AISC 326	(2002) Detailing for Steel Construction
AISC 348	(2000) Structural Joints Using ASTM A325 or A490 Bolts
AISC 360	(2005) Specification for Structural Steel Buildings, with Commentary
AISC 810	(1997) Erection Bracing of Low-Rise Structural Steel Frames/Fisher and West

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2007) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2008; Errata 2009) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B46.1	(2002) Surface Texture (Surface Roughness, Waviness and Lay)

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
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	(2009) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A 490	(2008b) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A 500/A 500M	(2009) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	(2007) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 514/A 514M	(2005) Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A 563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 6/A 6M	(2008a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 992/A 992M	(2006a) Standard Specification for Structural Steel Shapes
ASTM C 1107/C 1107M	(2008) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 827	(2001a; R 2005) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
ASTM F 436	(2009) Hardened Steel Washers
ASTM F 844	(2007a) Washers, Steel, Plain (Flat), Unhardened for General Use

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting

SSPC PS 13.01	(1982; E 2004) Epoxy-Polyamide Painting System
SSPC Paint 25	(1997; E 2004) Paint Specification No. 25Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel Type I and Type II
SSPC SP 3	(2004; E 2004) Power Tool Cleaning
SSPC SP 6	(2007) Commercial Blast Cleaning

1.2 SYSTEM DESCRIPTION

Provide the structural steel system, including shop primer or galvanizing as indicated in the design documents, 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 325 except as modified in this contract.

1.3 MODIFICATIONS TO REFERENCES

Conform to AISC 360, AISC 303, AISC 348, and AISC 325, except as modified 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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication drawings including description of connections; G

SD-03 Product Data

Shop primer

SD-07 Certificates

Welding procedures and qualifications

1.5 QUALITY ASSURANCE

1.5.1 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. 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. Use AWS A2.4 standard welding symbols. 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.

1.5.2 Certifications

1.5.2.1 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 A 36/A 36M.

2.1.2 High-Strength Structural Steel

2.1.3 Structural Shapes for Use in Building Framing

Wide flange shapes, ASTM A 992/A 992M.

2.1.4 Structural Steel Tubing

ASTM A 500/A 500M, Grade B; ASTM A 501.

2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.2.1 Structural Steel

2.2.1.1 Bolts

ASTM A 325, 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 A 563, Grade and Style for applicable ASTM bolt standard recommended.

2.2.1.3 Washers

ASTM F 844 washers for ASTM A 307 bolts, and ASTM F 436 washers for ASTM A 325 and ASTM A 490 bolts.

2.2.2 High-Strength Structural Steel and Structural Steel Tubing

2.2.2.1 Bolts

ASTM A 325, Type 1 ASTM A 490, Type 1 or 2.

2.2.2.2 Nuts

ASTM A 563, Grade and Style as specified in the applicable ASTM bolt standard.

2.2.2.3 Washers

ASTM F 436, plain carbon steel.

2.2.3 Foundation Anchorage

2.2.3.1 Anchor Bolts

ASTM A 307.

2.2.3.2 Anchor Nuts

ASTM A 563, Grade A, hex style.

2.2.3.3 Anchor Washers

ASTM F 844.

2.3 STRUCTURAL STEEL ACCESSORIES

2.3.1 Welding Electrodes and Rods

AWS D1.1/D1.1M.

2.3.2 Non-Shrink Grout

ASTM C 1107/C 1107M, with no ASTM C 827 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 and AISC 317 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.

2.5 GALVANIZING

ASTM A 123/A 123M or ASTM A 153/A 153M, as applicable, unless specified otherwise galvanize after fabrication where practicable.

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.

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, 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, 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 Surface Finishes

ASME B46.1 maximum surface roughness of 125 for pin, pinholes, and 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.

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 A 6/A 6M.

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 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 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 a licensed structural engineer.

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 with AISC 810.

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.

3.2.1 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

3.3 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 and pin 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.

3.3.1 Common Grade Bolts

ASTM A 307 bolts shall be tightened to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.3.2 High-Strength Bolts

ASTM A 325 and ASTM A 490 bolts shall be fully tensioned to 70 percent of their minimum tensile strength. 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 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.

3.5 WELDING

AWS D1.1/D1.1M. Do not stress relieve ASTM A 514/A 514M steel by heat treatment. 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 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

3.6.1 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.

3.7 GALVANIZING REPAIR

Provide as indicated or specified. Galvanize after fabrication where practicable. Repair damage to galvanized coatings using ASTM A 780 zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.8 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing. 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.

3.8.1 Welds

3.8.1.1 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.

3.8.2 High-Strength Bolts

3.8.2.1 Inspection

Inspection procedures shall be in accordance with AISC 348, Section 9. 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 proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of torque wrenches for high-strength bolts.

The Contractor shall inspect proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of torque wrenches for high-strength bolts.

3.8.2.2 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 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. Retest new bolts after installation.

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OPEN WEB STEEL JOIST FRAMING

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 B2.1/B2.1M	(2009) Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2008; Errata 2009) Structural Welding Code - Steel

STEEL JOIST INSTITUTE (SJI)

SJI 279167 SPECS/LOADS	(2006) 42nd Edition Standard Specifications and Load Tables for Steel Joists and Joist Girders

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 14.01	(1982; E 2004) Steel Joist Shop Painting System
SSPC Paint 15	(1999; E 2004) Steel Joist Shop Primer/Metal Building Primer

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

29 CFR 1910.1200	Hazard Communication
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.757	Steel Erection; Open Web Steel Joists

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

Welder qualification

Material Safety Data Sheet (MSDS) per OSHA 1910.1200

SD-02 Shop Drawings

Steel joist framing; G

SD-06 Test Reports

Welding inspections

SD-07 Certificates

Certification of Compliance

1.3 REGULATORY REQUIREMENT

All joist girder framing must conform to 29 CFR 1926.757. Secure all joist bridging and anchoring in place prior to the application of any construction loads. Distribute temporary loads so that joist capacity is not exceeded. Do not apply loads to bridging.

1.4 DELIVERY AND STORAGE

Handle, transport, and store joists in a manner to prevent damage affecting their structural integrity. Store all items off the ground in a well drained location protected from the weather and easily accessible for inspection and handling.

1.5 QUALITY ASSURANCE

All work must comply with the requirements set forth in 29 CFR 1926.

1.5.1 Drawing Requirements

Submit steel joist framing drawings. Show joist type and size, layout in plan, and erection details including methods of anchoring, framing at openings, type and spacing of bridging, requirements for field welding, and details of accessories as applicable.

1.5.2 Certification of Compliance

Prior to construction commencement, submit Material Safety Data Sheet per 29 CFR 1910.1200 for steel joists , and certification for welder qualification, compliance with AWS B2.1/B2.1M, welding operation, and tacker, 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.

Submit certification of compliance for the following:

29 CFR 1926

PART 2 PRODUCTS

2.1 JOISTS AND ACCESSORIES

Provide design data from SJI 279167 SPECS/LOADS for the joist series indicated.

2.2 PAINTING

2.2.1 Shop Painting

Clean and prime joists in accordance with SSPC Paint 15 and SSPC PS 14.01, Steel Joist Shop Painting System, using only Type I, "Red Oxide Paint."

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Handling and Erection

Conform to SJI 279167 SPECS/LOADS for the joist series indicated.

3.1.2 Welding

All welding must conform to AWS B2.1/B2.1M and AWS D1.1/D1.1M.

3.2 PAINTING

3.2.1 Touch-Up Painting

After erection of joists, touch-up connections and areas of abraded shop coat with paint of the same type used for the shop coat.

3.3 VISUAL INSPECTIONS

3.3.1 Erection Inspection

AWS D1.1/D1.1M, Section 6. Perform erection inspection and field welding inspections with AWS certified welding inspectors. Welding inspectors must visually inspect and mark welds.

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SECTION 05 30 00

STEEL DECKS

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 SG-913	(1991) LRFD Cold-formed Steel Design Manual
AISI SG03-3	(2002) Cold-Formed Steel Design Manual Set

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2008; Errata 2009) Structural Welding Code - Steel
AWS D1.3	(1998; Errata 1998) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 1008/A 1008M	(2009a) 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 A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A 653/A 653M	(2009a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 792/A 792M	(2009a) 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
FM P7825	(2009) Approval Guide

STEEL DECK INSTITUTE (SDI)

SDI 30	(2001) Design Manual for Composite Decks, Form Decks, and Roof Decks
SDI DDMO3	(3rd Edition) Diaphragm Design Manual
SDI DDP	(1987; R 2000) Deck Damage and Penetrations
SDI MOC2	(2006) Manual of Construction with Steel Deck

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 20	(2002; E 2004) Paint Specification No. 20 Zinc-Rich Coating Type I Inorganic and Type II Organic

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-01	Load Assumptions for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 209	(2005; Rev thru May 2007) Cellular Metal Floor Raceways and Fittings
UL 580	(2006; Rev thru Jul 2009) Tests for Uplift Resistance of Roof Assemblies
UL Bld Mat Dir	(2009) Building Materials 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-02 Shop Drawings

Fabrication Drawings; G

Metal Closure Strips

SD-03 Product Data

Accessories

Galvanizing Repair Paint

Joint Sealant Material

Mechanical Fasteners

Metal Roof Deck Units

Welder Qualifications

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

Wind Storm Resistance

1.3 QUALITY ASSURANCE

1.3.1 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.

1.3.2 Qualifications for Welding Work

Follows 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.

1.3.3 Regulatory Requirements

1.3.3.1 Fire Safety

Test roof deck as a part of a roof deck construction assembly of the type used for this project, listing as fire classified in the UL Bld Mat Dir, or listing as Class I construction in the FM P7825, and so labeled.

1.3.3.2 Wind Storm Resistance

Provide roof construction assembly capable of withstanding an uplift pressure of 90.5 pounds per square foot 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 3-310-01.

1.3.4 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.

1.4 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. Must not exceed the design live load. The maximum uniform distributed storage 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.

1.5 DESIGN REQUIREMENTS FOR ROOF DECKS

1.5.1 Properties of Sections

Properties of metal roof deck sections must comply with engineering design width as limited by the provisions of AISI SG-913.

1.5.2 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 A 653/A 653M designation G90 galvanized. Apply coating to both sides of sheet. Conform to UL 209 for coating on decking provided as wire raceways.

2.1.3 Galvanized Steel Angles for Roof Decks

Provide hot-rolled carbon steel angles conforming to ASTM A 36/A 36M, merchant quality, Grade Designation SAE/AISI 1023 or SAE/AISI 1025, and hot-dip galvanized in accordance with ASTM A 123/A 123M.

2.1.4 Joint Sealant Material for Roof Decks

Provide a nonskinning, gun-grade, bulk compound material as recommended by the manufacturer.

2.1.5 Galvanizing Repair Paint for Roof Decks

Provide a high zinc-dust content paint for regalvanizing welds in

galvanized steel and shall conform to ASTM A 780.

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 end walls, eaves, and openings through deck.

2.2.3 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.

2.2.4 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.

2.2.5 Hanger

Provide clips or loops for utility systems and suspended ceilings of one or more of the following types:

a. Tabs driven from top side of decking and arranged so as not to pierce electrical cells.

b. Decking manufacturer's standard as approved by the Contracting Officer.

2.2.6 Mechanical Fasteners

Provide mechanical fasteners for anchoring the deck to structural supports and adjoining units that are designed to meet the loads indicated. Provide positive locking-type fasteners standard with the Steel Deck Institute and the steel deck manufacturer, as approved by the Contracting Officer.

2.2.7 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 sample of Metal Roof Deck Units used to illustrate actual cross section dimensions and configurations.

2.3.1 Roof Deck Units

Conform to ASTM A 792/A 792M or ASTM A 1008/A 1008M for deck used in conjunction with insulation and built-up roofing. Fabricate roof deck units of 0.028 inch design thickness or thicker steel and galvanized in conformance with ASTM A 653/A 653M, G90 coating class.

2.3.1.1 Metal Closure Strips for 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.

2.3.2 Touch-Up Paint

Provide touch-up paint for zinc-coated units of an approved galvanizing repair paint with a high-zinc dust content. Touch-up welds with paint conforming to SSPC Paint 20 in accordance with ASTM A 780. Maintain finish of deck units and accessories by using touch-up paint whenever necessary to prevent the formation of rust.

After roof decking installation, wire brush, clean, and touchup paint the scarred areas on top and bottom surfaces of metal roof decking. The scarred areas include welds, weld scars, bruises, and rust spots. Touchup galvanized surfaces with galvanizing repair paint.

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 30, 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. Do not use unanchored deck units as a work or storage platform. 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.

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 normal 5/8 inch diameter puddle welds or fastened with screws as indicated on the design drawings and in accordance with manufacturer's recommended procedure and SDI 30. Clamp or weight deck units to provide firm contact between deck units and structural supports while performing fastening. Anchoring the deck to structural supports with powder-actuated fasteners or pneumatically driven fasteners is prohibited. Attachment of adjacent deck units by button-punching is prohibited.

3.2.1.1 Welding

Perform welding in accordance with AWS D1.3 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 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 manufacturer for location, size, and spacing of fastening. Do use welding washers at the connections of the deck to supports. Do not use welding washers at sidelaps. Holes and similar defects will not be acceptable. 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 A 780 finish with the manufacturer's standard touch-up paint.

3.2.1.2 Fastening

Anchor deck to structural supports and adjoining units with mechanical deck fasteners as recommended by the Steel Deck Institute and the steel deck manufacturer, as approved by the Contracting Officer.

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 inches on center. Reinforce holes and openings larger than 12 inches 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

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 Hangers

Provide as indicated to support utility system and suspended ceilings. Space devices as indicated so as to provide one device per 6.25 square feet.

3.3 JOINT SEALING FOR ROOF DECKS

Seal sidelaps and endlaps with manufacturer's recommended joint sealing material. Shop or field apply the material. Before applying the sealing material, completely remove dust, dirt, moisture, and other foreign material from the surfaces to which the sealing material is to be applied. Apply sealing material in strict accordance with the sealing material manufacturer's printed instructions.

3.4 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.

3.5 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.

3.6 CLEANING AND PROTECTION FOR ROOF DECKS

Upon completion of the deck, sweep surfaces clean and prepare for installation of the roofing.

3.7 FIELD QUALITY CONTROL

3.7.1 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.

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2.1.7.6 Washers
2.1.8 Aluminum Alloy Products
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2.2.2 Galvanize
2.2.3 Repair of Zinc-Coated Surfaces
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SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

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 46	(1978) Standards for Anodized Architectural Aluminum
AA DAF-45	(2003) Designation System for Aluminum Finishes

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2005) Code of Standard Practice for Steel Buildings and Bridges

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2008; Errata 2009) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(1996; Addenda A 1999; Errata 2003; R 2005) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 2005) Standard for Square and Hex Nuts
ASME B18.21.1	(1999; R 2005) Lock Washers (Inch Series)
ASME B18.22.1	(1965; R 2008) Plain Washers
ASME B18.6.2	(1998; R 2005) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws: Inch Series
ASME B18.6.3	(2003; R 2008) Machine Screws and Machine Screw Nuts

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

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 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A 467/A 467M	(2007) Standard Specification for Machine Coil and Chain
ASTM A 47/A 47M	(1999; R 2009) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 500/A 500M	(2009) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 653/A 653M	(2009a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 687	(1993) Standard Specification for High-Strength Nonheaded Steel Bolts and Studs
ASTM A 780/A 780M	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 786/A 786M	(2005) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A 924/A 924M	(2009a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 108/B 108M	(2008) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 221	(2008) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 26/B 26M	(2009) Standard Specification for Aluminum-Alloy Sand Castings
ASTM D 1187	(1997; R 2002e1) Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM E 488	(1996; R 2003) 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	(2000) Metal Bar Grating Manual

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3	(2004; E 2004) Power Tool Cleaning
SSPC SP 6	(2007) Commercial Blast Cleaning

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-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.

1.3 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.

1.4 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 A 36/A 36M.

2.1.2 Structural Tubing

ASTM A 500/A 500M.

2.1.3 Steel Pipe

ASTM A 53/A 53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Standard malleable iron fittings ASTM A 47/A 47M.

2.1.5 Gratings

a. Gray cast iron ASTM A 48/A 48M, Class 40.

b. Metal plank grating, non-slip requirement, aluminum ASTM B 209, 6061-T6; steel ASTM A 653/A 653M, G90.

c. Metal bar type grating NAAMM MBG 531.

2.1.6 Floor Plates, Patterned

Floor plate ASTM A 786/A 786M. Steel plate shall not be less than 14 gage.

2.1.7 Anchor Bolts

ASTM A 307. 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 as indicated on the drawings. Minimum concrete embedment shall be as indicated on the drawings. Design values listed shall be as tested according to ASTM E 488.

a. Minimum allowable pullout value shall be 4000lb.

b. Minimum allowable shear value shall be 5000lb.

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 and ASTM A 687 or ASTM A 307.

2.1.7.5 Screws

ASME B18.2.1, ASME B18.6.2, and ASME B18.6.3.

2.1.7.6 Washers

Provide plain washers to conform to ASME B18.22.1. 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 B 209 for sheet plate, ASTM B 221 for extrusions and ASTM B 26/B 26M or ASTM B 108/B 108M 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 A 123/A 123M, ASTM A 153/A 153M, ASTM A 653/A 653M or ASTM A 924/A 924M, G90, as applicable.

2.2.2 Galvanize

Anchor bolts, grating fasteners, 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 A 780/A 780M 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. 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.

2.2.4.2 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.

2.2.5 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 sheet, plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF-45, or AA 46. 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 DAF-45. Provide a polished satin finish on items to be anodized.

2.3 GUARD POSTS (BOLLARDS/PIPE GUARDS)

Provide 6-inch galvanized standard weight steel pipe as specified in ASTM A 53/A 53M. Anchor posts in concrete as indicated and fill solidly with concrete with minimum compressive strength of 2500 psi.

2.4 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 A 36/A 36M, for embedment as indicated. Galvanize embedded items exposed to the elements according to ASTM A 123/A 123M.

2.5 SAFETY CHAINS

Construct safety chains of galvanized steel, straight link type, 3/16 inch diameter, with at least twelve links per foot, and with snap hooks on each end. Test safety chain in accordance with ASTM A 467/A 467M, Class CS. Provide snap hooks of boat type. Provide galvanized 3/8 inch bolt with 3/4 inch eye diameter for attachment of chain, anchored as indicated. Supply two chains, 4 inches longer than the anchorage spacing, for each guarded area. Locate safety chain where indicated. Mount the top chain 3 feet 6 inches above the floor and mount the lower chain 2 feet above the floor.

2.6 PORTABLE CRANE

Provide a 3-ton portable crane for use with the new W-5 Pump Station. Also provide a manual push trolley and manual chain hoist rated for 3 tons. The crane shall have a span of 20 feet and an overall height of 16 feet. The crane shall be model number FHS616-S20 AC by Wallace Cranes or approved equal. The manual push trolley shall be model number 70-3820 by Wallace Cranes or approved equal. The manual chain hoist shall be model number 5-619-15 by Wallace Cranes or approved equal.

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 D 1187, 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 INSTALLATION OF GUARD POSTS (BOLLARDS/PIPE GUARDS)

Set pipe guards vertically in concrete piers. Construct piers of, and the hollow cores of the pipe filled with, concrete having a compressive strength of 3000 psi.

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METAL ROOF PANELS

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

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2007) North American Specification for the Design of Cold-Formed Steel Structural Members

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE/SEI 7-05	(2005; R 2006) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2004; Errata 2004) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2008; Errata 2009) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2008) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A 653/A 653M	(2009a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 117	(2009) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 792	(2004; R 2008) Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants
ASTM C 920	(2008) Standard Specification for

	Elastomeric Joint Sealants
ASTM D 1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1308	(2002; R 2007) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(2008) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 1667	(2005) Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D 2244	(2009a) Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(2002) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993; R 2004) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(2009) Measuring Adhesion by Tape Test
ASTM D 3363	(2005) Film Hardness by Pencil Test
ASTM D 4214	(2007) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D 4587	(2005) Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
ASTM D 522	(1993a; R 2008) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(2008) Standard Test Method for Specular Gloss
ASTM D 5894	(2005) Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM D 610	(2008) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(2002; R 2009) Evaluating Degree of Blistering of Paints
ASTM D 822	(2001; R 2006) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related

Coatings

ASTM D 968 (2005e1) Abrasion Resistance of Organic Coatings by Falling Abrasive

ASTM E 1592 (2005) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference

ASTM E 2140 (2001) Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head

ASTM E 84 (2009c) Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM G 23 (1996) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials

FM GLOBAL (FM)

FM 4471 (1995) Class I Panel Roofs

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA RSDM (2000) Metal Roofing Systems Design Manual

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0405 (2001; R 2003, 5th Ed) Roofing and Waterproofing Manual

NRCA ASMMRM (2006) Architectural Sheet Metal and Metal Roofing Manual

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793 (2003) Architectural Sheet Metal Manual, 6th Edition

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 12 (1982; E 2000) Paint Specification No. 12 Cold-Applied Asphalt Mastic (Extra Thick Film)

U.S. NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)

NAVFAC A-A-50570 (1997) Paint, Water-Borne, Acrylic Or Modified Acrylic, Semigloss, For Metal Surfaces

UNDERWRITERS LABORATORIES (UL)

UL 580 (2006; Rev thru Jul 2009) Tests for Uplift Resistance of Roof Assemblies

1.2 DESCRIPTION OF METAL ROOF SYSTEM

1.2.1 Performance Requirements

Roof panels and accessory components must conform to the following standards:

1.2.1.1 Hydrostatic Head Resistance

No water penetration when tested according to ASTM E 2140. Submit leakage test report upon completion of installation.

1.2.1.2 Wind Uplift Resistance

Provide metal roof panel system that conform to the requirements of ASTM E 1592 and UL 580. Uplift force due to wind action governs the design for panels. Submit wind uplift test report prior to commencing installation.

Roof system and attachments must resist the wind loads as determined by ASCE/SEI 7-05, in pounds per square foot. Metal roof panels and component materials must also comply with the requirements in FM 4471 as part of a panel roofing system as listed in Factory Mutual Guide (FMG) "Approval Guide" for class 1 or noncombustible construction, as applicable. Identify all materials with FMG markings.

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

Roofing Panels; G

Flashing and Accessories; G

Gutter/Downspout Assembly; G

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Roof panels; G

Factory-Applied Color Finish; G

Accessories; G

Fasteners; G

Pressure Sensitive Tape

Coil Stock

Attachment Clips; G

Enamel Repair Paint; G

SD-04 Samples

Roof Panels; G

Factory-applied Color Finish, samples, 9 inch lengths, full width; G

SD-05 Design Data

Wind Uplift Resistance; G

SD-06 Test Reports

Leakage Test Report; G

Wind Uplift Test Report; G

Factory Finish and Color Performance Requirements; G

SD-07 Certificates

Coil stock compatibility; G

Qualification of Manufacturer; G

Qualification of Applicator; G

SD-09 Manufacturer's Field Reports

Manufacturer's Field Inspection Reports; G

SD-11 Closeout Submittals

Warranties; G

Information Card; G

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Manufacturer

Submit documentation verifying metal roof panel manufacturer has been in the business of manufacturing metal roof panels for a period of not less than 5 years.

Manufacturer must also provide engineering services by an authorized engineer, currently licensed in the geographic area of the project, with a minimum of five (5) years experience as an engineer knowledgeable in roof wind design analysis, protocols and procedures for MBMA RSDM, ASCE/SEI 7-05, UL 580, and FM 4471. Engineer must provide certified engineering calculations for the project conforming to the stated references.

1.4.1.1 Manufacturer's Technical Representative

The manufacturer's technical representative must be thoroughly familiar with the products to be installed, installation requirements and practices,

and with any special considerations in the geographical area of the project. The representative must perform field inspections and attend meetings as specified.

1.4.1.2 Single Source

Roofing panels, clips, closures, and other accessories must be standard products of the same manufacturer, and the most recent design of the manufacturer to operate as a complete system for the intended use.

1.4.2 Qualification of Applicator

Metal roof system applicator must be approved, authorized, or licensed in writing by the roof panel manufacturer and have a minimum of 3 years experience as an approved, authorized, or licensed applicator with that manufacturer, approved at a level capable of providing the specified warranty. Supply the names, locations and client contact information of 5 projects of similar size and scope constructed by applicator using the manufacturer's roofing products submitted for this project within the previous three years.

1.4.3 Field Verification

Prior to the preparation of drawings and fabrication, verify location of roof framing, roof openings and penetrations, and any other special conditions. Indicate all special conditions and measurements on final shop drawings.

1.4.4 Qualifications for Welding Work

Welding procedures must conform to AWS D1.2/D1.2M for aluminum.

Operators are permitted to make only those types of weldments for which each is specifically qualified.

1.4.5 Pre-roofing Conference

After approval of submittals and before performing roofing system installation work, hold a pre-roofing conference to review the following:

a. Drawings, specifications, and submittals related to the roof work. Submit, as a minimum; sample profiles of roofing panels, with factory-applied color finish samples, flashing and accessories, gutter/downspout assembly samples, typical fasteners and pressure sensitive tape. Also include data and 1/2 pint sample of enamel repair paint, and technical data on coil stock and coil stock compatibility.

b. Roof system components installation;

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the 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 representative;

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; and

e. Quality control plan for the roof system installation;

f. Safety requirements.

Coordinate pre-roofing conference scheduling with the Contracting Officer. Attendance is mandatory for the Contractor, the Contracting Officer's designated personnel, personnel directly responsible for the installation of metal roof system, flashing and sheet metal work, electrical work, other trades interfacing with the roof work, and representative of the metal roofing 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 DELIVERY, HANDLING, AND STORAGE

Deliver, store, and handle panel materials, bulk roofing products, accessories, and other manufactured items in a manner to prevent damage and deformation, as recommended by the manufacturer, and as specified.

1.5.1 Delivery

Package and deliver materials to the site in undamaged condition. 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, deformation, dampness, and staining. Remove affected materials from the site and immediately replace. Remove moisture from wet materials not otherwise affected, restack and protect from further moisture exposure.

1.5.2 Handling

Handle materials in a manner to avoid damage. Select and operate material handling equipment so as not to damage materials or applied roofing.

1.5.3 Storage

Stack materials stored on site on platforms or pallets, and cover with tarpaulins or other weathertight covering which prevents trapping of water or condensation under the covering. Store roof panels so that water which may have accumulated during transit or storage will drain off. Do not store panels in contact with materials that might cause staining. Secure coverings and stored items to protect from wind displacement.

1.6 PROJECT CONDITIONS

Weather Limitations: Proceed with installation only when existing and forecast weather conditions permit metal roof panel work to be performed according to manufacturer's written instructions and warranty requirements, and specified safety requirements.

1.7 FABRICATION

Fabricate and finish metal roof panels and accessories on a factory stationary industrial type rolling mill to the greatest extent possible, per manufacturer's standard procedures and processes, and as necessary to fulfill indicated performance requirements. Comply with indicated profiles, dimensional and structural requirements.

Provide panel profile, as indicated on drawings for full length of panel. Fabricate panel side laps with factory installed captive gaskets providing a weather tight seal and preventing metal-to metal contact, and minimizing noise from movements within the panel assembly.

1.7.1 Finishes

Finish quality and application processes must conform to the related standards specified within this section. Noticeable variations within the 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 any contrasting variations.

1.7.2 Accessories

Fabricate flashing and trim to comply with recommendations in SMACNA 1793 as applicable to the design, dimensions, metal, and other characteristics of the item indicated.

a. Form exposed sheet metal accessories which are free from excessive oil canning, buckling, and tool marks, and are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.

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.

e. Fabricate cleats and attachments devices of size and metal thickness recommended by SMACNA or by metal roof panel manufacturer for application, but not less than the thickness of the metal being secured.

1.8 WARRANTIES

Provide metal roof system material and workmanship warranties meeting specified requirements. Provide revision or amendment to manufacturer's standard warranty as required to comply with the specified requirements.

1.8.1 Metal Roof Panel Manufacturer Warranty

Furnish the metal roof panel manufacturer's 20-year no dollar limit roof system materials and installation workmanship warranty, including flashing, components, trim, and accessories necessary for a watertight roof system construction. Make warranty directly to the Government, commencing at time of Government's acceptance of the roof work. The warranty must state that:

a. If within the warranty period, the metal 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, displaces, corrodes, perforates, 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 metal roof system and

correction of defective workmanship is the responsibility of the metal roof panel manufacturer. All costs associated with the repair or replacement work are the responsibility of the metal roof panel manufacturer.

b. If 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.

1.8.2 Manufacturer's Finish Warranty

Provide a manufacturer's no-dollar-limit 20 year warranty for the roofing system. Issue the warranty directly to the Government at the date of Government acceptance.warranting that the factory color finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of 8 when measured in accordance with ASTM D 4214; or fade or change colors in excess of 5 NBS units as measured in accordance with ASTM D 2244.

1.8.3 Metal Roof System Installer Warranty

Provide roof system installer warranty for a period of not less than 2 years that the roof system, as installed, is free from defects in installation workmanship, to include the roof panel installation, flashing, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Issue warranty directly to the Government. Correction of defective workmanship and replacement of damaged or affected materials is the responsibility of the metal roof system installer. All costs associated with the repair or replacement work are the responsibility of the installer.

1.8.4 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty period must be approved, as required, and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the metal roof system manufacturer warranty for the remainder of the manufacturer warranty period.

1.9 CONFORMANCE AND COMPATIBILITY

The entire metal roofing and flashing system must be in accordance with specified and indicated requirements, including wind resistance requirements. Work not specifically addressed and any deviation from specified requirements must be in general accordance with recommendations of the MBMA RSDM, NRCA 0405, the metal panel manufacturer's 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.

1.10 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of English unit measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

	PRODUCTS	ENGLISH UNITS	METRIC UNITS
a.	Sheet Aluminum	0.040 inch	1.0 mm
b.	Panels	minimum 12 inches	minimum 300 mm
	- vertical legs	2 inches	50 mm
	- stiffening ribs	4 inches	100 mm
c.	Screws	No. 14	0.242 mm
		No. 12	0.216 mm
d.	Bolts	1/4 inch	6 mm
e.	Studs	3/16 inch	5 mm
f.	Fasteners	1/2 inch	13 mm
		One inch	25 mm
g.	Rivets	1/16 inch	5 mm
		1/8 inch	3 mm

PART 2 PRODUCTS

2.1 ROOF PANELS

2.1.1 Aluminum Sheet Panels

Roll-form aluminum roof panels to the specified profile, with fy = 30 ksi, .040 thickness and depth as indicated.

Material must be plumb and true, and within the tolerances listed:

a. Aluminum sheet conforming to ASTM B 209, and AA ADM-105

b. Individual panels to have continuous length sufficient to cover the entire length of any unbroken roof slope with no joints or seams and formed without warping, waviness, or ripples that are not a part of the panel profile and free from damage to the finish coating system.

c. Provide panels with thermal expansion and contraction consistent with the type of system specified, and the following profile:

i. profile to be a 2 inch high standing seam with mechanical crimping or snap-together seams with concealed clips and fasteners.

2.2 FACTORY FINISH AND COLOR PERFORMANCE REQUIREMENTS

All panels are to receive a factory applied Kynar 500/Hylar 5000 finish consisting of a baked topcoat with a manufacturer's recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with an acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated

to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 + 0.05 mils. The prime coat must be oven cured prior to application of the finish coat.

c. Exterior Finish Coating: Apply the exterior finish coating over the primer by roll coating to a dry film thickness of 0.80 + 0.05 mils (3.80 + 0.05 mils for Vinyl Plastisol) for a total dry film thickness of 1.00 +0.10 mils (4.00 + 0.10 mils for Vinyl Plastisol). This exterior finish coat must be oven-cured.

d. Interior finish coating: Apply a wash coat on the reverse side over primer by roll coating to a dry film thickness of 0.30 + 0.05 mils for a total dry fill thickness of 0.50 +0.10 mils. The wash coat must be oven cured.

e. Color: The exterior finish chosen from the manufacturer's standard color chart.

f. Physical Properties: Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

General: SSPC Paint 12, NAVFAC A-A-50570, ASTM D 5894, and ASTM D 4587.

Abrasion: ASTM D 968
Adhesion: ASTM D 3359
Chalking: ASTM D 4214
Chemical Pollution: ASTM D 1308
Color Change and Conformity: ASTM D 2244
Creepage: ASTM D 1654
Cyclic Corrosion Test: ASTM D 5894
Flame Spread: ASTM E 84
Flexibility: ASTM D 522
Formability: ASTM D 522
Gloss at 60 and 85 degrees: ASTM D 523
Humidity: ASTM D 2247 and ASTM D 714
Oxidation: ASTM D 610
Pencil Hardness: ASTM D 3363
Reverse Impact: ASTM D 2794
Salt Spray: ASTM B 117
Weatherometer: ASTM G 23 and ASTM D 822

2.2.1 Specular Gloss

Finished roof surfaces to have a specular gloss value of 30 plus or minus 5 at an angle of 60 degrees when measured in accordance with ASTM D 523.

2.3 MISCELLANEOUS METAL FRAMING

2.3.1 General

Provide cold formed metallic-coated steel sheet conforming to ASTM A 653/A 653M and AISI S100.

2.3.2 Fasteners and Miscellaneous Metal Framing

Provide compatible type, corrosion resistant, of sufficient size and length

to penetrate the supporting element a minimum of one inch with other required properties to fasten miscellaneous metal framing members to substrates in accordance with the roof panel manufacturer's and ASCE/SEI 7-05 requirements.

2.3.2.1 Exposed Fasteners

Fasteners for roof panels must be corrosion resistant, compatible with the sheet panel or flashing material and of the 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 for exposed fasteners.

2.3.2.2 Screws

Provide corrosion resistant screws of the type and size recommended by the manufacturer to meet the performance requirements.

2.3.2.3 Rivets

Provide closed-end type rivets, corrosion resistant stainless steel where watertight connections are required.

2.3.2.4 Attachment Clips

Provide stainless steel, series 300 clips. Size, shape, thickness and capacity must meet the thickness and design load criteria specified.

2.3.3 Electrodes for Manual, Shielded Metal Arc Welding

Electrodes for manual, shielded metal arc welding must meet the requirements of AWS D1.1/D1.1M, and be covered, mild-steel electrodes conforming to AWS A5.1/A5.1M.

2.4 ACCESSORIES

Accessories must be compatible with the metal roof panels. Sheet metal flashing, trim, metal closure strips, caps, and similar metal accessories must be not less than the minimum thicknesses specified for roof panels. Provide exposed metal accessories to match the panels furnished. Molded foam rib, ridge and other closure strips must be closed-cell or solid-cell synthetic rubber or neoprene premolded to match configuration of the panels and not absorb or retain water.

2.4.1 Pre-manufactured Accessories

Pre-manufactured accessories must be manufacturer's standard for intended purpose, compatible with the metal roof system and approved for use by the metal roof panel manufacturer. Construct curbs to match roof slope.

2.4.2 Metal Closure Strips

Provide factory fabricated aluminum closure strips of the same gauge, color, finish and profile as the specified roof panel.

2.4.3 Rubber Closure Strips

Provide closed-cell, expanded cellular rubber closure strips conforming to ASTM D 1056 and ASTM D 1667, extruded or molded to the configuration of the specified roof panel profile and in lengths supplied by roof panel manufacturer.

2.4.4 Subgirts for Retrofits

Provide bar subgirts 1-1/2- by 1/8 inch galvanized steel with slotted holes for welding to end of impaling clip spikes.

2.5 JOINT SEALANTS

2.5.1 Sealants

Sealants are to be an approved gun type for use in hand or air pressure caulking guns at temperatures above 40 degrees F (or frost-free application at temperatures above 10 degrees F) with a minimum solid content of 85 percent of the total volume. Sealant must dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather tight joint. No migratory staining, in conformance with to ASTM C 792, is permitted on painted or unpainted metal, stone, glass, vinyl or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the roof panel manufacturer.

2.5.1.1 Shop Applied Sealants

Sealant for shop-applied caulking must be an approved gun grade, non-sag one-component polysulfide or silicone conforming to ASTM C 792 and ASTM C 920, Type II, with a curing time which ensures the sealants plasticity at the time of field erection. Color to match panel color.

2.5.1.2 Field Applied Sealants

Sealants for field-applied caulking must be an approved gun grade, non-sag on-component polysulfide or two component polyurethane with an initial maximum Shore A durometer hardness of 25, conforming to ASTM C 920, Type II. Color to match panel color.

2.5.1.3 Tape Sealants

Provide pressure sensitive, 100 percent solid tape sealant with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the roof panel manufacturer.

2.5.2 Sheet Metal Flashing and Trim

2.5.2.1 Fabrication, General

Custom fabricate sheet metal flashing and trim to comply with recommendations within the SMACNA 1793 that apply to design, dimensions, metal type, and other characteristics of design indicated. Shop fabricate items to the greatest extent possible. Obtain and verify field measurements for accurate fit prior to shop fabrication. Fabricate flashing and trim without excessive oil canning, buckling, and tool marks, true to line and levels indicated, with exposed edges folded back to form

hems.

2.5.2.2 Roof Drainage Sheet Metal Fabrications

Refer to Section 07 60 00 FLASHING AND SHEET METAL for fabrication of gutters and downspouts.

2.6 GASKETS AND SEALING/INSULATING COMPOUNDS

Gaskets and sealing/insulating compounds must be nonabsorptive and suitable for insulating contact points of incompatible materials. Sealing/insulating compounds must be non-running after drying.

2.7 FINISH REPAIR MATERIAL

Only use repair and touch-up paint supplied by the roof panel manufacturer and is compatible with the specified system.

PART 3 EXECUTION

3.1 EXAMINATION

Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the work.. Ensure surfaces are suitable, dry and free of defects and projections which might affect the installation.

Examine primary and secondary roof framing to verify that rafters, purlins, angels, channels, and other structural support members for panels and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer, UL, ASTM, and ASCE/SEI 7-05 requirements.

Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking; and that installation is within flatness tolerances required by metal roof panel manufacturer.

Examine rough-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of panels prior to installation.

Submit a written report to the Contracting Officer, endorsed by the installer, listing conditions detrimental to the performance of the work. Proceed with installation only after defects have been corrected.

3.2 INSTALLATION

Installation must meet specified requirements and be in accordance with the manufacturer's installation instructions and approved shop drawings. Do not install damaged materials. Dissimilar materials which are not compatible when contacting each other must be insulated by means of gaskets or sealing/insulating compounds. Keep all exposed surfaces and edges clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Remove stained, discolored, or damaged materials from the site.

3.2.1 Preparation

Clean all substrate substances which may be harmful to roof panels including removing projections capable of interfering with with roof panel

attachment.

Install sub-purlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written instructions.

3.3 PROTECTION OF APPLIED MATERIALS

Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to indicated live load limits of roof construction.

3.4 FASTENER INSTALLATION

Anchor metal roof panels and other components of the Work securely in place, using approved fasteners according to manufacturer's written instructions.

3.4.1 Welding

Procedures for manual, shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting welding work must be in accordance with AWS D1.1/D1.1M.

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. Set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently water tight and weather resistant. Work is to be accomplished to form weather tight construction without waves, warps, buckles, fastening stresses or distortion, and to allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accomplish the work must conform to the manufacturers written instructions.

3.5.2 Metal Flashing

Install exposed metal flashing at building corners, rakes, eaves, junctions between metal siding and roofing, valleys and changes off slope or direction in metal roofing, building expansion joints and gutters.

Exposed metal flashing must be the same material, color, and finish as the specified metal roofing panels. Furnish flashing in minimum 8 foot lengths. Exposed flashing must have 1 inch locked and blind soldered end joints, with expansion joints at intervals of no greater than 16 feet.

Fasten flashing at not more than 8 inches on center for roofs, except where flashing is held in place by the same screws used to secure panels. Exposed flashing and flashing subject to rain penetration must be bedded in specified joint sealant. Flashing which is contact with dissimilar metals must be isolated by means of the specified asphalt mastic material to prevent electrolytic deterioration.

Form drips to the profile indicated, with the edge folded back 1/2 inch to

form a reinforced drip edge.

3.6 ROOF PANEL INSTALLATION

Provide metal roof panels of full length from eave to ridge or eave to wall as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels or other components of the Work securely in place, with provisions for thermal and structural movement in accordance with NRCA ASMMRM.

Aluminum Roof Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior and aluminum or galvanized steel fasteners for unexposed surfaces.

Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using approved fasteners according to manufacturer's written instructions. Provide all blocking and nailers as required.

Metal Protection: Where dissimilar metals contact each other or possibly corrosive substrates, protect against galvanic action by permanent separation as recommended by the metal roof panel manufacturer.

Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and required for weatherproof performance of metal roof panel system. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.

3.6.1 Handling and Erection

Erect roofing system in accordance with the approved erection drawings, printed instructions and safety precautions of the manufacturer.

Do not subject panels to overloading, abuse, or undue impact. Do not apply bent, chipped, or defective panels. Damaged panels must be replaced and removed from the site at the contractors expense. Erect panels true, plumb, and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with indicated rake, eave, and curb overhang. Allow for thermal movement of the roofing, movement of the building structure, and provide permanent freedom from noise due to wind pressure.

Do not permit storage, walking, wheeling or trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to the installed roofing materials, and to distribute weight to conform to the indicated live load limits of the roof construction.

Roof panels must be laid with corrugations in the direction of the roof slope. End laps of exterior roofing must not be less than 8 inches.

Field cutting of metal roof panels by torch is not permitted. Field cut only as recommended by manufacturer's written instructions.

3.6.2 Closure Strips

Install metal closure strips at open ends of metal ridge rolls; open ends of corrugated or ribbed pattern roofs, and at intersection of wall and roof, unless open ends are concealed with formed eave flashing; rake of metal roof unless open end has a formed flashing member; and in other

required areas.

Install closure strips at intersection of the wall with metal roofing; top and bottom of metal siding; heads of wall openings; and in other required locations.

3.6.3 Workmanship

Make lines, arises, and angles sharp and true. Free exposed surfaces from any 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 as necessary to make the work watertight.

3.7 ACCEPTANCE PROVISIONS

3.7.1 Erection Tolerances

Erect metal roofing straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Horizontal lines must not vary more than 1/8 inch in 40 feet.

3.7.2 Leakage Tests

Finished application of metal roofing is to be subject to inspection and test for leakage by the Contracting Officer or his designated representative. Inspection and tests will be conducted without cost to the Government.

Inspection and testing is to be made promptly after erection to permit correction of defects and removal/replacement of defective materials.

3.7.3 Repairs to Finish

Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials and as recommended by the metal roof panel manufacturer. 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 are to be immediately removed and replaced with new material.

3.7.4 Paint Finished Metal Roofing

Paint finished metal roofing will be tested for color stability by the Contracting Officer during the manufacturer's specified guarantee period. Panels that indicate color changes, fading, or surface degradation, determined by visual examination, must be removed and replaced with new panels at no expense to the Government. New panels will be subject to the specified tests for an additional year from the date of their installation.

3.8 CLEAN UP AND DISPOSAL

Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs. 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. Touch up scratches in panel finish with manufacturer supplied touch-up paint system to match panel finish. Treat exposed cut edges with manufacturer supplied clear coat.

Collect all scrap/waste materials and place in containers. Promptly dispose of demolished and scrap materials. Do not allow scrap/waste materials to accumulate on-site; transport immediately from the government property and legally dispose of them.

3.9 FIELD QUALITY CONTROL

3.9.1 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. Make inspections during the first 20 squares of roof panel installation, at mid-point of the installation, and at substantial completion, at a minimum. Additional inspections are required 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.

Submit three signed copies of the manufacturer's field inspection reports to the Contracting Officer within one week of substantial completion.

3.10 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 1 mm (0.032) inch thick aluminum card for exterior display. Format as directed in paragraph titled "Form One".

Make card 8 1/2 by 11 inches minimum. Information card must identify facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, roof panel manufacturer and product name, type underlayment(s), date of completion; installing contractor identification and contact information; manufacturer warranty expiration, warranty reference number, and contact information. Install card at location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

3.10.1 Form One

FORM 1 - PREFORMED ALUMINUM PANEL ROOFING SYSTEM AND 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:

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:

3.11 NASA WARRANTY

CONTRACTOR'S TWENTY (20) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM

FACILITY DESCRIPTION_____

BUILDING NUMBER:_____

NASA CONTRACT NUMBER:_____

CONTRACTOR

CONTRACTOR:_____

ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

OWNER

OWNER:_____

ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

CONSTRUCTION AGENT

CONSTRUCTION AGENT:_____

ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

CONTRACTOR'S TWENTY (20) YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOFING SYSTEM
(continued)

THE CONTRACTOR MUST SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE NON-STRUCTURAL METAL ROOFING SYSTEM.SUBMIT ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR IS ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE NON-STRUCTURAL METAL ROOF DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN MUST INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.

6. THIS WARRANTY APPLIES TO THE NON-STRUCTURAL METAL ROOFING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

-- End of Section --

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

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SECTION 07 60 00

FLASHING AND SHEET METAL

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 D1.2/D1.2M	(2008) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 308/A 308M	(2006) Standard Specification for Steel Sheet, Terne (Lead-Tin Alloy) Coated by the Hot Dip Process
ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(2008) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 32	(2008) Standard Specification for Solder Metal
ASTM B 370	(2009) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B 69	(2008) Standard Specification for Rolled Zinc
ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 226/D 226M	(2009) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 41	(2005) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 4586	(2007) Asphalt Roof Cement, Asbestos-Free

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

Gutters

Downspouts

Expansion joints

Base flashing

Counterflashing

Flashing at roof penetrations

Caulked Reglets; G

Drip edge

Eave flashing

Indicate thicknesses, dimensions, fastenings and anchoring methods, expansion joints, and other provisions necessary for thermal expansion and contraction. Scaled manufacturer's catalog data may be submitted for factory fabricated items.

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 lead, lead-coated metal, or 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, except that if copper is selected for any exposed item, all exposed items must be copper.

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: gutters, including hangers; downspouts; gravel stops and fascias; cap, valley, steeped, base, and eave flashings and related accessories.

2.1.2 Drainage

Do not use copper for an exposed item if drainage from that item will pass over exposed masonry, stonework or other metal surfaces. In addition to the metals listed in Table I, lead-coated copper may be used for such items.

2.1.3 Copper, Sheet and Strip

ASTM B 370, cold-rolled temper, H 00 (standard).

2.1.4 Zinc Sheet and Strip

ASTM B 69, Type I, a minimum of 0.024 inch thick.

2.1.5 Stainless Steel

ASTM A 167, Type 302 or 304, 2D Finish, fully annealed, dead-soft temper.

2.1.6 Terne-Coated Steel

Minimum of 14 by 20 inch with minimum of 40 pound coating per double base box. ASTM A 308/A 308M.

2.1.7 Aluminum Alloy Sheet and Plate

ASTM B 209, anodized clear form alloy, and temper appropriate for use.

2.1.8 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B 221.

2.1.9 Solder

ASTM B 32, 95-5 tin-antimony.

2.1.10 Polyvinyl Chloride Reglet

ASTM D 1784, Type II, Grade 1, Class 14333-D, 0.075 inch minimum thickness.

2.1.11 Bituminous Plastic Cement

ASTM D 4586, Type I.

2.1.12 Roofing Felt

ASTM D 226/D 226M Type I.

2.1.13 Asphalt Primer

ASTM D 41.

2.1.14 Fasteners

Use the same metal or a metal compatible with the item fastened. Use stainless steel fasteners to fasten dissimilar materials.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Welding and Mechanical Fastening

Use welding for aluminum of thickness greater than 0.040 inch. Aluminum 0.040 inch or less in thickness must be butted and the space backed with formed flashing plate; or lock joined, mechanically fastened, and filled with sealant as recommended by the aluminum manufacturer.

3.1.1.1 Welding of Aluminum

Use welding of the inert gas, shield-arc type. For procedures, appearance and quality of welds, and the methods used in correcting welding work, conform to AWS D1.2/D1.2M.

3.1.1.2 Mechanical Fastening of Aluminum

Use No. 12, aluminum alloy, sheet metal screws or other suitable aluminum alloy or stainless steel fasteners. Drive fasteners in holes made with a No. 26 drill in securing side laps, end laps, and flashings. Space fasteners 12 inch maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 2 inch from the end of the overlapping sheet.

3.1.2 Protection from Contact with Dissimilar Materials

3.1.2.1 Copper or Copper-bearing Alloys

Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moistureproof building felts.

3.1.2.2 Aluminum

Do not allow aluminum surfaces in direct contact with other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, paint the dissimilar metal with a primer followed by two coats of aluminum paint. Where drainage from a dissimilar metal passes over aluminum, paint the dissimilar metal with a non-lead pigmented paint.

3.1.2.3 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.2.4 Wood or Other Absorptive Materials

Paint surfaces that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

3.1.3 Expansion and Contraction

Provide expansion and contraction joints at not more than 32 foot intervals for aluminum and 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. Join extruded aluminum gravel stops and fascias by expansion and contraction joints spaced not more than 12 feet apart.

3.1.4 Base Flashing

Lay the base flashings with each course of the roof covering, shingle fashion, where practicable, where sloped roofs abut chimneys, curbs, walls, or other vertical surfaces. Extend up vertical surfaces of the flashing not less than 8 inch and not less than 4 inch under the roof covering. Where finish wall coverings form a counterflashing, extend the vertical leg of the flashing up behind the applied wall covering not less than 6 inch. Overlap the flashing strips with the previously laid flashing not less than 3 inch. Fasten the strips at their upper edge to the deck. Horizontal flashing at vertical surfaces must extend vertically above the roof surface and fastened at their upper edge to the deck a minimum of 6 inch on center with a minimum of 2-inch lap of any surface. Solder end laps and provide for expansion and contraction. Install and fit the flashings so as to be completely weathertight. Provide factory-fabricated base flashing for interior and exterior corners. Do not use metal base flashing on built-up roofing.

3.1.5 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 not less than 3 inch. 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; on short runs, place wedges closer together. Fill caulked-type reglets or

raked joints which receive counterflashing with caulking compound. Turn up the concealed edge of counterflashings built into masonry or concrete walls not less than 1/4 inch and extend not less than 2 inch into the walls. Install counterflashing to provide a spring action against base flashing.

3.1.6 Caulked Reglets

Provide with rounded edges and metal strap brackets or other anchors for securing to the concrete forms. Provide reglets with a core to protect them from injury during the installation. Provide built-up mitered corner pieces for internal and external angles. Wedge the flashing in the reglets with lead wedges every 18 inch, caulked full and solid with an approved compound.

3.1.7 Friction Reglets

Provide with flashing receiving slots not less than 5/8 inch deep, one inch jointing tongues, and upper and lower anchoring flanges installed at 24 inch maximum snaplock receiver. Insert the flashing the full depth of the slot and lock by indentations made with a dull-pointed tool, wedges, and filled with a sealant. For friction reglets, install flashing snaplock receivers at 24 inch on center maximum. When the flashing has been inserted the full depth, caulk the slot and lock with wedges and fill with sealant.

3.1.8 Edge Strip

Hook the lower edge of fascias at least 3/4 inch over a continuous strip of the same material bent outward at an angle not more than 45 degrees to form a drip. Nail hook strip to a wood nailer at 6 inchmaximum on center. Where fastening is made to concrete or masonry, use screws spaced 12 inch on center driven in expansion shields set in the concrete or masonry. Where horizontal wood nailers are slotted to provide for insulation venting, install strips to prevent obstruction of vent slots. Where necessary, install strips over 1/16 inch thick compatible spacer or washers.

3.1.9 Joints

Leave open the section ends of gravel stops and fascias 1/4 inch and backed with a formed flashing plate, mechanically fastened in place and lapping each section end a minimum of 4 inch set laps in plastic cement. Face nailing will not be permitted. Install prefabricated aluminum gravel stops and fascias in accordance with the manufacturer's printed instructions and details.

3.1.10 Metal Drip Edge

Provide a metal drip edge, designed to allow water run-off to drip free of underlying construction, at eaves and rakes prior to the application of roofing shingles. Apply directly on the wood deck at the eaves and over the underlay along the rakes. Extend back from the edge of the deck not more than 3 inch and secure with compatible nails spaced not more than 10 inch on center along upper edge.

3.1.11 Gutters

The hung type of shape indicated and supported on underside by brackets that permit free thermal movement of the gutter. Provide gutters in sizes indicated complete with mitered corners, end caps, outlets, brackets, and

other accessories necessary for installation. Bead with hemmed edge or reinforce the outer edge of gutter with a stiffening bar not less than 3/4 by 3/16 inch of material compatible with gutter. Fabricate gutters in sections not less than 8 feet. Lap the sections a minimum of one inch in the direction of flow or provide with concealed splice plate 6 inch minimum. Join the gutters, other than aluminum, by riveted and soldered joints. Join aluminum gutters with riveted sealed joints. Provide expansion-type slip joints midway between outlets. Support gutters on adjustable hangers spaced not more than 30 inch on center. Adjust gutters to slope uniformly to outlets, with high points occurring midway between outlets. Fabricate hangers and fastenings from metals.

3.1.12 Downspouts

Space supports for downspouts according to the manufacturer's recommendation for the masonry substrate. Types, shapes and sizes are indicated. Provide complete including elbows and offsets. Provide downspouts in approximately 10 foot lengths. Provide end joints to telescope not less than 1/2 inch and lock longitudinal joints. Provide gutter outlets with wire ball strainers for each outlet. Provide strainers to fit tightly into outlets and be of the same material used for gutters. Keep downspouts not less than one inch away from walls. Fasten to the walls at top, bottom, and at an intermediate point not to exceed 5 feet on center with leader straps or concealed rack-and-pin type fasteners. Form straps and fasteners of metal compatible with the downspouts.

3.1.12.1 Terminations

Neatly fit into the drainage connection the downspouts terminating in drainage lines and fill the joints with a portland cement mortar cap sloped away from the downspout. Provide downspouts terminating in splash blocks with elbow-type fittings. Provide splash pans as specified.

3.1.13 Eave Flashing

One piece in width, applied in 8 to 10 foot lengths with expansion joints spaced as specified in paragraph entitled "Expansion and Contraction." Provide a 3/4 inch continuous fold in the upper edge of the sheet to engage cleats spaced not more than 10 inch on center. Locate the upper edge of flashing not less than 18 inch from the outside face of the building, measured along the roof slope. Fold lower edge of the flashing over and loose-lock into a continuous edge strip on the fascia. Where eave flashing intersects metal valley flashing, secure with one inch flat locked joints with cleats that are 10 inch on center.

3.1.14 Expansion Joints

Provide expansion joints for roofs, walls, and floors. Provide expansion joints in continuous sheet metal at 40 foot intervals for copper and stainless steel and at 32 foot intervals for aluminum. Provide evenly spaced joints. 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 spacing. Conform to the requirements of Table I.

3.1.14.1 Floor and Wall Expansion Joints

Provide U-shape with extended flanges for expansion joints in concrete and masonry walls and in floor slabs.

3.1.15 Flashing at Roof Penetrations and Equipment Supports

Provide metal flashing for all pipes, ducts, and conduits projecting through the roof surface and for equipment supports, guy wire anchors, and similar items supported by or attached to the roof deck.

3.1.16 Stepped Flashing

Stepped flashing shall be installed where sloping roofs surfaced with shingles abut vertical surfaces. Separate pieces of base flashing shall be placed in alternate shingle courses.

3.2 PAINTING

Field-paint sheet metal for separation of dissimilar materials.

3.2.1 Aluminum Surfaces

Shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint.

3.3 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.

3.4 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.

3.5 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. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.

b. Verification that specified material is provided and installed.

c. Inspection of sheet metalwork, for proper size(s) and thickness(es), fastening and joining, and proper installation.

3.5.1 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 at the end of each day.

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES

Sheet Metal Items	Aluminum, Inch	Stainless Steel, Inch
Building Expansion Joints		
Cover	.032	.015
Downspouts and leaders	.032	.015
Downspout clips and anchors	.040 clip	-
	.125 anchor	-
Downspout straps, 2-inch	.060	.050
Flashings:		
Base	.040	.018
Cap (Counter-flashing)	.032	.015
Eave	-	.015
Spandrel beam	-	.010
Bond barrier	-	.015
Pipe vent sleeve		
Extrusions	.075	-
Sheets	.032	.015
Sheets, smooth	.050	.018
Edge Strip	.050	.025
Gutters:		
Gutter section	.032	.015
Continuous cleat	.032	.015
Hangers, dimensions	1 inch x .125 inch (c)	1 inch x .125 inch
Joint Cover plates (See Table II)	.032	.015
Reglets	-	.010

TABLE II. SHEET METAL JOINTS

Item Designation	TYPE OF JOINT Steel and Stainless Steel	Aluminum	Remarks
Joint cap for building expansion seam, cleated joint at roof	1.25 inch single lock, standing seam, cleated	1.25 inch single lock, standing	- - -
Flashings			
Base	One inch 3 inch lap for expansion joint	One inch flat locked, soldered; sealed; 3 inch lap for expansion joint	Aluminum producer's recommended hard setting sealant for locked aluminum joints. Fill

TABLE II. SHEET METAL JOINTS

	TYPE OF JOINT		
			each metal expansion joint with a joint sealing compound compound.
Cap-in reglet	3 inch lap	3 inch lap	Seal groove with joint sealing compound.
Reglets	Butt joint	- - -	Seal reglet groove with joint sealing compound.
Eave	One inch flat locked, cleated One inch loose locked, expansion joint cleated	One inch flat locked, locked, cleated one inch loose locked, sealed expansion joints, cleated	Same as base flashing.
Edge strip	Butt	Butt	- - -
Gutters	1.5 inch lap, riveted and soldered	One inch flat locked, riveted, and sealed	Aluminum producers recommended hard setting sealant for locked aluminum joints.

(a) Provide a 3 inch lap elastomeric flashing with manufacturer's recommended sealant.

(b) Seal polyvinyl chloride reglet with manufacturer's recommended sealant.

-- End of Section --

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

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SECTION 07 92 00

JOINT SEALANTS

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 C 509	(2006) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 734	(2006) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C 919	(2002) Use of Sealants in Acoustical Applications
ASTM C 920	(2008) Standard Specification for Elastomeric Joint Sealants
ASTM D 1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 217	(2002) Cone Penetration of Lubricating Grease
ASTM E 84	(2009c) 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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants

Primers

Bond breakers

Backstops

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.

1.3 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 40 and 90 degrees F.

1.4 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.

1.5 QUALITY ASSURANCE

1.5.1 Compatibility with Substrate

Verify that each of the sealants are compatible for use with joint substrates.

1.5.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.6 SPECIAL WARRANTY

Guarantee sealant joint against failure of sealant and against water penetration through each sealed joint for 10 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 C 920, Type M, Grade NS, Class 12.5, Use NT. Location(s) and color(s) of sealant for the following:

	LOCATION	COLOR
a.	Small voids between walls or partitions and adjacent lockers, casework, shelving, door frames, built-in or surface-mounted equipment and fixtures, and similar items.	Gray

	LOCATION	COLOR
b.	Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces.	Gray
c.	Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed.	Gray
d.	Joints between edge members for acoustical tile and adjoining vertical surfaces.	White
e.	Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted.	As selected
f.	Joints between shower receptors and ceramic tile; joints formed where nonplaner tile surfaces meet.	As selected
g.	Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.	As selected
h.	Behind escutcheon plates at valve pipe penetrations and showerheads in showers.	Gray

2.1.2 Exterior Sealant

For joints in vertical surfaces, provide ASTM C 920, Type M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C 920, Type M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

	LOCATION	COLOR
a.	Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations.	Match adjacent surface color
b.	Masonry joints where shelf angles occur.	Gray
c.	Expansion and control joints.	Match adjacent surface color
d.	Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required.	Gray
e.	Voids where items pass through exterior walls.	Gray
f.	Metal-to-metal joints where sealant is indicated or specified.	Gray

LOCATION	COLOR

2.1.3 Floor Joint Sealant

ASTM C 920, Type M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

LOCATION	COLOR
a. Seats of metal thresholds for exterior doors.	Gray
b. Control and expansion joints in floors, slabs, ceramic tile, and walkways.	As selected

2.1.4 Acoustical Sealant

Polymer-based acoustical sealant conforming to ASTM C 919 must have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E 84. Acoustical sealant must have a consistency of 250 to 310 when tested in accordance with ASTM D 217, and must remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C 734, and must be non-staining.

2.1.5 Preformed Sealant

Provide preformed sealant of polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, the sealant must be non-bleeding and no loss of adhesion.

2.1.5.1 Tape

Tape sealant: Provide cross-section dimensions of 1 inch by 1/8 inch.

2.1.5.2 Bead

Bead sealant: Provide cross-section dimensions to fit application.

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 BACKSTOPS

Provide glass fiber roving or neoprene, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Make backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

2.4.1 Rubber

Conform to ASTM D 1056, Type 1, open cell, or Type 2, closed cell, Class A, round cellular rubber sponge backing.

2.4.2 Synthetic Rubber

Conform to ASTM C 509, Option I, Type I preformed rods or tubes for synthetic rubber backing.

2.4.3 Neoprene

Conform to ASTM D 1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2 for neoprene backing.

2.4.4 Silicon Rubber Base

Provide Silicon Rubber Based Sealants of single component, solvent release, color gray, conforming to ASTM C 920, Non-sag, Type I, Class 25.

2.5 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer except for aluminum and bronze surfaces that will be in contact with sealant.

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 calk 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
over 1/4 inch	1/2 of width	Equal to width
For wood, concrete, masonry, stone:		
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 Backstops

Install backstops 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 backstop 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 PROTECTION AND CLEANING

3.4.1 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.

3.4.2 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.

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STEEL DOORS AND FRAMES

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	(2008; Errata 2009) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 879/A 879M	(2006) Standard Specification for Steel Sheet, zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
ASTM C 578	(2009e1) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(2009) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 612	(2009) Mineral Fiber Block and Board Thermal Insulation
ASTM D 2863	(2009) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM E 330	(2002) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.115	(2006) Hardware Preparation in Steel Doors and Steel Frames

FLORIDA DEPARTMENT OF COMMUNITY AFFAIRS (FDCA)

FBC TAS 201	(1994) Large Missile Impact
FBC TAS 202	(1994) Uniform Static Air Pressure

FBC TAS 203	(1994) Cyclic Wind Loading

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMMA HMM	(1999; R2000) Hollow Metal Manual

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	(2001) Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Frame Assemblies
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

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-02 Shop Drawings

Doors; G

Frames; G

Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

Schedule of doors; G

Schedule of frames; G

Submit door and frame locations.

SD-03 Product Data

Doors; G

Frames; G

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.

1.3 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.

PART 2 PRODUCTS

2.1 GENERAL

Ensure all exterior openings meet Florida wind load requirements. Test doors that are part of the exterior building envelope in accordance with ASTM E 330, to the design loads specified, and comply with the FBC TAS 201, FBC TAS 202, and FBC TAS 203. Refer to structural drawings for wind velocity.

Ensure welding is in accordance with the recommended practice of AWS D1.1/D1.1M, Sections 1 through 6, and as specified by the producer of the metal being welded. Ensure welds behind finished surfaces cause no distortion or discoloration on the exposed side.

2.2 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.

2.2.1 Classification - Level, Performance, Model

2.2.1.1 Maximum Duty Doors

SDI/DOOR A250.8, Level 4, physical performance Level A, Model 1, with core construction as required by the manufacturer for exterior doors, of size(s) and design(s) indicated. Where vertical stiffener cores are required, the space between the stiffeners shall be filled with mineral board insulation.

2.3 CUSTOM HOLLOW METAL DOORS

Provide custom hollow metal doors where nonstandard steel doors are indicated. At the Contractor's option, custom hollow metal doors may be provided in lieu of standard steel doors. Door size(s), design(s), materials, construction, gages, and finish shall be as specified for

standard steel doors and shall comply with the requirement of NAAMM HMMA HMM. Fill all spaces in doors with insulation. Close top and bottom edges with steel channels not lighter than 16 gage. Close tops of exterior doors flush with an additional channel and seal to prevent water intrusion. Prepare doors to receive hardware specified in Section 08 71 00 DOOR HARDWARE. Doors shall be 1-3/4 inch thick, unless otherwise indicated.

2.4 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 exterior locations.

2.5 ACCESSORIES

2.5.1 Astragals

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.

2.5.2 Moldings

Provide moldings around glass of exterior doors and louvers of interior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings. Muntins shall interlock at intersections and shall be fitted and welded to stationary moldings.

2.6 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 C 591, 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 D 2863; or

b. Rigid Polystyrene Foam Board: ASTM C 578, Type I or II; or

c. Mineral board: ASTM C 612, Type I.

2.7 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level 1, except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners. Provide steel frames for doors and sidelights, unless otherwise indicated.

2.7.1 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.

2.7.2 Transom Bars

Transom bars shall be closed or tubular construction and be removable. When the transom bar and transom are removed and the doors open, the opening shall be a minimum of 9 feet high and 6 feet wide clear for installing equipment.

2.7.3 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.

2.7.4 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.

2.7.4.1 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.

Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111.

2.8 WEATHERSTRIPPING

As specified in Section 08 71 00 DOOR HARDWARE.

2.9 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, with the exception of frames that will have weatherstripping, 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.

2.10 FINISHES

2.10.1 Factory-Primed Finish

All surfaces of 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.

2.10.2 Electrolytic Zinc-Coated Anchors and Accessories

Provide electrolytically deposited zinc-coated steel in accordance with ASTM A 879/A 879M, Commercial Quality, Coating Class A. Phosphate treat and factory prime zinc-coated surfaces as specified in SDI/DOOR A250.8.

2.11 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. On wraparound frames for masonry partitions, provide a throat opening 1/8 inch larger than the actual masonry thickness. Design frames in exposed concrete walls or partitions to allow sufficient space between the inside back of trim and concrete to receive caulking compound.

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.

3.1.2 Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

3.2 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.

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SECTION 08 33 23

OVERHEAD COILING DOORS

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	(2005; Supp 1) Minimum Design Loads for Buildings and Other Structures

ASME INTERNATIONAL (ASME)

ASME B29.400	(2001) Combination, "H" Type Mill Chains, and Sprockets

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 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 653/A 653M	(2009a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 666	(2003) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of

	Hot-Dip Galvanized Coatings
ASTM A 924/A 924M	(2009a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 221	(2008) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM D 2000	(2008) Standard Classification System for Rubber Products in Automotive Applications
ASTM E 330	(2002) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM F 568M	(2004) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MFM	(1988) Metal Finishes Manual

1.2 DESCRIPTION

Overhead coiling doors 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, guides, hood, and operating mechanisms, and designed for use on openings as indicated.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Wind Loading

Design and fabricate door assembly to withstand the wind loading pressure indicated on the contract drawings with a maximum deflection of 1/120 of the opening width. Provide test data showing compliance with ASTM E 330. 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.

1.3.2 Operational Cycle Life

All portions of the door, 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.

1.4 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

Provide fabrication drawings that show complete assembly with hardware and framing details for the following items:

Overhead Coiling Doors; G
Counterbalancing Mechanism; G
Manual Door Operators; G
Bottom Bar; G
Guides; G
Mounting Brackets; G
Overhead Drum; G

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; G
Hardware; G
Counterbalancing Mechanism; G
Manual 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; G

SD-10 Operation and Maintenance Data

Cleaning

1.5 OVERHEAD COILING DOOR DETAIL SHOP DRAWINGS

Provide installation drawings for overhead coiling door assemblies which shows elevations of 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.

1.6 WARRANTY, OPERATION AND MAINTENANCE DATA

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.

1.7 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 Curtain Materials and Construction

Provide curtain slats which are fabricated from steel sheets conforming to ASTM A 653/A 653M, Grade A, with the additional requirement of a minimum yield point of 33,000 psi. Provide sheets which are galvanized in accordance with ASTM A 653/A 653M and ASTM A 924/A 924M.

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.

2.1.2 Non-Insulated Curtains

Form Curtains from manufacturer's standard shapes of interlocking slats.

2.1.3 Curtain Bottom Bar

Curtain bottom bars must be pairs of angles from the manufacturer's standard steel, stainless and aluminum extrusions not less than 2.0 by 2.0 inches by 0.188 inch. Steel extrusions must conform to ASTM A 36/A 36M. Stainless steel extrusions conforming to ASTM A 666, Type 304. Aluminum extrusions conforming to ASTM B 221. Galvanize angles and fasteners in accordance with ASTM A 653/A 653M and ASTM A 924/A 924M. Coat welds and abrasions with paint conforming to ASTM A 780.

2.1.4 Locks

Provide end and/or wind locks of cast steel conforming to ASTM A 27/A 27M, Grade B; galvanized in accordance with ASTM A 653/A 653M, ASTM A 153/A 153M and ASTM A 924/A 924M and secured at every other curtain slat.

2.1.5 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 D 2000.

2.1.6 Locking Devices

Locking Device Assembly which includes cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

2.1.7 Overhead Drum

Fabricate drums from nominal 0.028-inch-thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.

2.2 HARDWARE

All hardware must conform to ASTM A 153/A 153M, ASTM A 307, ASTM F 568M, and ASTM A 27/A 27M.

2.2.1 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.

2.2.2 Equipment Supports

Fabricate door-operating equipment supports from the manufacturer's standard steel shapes and plates conforming to ASTM A 36/A 36M, galvanized in accordance with ASTM A 653/A 653M and ASTM A 924/A 924M. Size the shapes and plates in accordance with the industry standards for the size, weight, and type of door installation..

2.3 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.

2.3.1 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 A 48/A 48M.

2.3.2 Counterbalance Barrels

Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, conforming to ASTM A 53/A 53M, 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.

2.3.3 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.

2.3.4 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.

2.4 MANUAL DOOR OPERATORS

2.4.1 Manual Chain-Hoist Door Operators

Provide door operators which consist of an endless steel hand chain, chain-pocket wheel, guard, and a geared reduction unit of at least a 3 to 1 ratio required pull for operation must not exceed 35 pounds.

Provide chain hoists to have a self-locking mechanism allowing the curtain to be stopped at any point in its upward or downward travel and to remain in that position until moved to the fully open or closed position. Provide hand chains of cadmium-plated alloy steel conforming to ASME B29.400. Yield point of the chain must be at least three times the required hand-chain pull.

Provide chain sprocket wheels of cast iron conforming to ASTM A 48/A 48M.

2.5 SURFACE FINISHING

Comply with NAAMM MFM for recommendations for applying and designating finishes. Noticeable variations in the same metal component 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.

PART 3 EXECUTION

3.1 GENERAL

Install overhead coiling door assembly, anchors and inserts for guides, brackets, 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, 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 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 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 --

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INSULATED TRANSLUCENT FIBERGLASS SANDWICH PANEL

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INSULATED TRANSLUCENT FIBERGLASS SANDWICH PANEL

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 2604	(2005) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

ASTM INTERNATIONAL (ASTM)

ASTM C 1199	(2000) Standard Test Method for Measuring the Steady-State Thermal Transmittance of Fenestration Systems using Hot Box Methods
ASTM C 236	(1993) Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box
ASTM C 297	(2004) Flatwise Tensile Strength of Sandwich Constructions
ASTM D 1002	(2005) Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
ASTM D 1037	(2006a) Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D 2244	(2009a) Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D 572	(2004) Rubber Deterioration by Heat and Oxygen
ASTM D 635	(2006) Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM E 1423	(2006) Practice for Determining the Steady State Thermal Transmittance of Fenestration System
ASTM E 283	(2004) Determining the Rate of Air Leakage

	Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 331	(2000) Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 72	(2004) Conducting Strength Tests of Panels for Building Construction
ASTM E 84	(2009c) Standard Test Method for Surface Burning Characteristics of Building Materials

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC04	(2006) Acceptance Criteria for Sandwich Panels
ICC-ES AC05	(2005) Acceptance Criteria for Sandwich Panel Adhesives

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2004) Procedure for Determining Fenestration Product U-Factors

UNDERWRITERS LABORATORIES (UL)

UL 723	(2003; Rev thru May 2005) Standard for Test for Surface Burning Characteristics of Building Materials
UL 972	(2006) Burglary Resisting Glazing Material

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-02 Shop Drawings

Panel Components; G
Panel Construction; G
Batten and Perimeter Closure System; G

Submit shop drawings. Shop drawings shall indicate size, dimensions, and profile to structural translucent panel system. Include elevations, details, dimensions, and attachments to other work.

SD-03 Product Data

Panel Components; G
Panel Construction; G

Submit manufacturer's product data. Include construction details, material descriptions, profiles, and finishes of components.

1. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.

2. Indicate relative dollar value of recycled content product to total dollar value of product included in project.

3. If recycled content product is part of an assembly, indicate the percentage of recycled content product in the assembly by weight.

SD-04 Samples

Submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below. If finishes involve normal color variations, include sample sets consisting of two or more units showing the full range of variations expected.

a. Sandwich panels; G: 14 inch by 28 inch units.
b. Factory finished aluminum: 5 inch long sections.

SD-06 Test Reports

Submit product test reports (G) from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements.

SD-07 Certificates

Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.

Submit current documentation indicating regular, independent quality control monitoring under a nationally recognized building code review and listing program.

1.3 SECTION INCLUDES

Flat factory prefabricated structural insulated translucent sandwich panels.

Aluminum installation system.

Aluminum sill flashing.

1.4 PERFORMANCE REQUIREMENTS

a. Defection of entire system shall be no more than L/120, unless otherwise indicated.

b. Structural Loads: Provide system capable of handling the following loads indicated on the structural drawings.

Design translucent wall assembly for design pressures calculated in accordance with the Florida Building Code. System shall perform under wind speed (3-second gust) and design wind pressures indicated on

drawings.

c. Translucent panel manufacturer, materials and installation shall be currently listed or approved by the Florida Building Commission for use in Wind-Borne Debris Regions. Translucent panel design, materials and installation shall meet requirements of the 2004 Florida Building Code.

d. Air/Water Infiltration: For water penetration, curtainwall system shall be tested per procedures of ASTM E 331, and shall show no water entry at WTP=10.00 psf, at 5.00 gph/ft squared. Test shall be performed before and after uniform loads are applied. For air leakage, system shall be tested per procedures of ASTM E 283, and shall show results of no more than 0.02 cfm/ft squared at 1.56 psf (25 mph) and 0.01 cfm/ft squared at 6.24 psf (50 mph).

1.5 QUALITY ASSURANCE

1.5.1 Manufacturer's Qualifications

Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least 10 consecutive years and which can show evidence of those materials being satisfactorily used on at least six projects of similar size, scope, and location. At least three of the projects shall have been in successful use for 10 years or longer.

Panel system must be listed by the International Code Council - Evaluation Service (ICC-ES) which requires quality control inspections and fire, structural, and water infiltration testing of sandwich panel systems by an approved agency.

Quality control inspections and required testing shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with ICC-ES AC04.

Translucent panel manufacturer, materials and installation shall be currently listed or approved by the Florida Building Commission for use in Non-Wind-Borne Debris Regions. Translucent panel design, materials, and installation shall meet current requirements of the Florida Building Code.

1.5.2 Installer's Qualifications

Installation shall be by an experienced installer, which has been in the business of installing specified panel systems for at least five consecutive years and can show evidence of satisfactory completion of projects of similar size, scope, and type.

1.5.3 Performance Requirements

The manufacturer shall be responsible for the configuration and fabrication of the complete panel system.

Drawings and panel calculations to be reviewed and stamped by a Florida registered engineer.

1.6 TEST REPORTS

Previously completed test reports will be acceptable if for current

manufacturer and indicative of products used on this project.

Test reports required are:

a. Flame Spread and Smoke Developed (ASTM E 84 by UL 723)
b. Burn Extent (ASTM D 635)
c. Color Difference (ASTM D 2244)
d. Impact Strength (UL 972)
e. Bond Tensile Strength (ASTM C 297 after aging by ASTM D 1037)
f. Bond Shear Strength (ASTM D 1002)
g. Beam Bending Strength (ASTM E 72)
h. Insulation U-Factor (NFRC 100; ASTM C 236; ASTM E 1423; and ASTM C 1199)
i. NFRC System Certification

1.7 PROJECT CONDITIONS

Field Measurements: Verify dimensions in system installation areas and indicate if dimensions on drawings are actual or guaranteed dimensions.

1.8 DELIVERY, STORAGE, AND HANDLING

Deliver panel system, components and materials in manufacturer's standard protective packaging.

Store panels on the long edge, several inches above the ground, blocked, and under cover in accordance with manufacturer's storage and handling instructions.

1.9 WARRANTY

Submit manufacturer's and installer's written warranty agreeing to repair or replace panel system work which fails in materials or workmanship within one year of the date of delivery. Failure of materials or workmanship shall include leakage, excessive deflection, deterioration of finish on metal in excess of normal weathering and defects in accessories, insulated translucent sandwich panels and other components of the work.

PART 2 PRODUCTS

2.1 MANUFACTURER

Basis of design product by Kalwall Corporation, phone 800.258.9777, fax 603.627.7905, www.kalwall.com. Alternate manufacturer may be approved equal complying with design intent and all performance and material requirements.

2.2 PANEL COMPONENTS

2.2.1 Face Sheets

Translucent faces: manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.

Flammability of interior face sheets:

a. Flamespread: UL listed, which requires periodic unannounced retesting, with flamespread rating no greater than 50 and smoke

developed no greater than 250 when tested in accordance with UL 723.

b. Burn extent by ASTM D 635 shall be no greater than 1-inch.

c. Face sheets shall not deform, deflect, or drip when subjected to fire or flame.

d. Face sheets shall not delaminate when exposed to 300°F for 25 minutes.

Weatherability of exterior face sheets:

a. Color stability: full thickness of the exterior face sheet shall not change color more than 3.0 Hunter or CIE Units DELTA E by ASTM D 2244 after five years outdoor South Florida weathering at 5 degrees facing south, determined by the average of at least three white samples with and without protective film or coating to ensure long-term color stability.

b. Erosion barrier: exterior face shall have a permanent glass erosion barrier embedded beneath the surface to provide long-term resistance to reinforcing fiber exposure. Sacrificial surface films or coatings are not acceptable erosion barriers.

Appearance:

a. Exterior face sheets: smooth, 0.070 inch thick and white in color.
b. Interior face sheets: smooth, 0.045 inch thick and crystal in color.
c. Face sheets shall not vary more than +/- 10 percent in thickness and be uniform in color.

2.2.2 Grid Core

Grid pattern shall be nominal 24 inch x 12 inch shoji and symmetrical about the horizontal center line for each flat panel.

Aluminum I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16-inch. The I-beam grid shall be machined to tolerances of not greater than +/- .002-inch.

Thermal break: minimum 1-inch.

2.2.3 Laminate Adhesive

Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25 years field use. Adhesive shall pass testing requirements specified by ICC-ES AC05.

Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037.

Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to five separate conditions:

a. 50 percent Relative Humidity at 73°F: 540 PSI
b. 182°F: 100 PSI

c. Accelerated Aging by ASTM D 1037 at room temperature: 800 PSI
d. Accelerated Aging by ASTM D 1037 at 182°F: 250 PSI
e. 500 Hour Oxygen Bomb by ASTM D 572: 1400 PSI

2.3 PANEL CONSTRUCTION

Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking thermally broken (aluminum) I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat sharp edge.

a. Thickness: 2-3/4 inches.

b. Light transmission: 15 percent.

c. Solar heat gain coefficient: 0.173.

d. U-factor by NFRC certified laboratory:

Complete insulated panel system shall have NFRC certified U-factor of 0.29.

e. Grid pattern: Nominal 24 inch by 12 inch reverse shoji.

Panels shall deflect no more than 1.9 inches at 30 psf in 10 foot span without a supporting frame by ASTM E 72.

Panels shall withstand 1200°F fire for minimum one hour without collapse or exterior flaming.

2.4 BATTEN AND PERIMETER CLOSURE SYSTEM

2.4.1 Closure System

Extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamp-tite screw type closure system.

2.4.2 Sealing Tape

Manufacturer's standard, pre-applied to closure system at the factory under controlled conditions.

2.4.3 Fasteners

300 series stainless steel screws for aluminum closures, excluding final fasteners to the building.

2.4.4 Finish

Finish: exposed aluminum to be architectural corrosion resistant finish that meets the performance requirements of AAMA 2604.

a. Color to be selected from manufacturer's standard colors.

PART 3 EXECUTION

3.1 EXAMINATION

Examine substrates, supporting structure and installation conditions. Do

not proceed with panel erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

3.2.1 Metal Protection

Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

3.3 INSTALLATION

Install the panel system in accordance with the manufacturer's installation recommendations and approved shop drawings.

a. Anchor component parts securely in place by permanent mechanical attachment system.

b. Accommodate thermal and mechanical movements.

c. Set perimeter framing in a full bed of sealant compound, or with joint fillers or gaskets to provide weathertight construction.

Install joint sealants at perimeter joints and within the panel system in accordance with manufacturer's installation instructions.

3.4 CLEANING

Clean the panel system inside and outside, immediately after installation, according to manufacturer's written recommendations.

-- End of Section --

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DIVISION 08 - OPENINGS

SECTION 08 71 00

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SECTION 08 71 00

DOOR HARDWARE

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 E 283	(2004) 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 A156.13	(2005) Mortise Locks & Latches, Series 1000
ANSI/BHMA A156.2	(2003) Bored and Preassembled Locks and Latches
ANSI/BHMA A156.21	(2009) American National Standard for Thresholds
ANSI/BHMA A156.3	(2008) Exit Devices
ANSI/BHMA A156.4	(2008) Door Controls - Closers
ANSI/BHMA A156.5	(2001) Auxiliary Locks & Associated Products
ANSI/BHMA A156.7	(2009) Template Hinge Dimensions
ANSI/BHMA A156.8	(2005) Door Controls - Overhead Stops and Holders
BHMA A156.1	(2006) Butts and Hinges
BHMA A156.16	(2008) Auxiliary Hardware
BHMA A156.18	(2006) Materials and Finishes
BHMA A156.22	(2005) Door Gasketing and Edge Seal Systems
BHMA A156.6	(2005) Architectural Door Trim

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2009; Amd 09-1 & 09-2) Life Safety Code

NFPA 80 (2010; Am 10-1) Standard for Fire Doors and Other Opening Protectives

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8 (2003; R2008) Recommended Specifications for Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir (2009) Building Materials 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-02 Shop Drawings

Hardware schedule; G

SD-03 Product Data

Hardware items; G

1.3 HARDWARE SCHEDULE

Prepare and submit hardware schedule in the following form:

Hardware Item	Quantity	Size	Reference Publication Type No.	Finish	Mfr. Name and Catalog No.	Key Control Symbols	UL Mark (If fire rated and listed)	BHMA Finish Designation

1.4 QUALITY ASSURANCE

1.5.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, and closers of one lock, hinge, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

1.4.1 Key Shop Drawings Coordination Meeting

Prior to the submission of the key shop drawing, the Contracting Officer, Contractor, Door Hardware subcontractor, using Activity and Base Locksmith shall meet to discuss key requirements for the facility.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown in hardware schedule.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

Provide hardware to be applied to metal or to prefinished doors manufactured to template. Promptly furnish template information or templates to door and frame manufacturers. Conform to ANSI/BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 80 for fire doors and NFPA 101 for exit doors, as well as to other requirements indicated, even if such hardware is not specifically mentioned under paragraph entitled "Hardware Schedule." Provide the label of Underwriters Laboratories, Inc. for such hardware listed in UL Bld Mat Dir or labeled and listed by another testing laboratory acceptable to the Contracting Officer.

2.3 HARDWARE ITEMS

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. For closers with covers, the name or trademark may be beneath the cover.

2.3.1 Hinges

BHMA A156.1, 4-1/2 by 4-1/2 inch unless otherwise indicated. Construct loose pin hinges for exterior doors and reverse-bevel interior doors so that pins will be nonremovable when door is closed. Other antifriction bearing hinges may be provided in lieu of ball-bearing hinges.

2.3.1.1 Protection Devices

Provide full height hand and finger protection device at the hinge-side area opening of doors and gates. Hinge-side protection device shall be provided on both sides of the doors and gates, covering hinges and space between door and frame when doors are in the open position. The installed device shall push hand and/or fingers out of the opening and away from a crushing hazard.

2.3.2 Pivots

ANSI/BHMA A156.4.

2.3.3 Locks and Latches

2.3.3.1 Mortise Locks and Latches

ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2. Provide mortise locks with escutcheons not less than 7 by 2-1/4 inch with a bushing at least 1/4 inch long. Cut escutcheons to suit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges. Install levers and roses of mortise locks with screwless shanks and no exposed screws.

2.3.3.2 Bored Locks and Latches

ANSI/BHMA A156.2, Series 4000, Grade 1.

2.3.3.3 Auxiliary Locks

ANSI/BHMA A156.5, Grade 1.

2.3.4 Exit Devices

ANSI/BHMA A156.3, Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Provide open back strikes for pairs of doors with mortise and vertical rod devices. Provide touch bars in lieu of conventional crossbars and arms.

2.3.5 Cylinders and Cores

Provide cylinders and cores for new locks, including locks provided under other sections of this specification. Provide cylinders and cores with seven pin tumblers. Provide cylinders from products of one manufacturer, and provide cores from the products of one manufacturer. Rim cylinders, mortise cylinders, and knobs of bored locksets have interchangeable cores which are removable by special control keys. Stamp each interchangeable core with a key control symbol in a concealed place on the core.

2.3.6 Keying System

Provide construction interchangeable cores.

The Government will provide permanent cores and keys for mortise locksets, auxiliary locks, and exit devices. Furnish cylinders as manufactured by Best Lock Corp.. Provide temporary cores and keys for the Contractor's use during construction, and for testing the locksets.

2.3.7 Lock Trim

Cast, forged, or heavy wrought construction and commercial plain design.

2.3.7.1 Roses

Conform to the minimum test requirements of ANSI/BHMA A156.2 and ANSI/BHMA A156.13 for roses and escutcheons. For roses and escutcheons, provide 0.050 inch thickness. For roses and escutcheons, provide outer shell of 0.035 inch thickness, and combined thickness of 0.070 inch, except for knob shanks, which are 0.060 inch thick.

2.3.7.2 Lever Handles

Provide lever handles. Conform to the minimum requirements of ANSI/BHMA A156.13 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when force in excess of that specified in ANSI/BHMA A156.13 is applied to the lever handle. Provide lever handles return to within 1/2 inch of the door face.

2.3.8 Keys

Furnish construction master keys.

2.3.9 Door Bolts

BHMA A156.16. Provide dustproof strikes for bottom bolts, except for doors having metal thresholds. Automatic latching flush bolts: ANSI/BHMA A156.3, Type 25.

2.3.10 Closers

ANSI/BHMA A156.4, Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, full size covers and other features necessary for the particular application. Size closers in accordance with manufacturer's recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty.

2.3.10.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation located to be visible after installation.

2.3.11 Overhead Holders

ANSI/BHMA A156.8.

2.3.12 Door Protection Plates

BHMA A156.6.

2.3.12.1 Sizes of Kick Plates

2 inch less than door width for single doors; one inch less than door width for pairs of doors. Provide 10 inch kick plates for flush doors.

2.3.13 Door Stops and Silencers

BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

2.3.14 Thresholds

ANSI/BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening out, unless specified otherwise.

2.3.15 Weather Stripping Gasketing

BHMA A156.22. Provide the type and function designation where specified in paragraph entitled "Hardware Schedule". Provide a set to include head and jamb seals, sweep strips, and, for pairs of doors, astragals. Air leakage of weather stripped doors not to exceed 1.25 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E 283. Provide weather stripping with one of the following:

2.3.15.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide clear anodized aluminum.

2.3.15.2 Interlocking Type

Zinc or bronze not less than 0.018 inch thick.

2.3.15.3 Spring Tension Type

Spring bronze or stainless steel not less than 0.008 inch thick.

2.3.16 Rain Drips

Extruded aluminum, not less than 0.08 inch thick, clear anodized. Set drips in sealant and fasten with stainless steel screws.

2.3.16.1 Door Rain Drips

Approximately 1-1/2 inch high by 5/8 inch projection. Align bottom with bottom edge of door.

2.3.16.2 Overhead Rain Drips

Approximately 1-1/2 inch high by 2-1/2 inch projection, with length equal to overall width of door frame. Align bottom with door frame rabbet.

2.3.17 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, required to service and adjust hardware items.

2.4 FASTENERS

Provide fasteners of proper type, quality, size, quantity, and finish with hardware. Provide stainless steel or nonferrous metal fasteners that are exposed to weather. Provide fasteners of type necessary to accomplish a permanent installation.

2.5 FINISHES

BHMA A156.18. Provide hardware in BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except aluminum paint finish for surface door closers, and except BHMA 652 finish (satin chromium plated) for steel hinges. Provide hinges for exterior doors in stainless steel with BHMA 630 finish or chromium plated brass or bronze with BHMA 626 finish. Furnish exit devices in BHMA 626 finish in lieu of BHMA 630 finish except where BHMA 630 is specified under paragraph entitled "Hardware Sets". Match exposed parts of concealed closers to lock and door trim. Match hardware finish for aluminum doors to the doors.

PART 3 EXECUTION

3.1 INSTALLATION

Install hardware in accordance with manufacturers' printed installation instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core

construction. Provide through bolts where necessary for satisfactory installation.

3.1.1 Weather Stripping Installation

Handle and install weather stripping to prevent damage. Provide full contact, weather-tight seals. Operate doors without binding.

3.1.1.1 Stop-Applied Weather Stripping

Fasten in place with color-matched sheet metal screws not more than 9 inch on center after doors and frames have been finish painted.

3.1.1.2 Interlocking Type Weather Stripping

Provide interlocking, self-adjusting type on heads and jambs and flexible hook type at sills. Nail weather stripping to door one inch on center and to heads and jambs at 4 inch on center

3.1.1.3 Spring Tension Type Weather Stripping

Provide spring tension type on heads and jambs. Provide bronze nails with bronze, stainless steel nails with stainless steel. Space nails not more than 1-1/2 inch on center.

3.1.2 Soundproofing Installation

Install as specified for stop-applied weather stripping.

3.1.3 Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws in expansion sleeves.

3.2 FIRE DOORS AND EXIT DOORS

Install hardware in accordance with NFPA 80 for fire doors and NFPA 101 for exit doors.

3.3 HARDWARE LOCATIONS

SDI/DOOR A250.8, unless indicated or specified otherwise.

a. Kick Plates: Push side of single-acting doors. Both sides of double-acting doors.

b. Mop Plates: Bottom flush with bottom of door.

3.4 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, as directed, errors in cutting and fitting and damage to adjoining work.

3.5 HARDWARE SETS

Provide hardware for aluminum doors under this section. Deliver Hardware templates and hardware, except field-applied hardware to the aluminum door and frame manufacturer for use in fabricating the doors and frames.

HW-01 - EXTERIOR ENTRY/EGRESS
Door: Pump Area 001 and Electrical 002

3	Hinges	T4A3386 4-1/2 x 4-1/2 NRP	32D	McKinney
1	Exit Device	HC 8813 F ETL TB (panic/crash bar)	26D	Sargent
1	Core	Permanent Keyed Cylinder Core	26D	BEST
1	Closer	351 P3 SR TB	EN	Sargent
1	Overhead Stop	598S	26D	Sargent
1	Smoke Seal	MCK588 D 204		Pemko
1	Raindrip	MCK236 C 40		Pemko
1	Weatherseal	MCK303 AV 84		Pemko
1	Threshold	MCK2001 AV 40		Pemko

HW-02 - INTERIOR, SECURE ROOM
Doors: Electrical 003

6	Hinges	TA2314 4-1/2 x 4-1/2	26D	McKinney
1	Set Flush Bolts	1845	US26D	Rockwood
1	Lockset	Storeroom Function	32D	
1	Coordinator	1672	PC	Rockwood
1	Dust Proof Strike	570	US26D	Rockwood
1	Removable Transom Bar			

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METAL WALL LOUVERS

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-D	(1998) Laboratory Methods of Testing Dampers for Rating
AMCA 511	(1999; R 2004) Certified Ratings Program for Air Control Devices

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2603	(2002) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 366/A 366M	(1997e1) Standard Specification for Commercial Steel, Sheet, Carbon,(0.15 Maximum Percent Cold-Rolled
ASTM A 653/A 653M	(2009a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(2008) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

FLORIDA DEPARTMENT OF COMMUNITY AFFAIRS (FDCA)

FBC TAS 201	(1994) Large Missile Impact
FBC TAS 202	(1994) Uniform Static Air Pressure

FBC TAS 203 (1994) Cyclic Wind Loading

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-02 Shop Drawings

Wall louvers; G

SD-03 Product Data

Metal Wall Louvers; G

1.3 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.

1.4 DETAIL DRAWINGS

Show all information necessary for fabrication and installation of wall louvers. Indicate materials, sizes, thicknesses, fastenings, and profiles.

1.5 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 for selection.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Sheet

ASTM A 653/A 653M, coating designation G90.

2.1.2 Aluminum Sheet

ASTM B 209, alloy 3003 or 5005 with temper as required for forming.

2.1.3 Extruded Aluminum

ASTM B 221, alloy 6063-T5 or -T52.

2.1.4 Stainless Steel

ASTM A 167, Type 302 or 304, with 2B finish.

2.1.5 Cold Rolled Steel Sheet

ASTM A 366/A 366M, Class 1, with matte finish. Use for interior louvers only.

2.2 METAL WALL LOUVERS

Weather resistant type, with bird screens and made to withstand wind pressures indicated on the structural drawings. Wall louvers shall bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500-D and AMCA 511. Test wall louvers in accordance with, and pass FBC TAS 201, FBC TAS 202, and FBC TAS 203. The rating shall show a water penetration of 0.01 or less ounce per square foot of free area at a free velocity of 1250 feet per minute.

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.

2.2.2 Formed Metal Louvers

Formed of zinc-coated steel sheet not thinner than 16 U.S. gage, or aluminum sheet not less than 0.08 inch thick.

2.2.3 Mullions and Mullion Covers

Same material and finish as louvers. Provide mullions for all louvers more than 5 feet in width at not more than 5 feet on centers. Provide mullions covers on both faces of joints between louvers.

2.2.4 Screens and Frames

For aluminum louvers, provide 1/2 inch square mesh, 14 or 16 gage aluminum or 1/4 inch square mesh, 16 gage aluminum bird screening. For steel louvers, provide 1/2 inch square mesh, 12 or 16 gage zinc-coated steel; 1/2 inch square mesh, 16 gage copper; or 1/4 inch square mesh, 16 gage zinc-coated steel or copper bird screening. Mount screens in removable, rewirable frames of same material and finish as the louvers.

2.3 FASTENERS AND ACCESSORIES

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.

2.4 FINISHES

2.4.1 Aluminum

Exposed aluminum surfaces shall be factory finished with an organic coating. Color shall match roof color.

2.4.1.1 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a baked enamel finish conforming to AAMA 2603, with total dry film thickness not less than 0.8 mil, color to match metal roofing.

2.4.2 Steel

Provide factory-applied coating. Clean and phosphate treat exposed surfaces and apply rust-inhibitive primer and baked enamel finish coat, one

mil minimum total dry film thickness, color gray.

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 Copper or Copper-Bearing Alloys

Paint copper or copper-bearing alloys in contact with dissimilar metal with heavy-bodied bituminous paint or separate with inert membrane.

3.2.2 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

3.2.3 Metal

Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

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ACOUSTICAL WALL TREATMENT

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 16	(1964; R 2004) Colorfastness to Light

ASTM INTERNATIONAL (ASTM)

ASTM C 423	(2009a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM E 84	(2009c) 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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Acoustical Wall Panels; G

SD-04 Samples

Acoustical Wall Panels; G

1.3 DELIVERY, STORAGE, AND HANDLING

Protect materials delivered and placed in storage from the weather, humidity and temperature variations, dirt, dust, or other contaminants.

1.4 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

PART 2 PRODUCTS

2.1 FABRIC COVERED ACOUSTICAL WALL PANELS

Provide acoustical wall panels consisting of prefinished, factory assembled cementitious wood fiber, fiberglass, or mineral fiber core system as described below. Ensure panels are manufactured to the dimensions and configurations shown on the drawings.

Subject to conformance with the specified product characteristics and performance requirements, provide the basis-of-design product or equal. Basis-of-design: Tectum Inc. (www.tectum.com), Standard Tectum Tile.

a. Panel Width: 48 inches. Panel width shall be as detailed.

b. Panel Height: 96. Panel height shall be as detailed.

c. Panel Thickness: 2 inches.

d. 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 E 84.

e. Substrate: Cementitious wood fiber, fiberglass or mineral fiber.

f. Noise Reduction Coefficient (NRC) Range: 0.60-1.0, ASTM C 423.

g. Mounting: Acoustical panels shall be mounted to walls with concealed stainless steel z-clip rails, 18 gauge minimum thickness, and stainless steel fasteners. Attach one z-clip rail 24 inches from panel bottom and one z-clip rail 24 inches from panel top.

2.1.1 Cementitious Wood Fiber Acoustic Wall Panels

a. Color Finish: Painted finish with custom color to match adjacent wall surface, as selected by Architect.

b. Edge Shape: Beveled.

c. Edge Finish: Edge finish shall match finish of primary panel face.

d. Core Type: Standard acoustical core.

2.1.2 Fiberglass or Mineral Fiber Acoustic Wall Panels

a. Fabric Covering: Seamless perforated vinyl covering with fabric backing, minimum 20 ounces/linear yard total weight. Fabric covering shall be stretched free of wrinkles and then bonded to the edges and back or bonded directly to the panel face, edges, and back of panel a minimum distance standard with the manufacturer. Light fastness (fadeometer) shall be approximately 40 hours in accordance with AATCC TM 16.

b. Edge Shape: Square.

c. Fabric Edge Construction: Heat sealed.

d. Core Type: Standard acoustical core.

2.2 COLOR

Color shall be selected from manufacturers standard colors.

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.

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3.4 MIXING AND APPLICATION
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PAINTING AND COATING

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 C 920	(2008) Standard Specification for Elastomeric Joint Sealants

MASTER PAINTERS INSTITUTE (MPI)

MPI 3	Primer, Alkali Resistant, Water Based
MPI 4	(Jan 2004) Interior/Exterior Latex Block Filler
MPI 47	(Jan 2004) Interior Alkyd, Semi-Gloss, MPI Gloss Level 5
MPI 54	(Jan 2004) Interior Latex, Semi-Gloss, MPI Gloss Level 5
MPI 79	(Oct 2009) Alkyd Anti-Corrosive Metal Primer

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3	(2004; E 2004) Power Tool Cleaning

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C, 2008) Colors Used in Government Procurement
FS A-A-1500	Performance Alternates
FS TT-E-508	Enamel, Interior, Semi-Gloss, Tints and White
FS TT-E-509	Enamel, Odorless, Alkyd, Interior Semi-Gloss, White and Tint
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

FS TT-P-1511	Paint, Latex Exterior - Gloss and Semi-Gloss
FS TT-S-223	Floor Sealant, Water Emulsion

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.

Manufacturer's Standard Color Charts shall be submitted for architectural painting materials in accordance with the paragraph entitled, "General," of this section.

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.

Caulk/Sealer
Inhibitive Metal Primer
Latex Block Filler
Masonry Primer/Sealer
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.

Manufacturer's Standard Color Charts shall be submitted for architectural painting Materials showing manufacturer's recommended finish colors. Three color chips of each color and gloss scheduled shall also be submitted.

2.2 EXTERIOR PRODUCTS

	FEDERAL SPECIFICATION	PITTSBURGH	SHERWIN WILLIAMS	ICI / GLIDDEN
Caulk/Sealer	ASTM C 920	Chem Calk	Elastomeric	--
Latex Block Filler, MPI 4	FS A-A-1500	6-15	B25W25	4000
Masonry Primer/Sealer, MPI 3	FS TT-S-223	6-14	A 24W300	3030

Elastomeric Masonry Coating Basis of Design: TEXCOTE Super Cote Cool Walls Textured Coating.

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 INTERIOR PRODUCTS

	FEDERAL SPECIFICATION	PITTSBURGH	SHERWIN WILLIAMS	ICI / GLIDDEN
Inhibitive Metal Primer, MPI 79	FS TT-P-664 FS TT-P-664	--	B50NN26 B50W21	4100 4160
Enamel, MPI 47	FS TT-E-508 FS TT-E-509	6-110	B34W251	1507
Acrylic Latex, MPI 54	FS TT-P-1511	6-500	B48 Series	1406 1407

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. Shrubs shall be cut back from structures to be painted. 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	Exterior metal primer	Enamel	Gray - semi-gloss

3.7.2 Interior Paint Schedule

Colors shall be in accordance with FED-STD-595.

SURFACE	PRIMER	FINISH COAT	FINISH COLOR AND SHEEN
Interior metal	Interior metal primer	Enamel	Semi-gloss

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DRY PIPE SPRINKLER SYSTEM, FIRE PROTECTION

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 SANITARY ENGINEERING (ASSE)

ASSE 1015	(2009) Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2004) Hypochlorites
AWWA B301	(2004) Liquid Chlorine
AWWA C104/A21.4	(2008) 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 C151/A21.51	(2009) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C203	(2008) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains
AWWA C652	(2002) Disinfection of Water-Storage Facilities

ASME INTERNATIONAL (ASME)

ASME B16.1	(2005) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2005) Nonmetallic Flat Gaskets for Pipe

Flanges

ASME B16.9 (2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings

ASME B18.2.2 (1987; R 2005) Standard for Square and Hex Nuts

ASTM INTERNATIONAL (ASTM)

ASTM A 135/A 135M (2009) Standard Specification for Electric-Resistance-Welded Steel Pipe

ASTM A 183 (2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts

ASTM A 449 (2007b) Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

ASTM A 47/A 47M (1999; R 2009) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process

ASTM A 53/A 53M (2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 536 (1984; R 2009) Standard Specification for Ductile Iron Castings

ASTM A 795/A 795M (2008) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use

ASTM F 436 (2009) Hardened Steel Washers

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101 (1970; Rev B) Color Code for Pipelines & for Compressed Gas Cylinders

UFC 3-310-04 (2007; Change 1) Seismic Design for Buildings

FM GLOBAL (FM)

FM APP GUIDE (updated on-line) Approval Guide http://www.approvalguide.com/CC_host/pages/public/cust

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595 (Rev C, 2008) Colors Used in Government Procurement

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2005) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2009; Amd 09-1 & 09-2) Life Safety Code
NFPA 13	(2010) Standard for the Installation of Sprinkler Systems
NFPA 1963	(2009; Errata 09-1) Standard for Fire Hose Connections
NFPA 24	(2010) Standard for the Installation of Private Fire Service Mains and Their Appurtenances

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 Bld Mat Dir	(2009) Building Materials Directory
UL Fire Prot Dir	(2009) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

a. Furnish piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction. Install sprinkler over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

b. Provide dry pipe sprinkler system in all areas of the building. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, design and install the system in accordance with NFPA 13. Pipe sizes, which are not indicated on the drawings, shall be determined by hydraulic calculation. Gridded systems shall not be used.

c. Design any portions of the sprinkler system that are not indicated on the drawings or are not specified herein, including locating sprinklers, piping, and equipment, and size piping and equipment. Base the design of the sprinkler system on hydraulic calculations, and the other provisions specified herein.

1.2.1 Hydraulic Design

Hydraulically design the system to discharge a minimum density of 0.2 gpm

per square foot over the hydraulically most demanding 1,950 square feet of floor area. Provide hydraulic calculations in accordance with the Area\Density Method of NFPA 13. Water velocity in the piping shall not exceed 20 ft/s.

1.2.1.1 Hose Demand

Add an allowance for exterior hose streams of 250 gpm to the sprinkler system demand at the point of connection to the existing water system.

1.2.1.2 Basis for Calculations

Base the design of the system upon a water supply with a static pressure of 65, and a flow of 1,573 gpm at a residual pressure of 50. Water supply shall be presumed available at the point of connection to existing. Base hydraulic calculations upon the Hazen-Williams formula with a "C" value of 120 for galvanized steel piping, 140 for new cement-lined ductile-iron piping, and 100 for existing underground piping.

a. Outline hydraulic calculations as in NFPA 13, except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Software that uses k-factors for typical branch lines is not acceptable. Calculations shall substantiate that the design area used in the calculations is the most demanding hydraulically.

b. Plot water supply curves and system requirements on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows. Indicate elevations of hydraulic reference points (nodes). Documentation shall identify each pipe individually and the nodes connected thereto. Indicate for each pipe the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient.

c. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, include a flow diagram indicating the quantity and direction of flows. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

1.2.2 Sprinkler Coverage

Uniformly space sprinklers on branch lines. In buildings protected by automatic sprinklers, provide coverage throughout 100 percent of the building. This includes, but is not limited to, electrical equipment rooms, pump room, and other electrical and mechanical spaces. Coverage per sprinkler shall be in accordance with NFPA 13, but not exceeding 100 square feet for extra hazard occupancies, 130 square feet for ordinary hazard occupancies, and 225 square feet for light hazard occupancies. Exceptions are as follows:

a. Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.

1.2.3 System Volume Limitations

Where the volume of any individual system piping volume exceeds 500 gallons, provide the dry pipe valve with a quick-opening device. The maximum system capacity controlled by one dry pipe valve shall not exceed 750 gallons. Indicate the calculated volume of each system on the sprinkler system shop d rawings.

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

Shop Drawings; G

Three copies of the sprinkler system drawings, no later than 21 days prior to the start of sprinkler system installation. The drawings shall conform to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance.

As-Built Drawings

As-built shop drawings, at least 14, but not more than 28, days after completion of the Final Tests.

SD-03 Product Data

List of the Submittals

A list of the Fire Protection Related Submittals, no later than 7 days after the approval of the Fire Protection Specialist.

Materials and Equipment; G

Manufacturer's catalog data included with the sprinkler system d rawings for all items specified herein. Highlight the data to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, provide a complete equipment list that includes equipment description, model number and quantity.

Spare Parts

Spare parts data for each different item of material and equipment specified.

Fire Protection Specialist; G

The name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system shop

drawings and hydraulic calculations.

Installer Qualifications; G

The name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications.

Onsite Training; G

Proposed Onsite Training schedule, at least 14 days prior to the start of related training.

SD-05 Design Data

Sway Bracing

For systems that are required to be protected against damage from earthquakes, load calculations for sizing of sway bracing.

Hydraulic Calculations; G

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

SD-06 Test Reports

Preliminary Tests; G

Proposed procedures for Preliminary Tests, no later than 14 days prior to the proposed start of the tests. Proposed date and time to begin Preliminary Tests, submitted with the Preliminary Tests Procedures.

Three copies of the completed Preliminary Tests Reports, no later that 7 days after the completion of the Preliminary Tests. The Preliminary Tests Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist.

Final Acceptance Test; G

Proposed procedures for Final Acceptance Test, no later than 14 days prior to the proposed start of the tests. Proposed date and time to begin Final Acceptance Test, submitted with the Final Acceptance Test Procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates.

Three copies of the completed Final Acceptance Tests Reports, no later that 7 days after the completion of the Final Acceptance Tests. All items in the Final Acceptance Report shall be signed by the Fire Protection Specialist.

SD-07 Certificates

Inspection by Fire Protection Specialist; G

Concurrent with the Final Acceptance Test Report, certification by the Fire Protection Specialist that the sprinkler system is installed in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the Government for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment.

1.4 QUALITY ASSURANCE

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

1.4.1 Fire Protection Specialist

Perform the work specified in this section under the supervision of and certified by the Fire Protection Specialist who is a registered professional engineer and a Full Member of the Society of Fire Protection Engineers or who is certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. The Fire Protection Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful installation of the sprinkler systems(s). The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.2 Installer Qualifications

Work specified in this section shall be performed by the Sprinkler System Installer. The Installer shall be regularly engaged in the installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.3 Shop Drawings

Submit shop drawings, on reproducible full-size mylar film, as specified herein and in the Submittals paragraph; update the shop drawings to reflect as-built conditions after all related work is completed. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1/8" = 1'-0" which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Indicate each type of fitting used and the locations of bushings, reducing couplings, and welded joints..

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; air supply system and piping; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring.

1.5 DELIVERY, STORAGE, AND HANDLING

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are standard products of a manufacturer 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.

2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Materials and Equipment shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM APP GUIDE.

2.4 UNDERGROUND PIPING COMPONENTS

2.4.1 Pipe

Piping from a point 6 inches above the floor to a point 5 feet outside the building wall shall be ductile iron with a rated working pressure of 175 psi conforming to AWWA C151/A21.51, with cement mortar lining conforming to AWWA C104/A21.4. Piping more than 5 feet outside the building walls shall comply with Section 33 11 00 WATER DISTRIBUTION.

2.4.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110/A21.10. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111/A21.11.

2.4.3 Gate Valve and Indicator Post

Gate valves for underground installation shall be of the inside screw type with counter-clockwise rotation to open. Where indicating type valves are shown or required, indicating valves shall be gate valves with an approved indicator post of a length to permit the top of the post to be located 3 feet above finished grade. Gate valves and indicator posts shall be listed in UL Fire Prot Dir or FM APP GUIDE.

2.5 ABOVEGROUND PIPING COMPONENTS

2.5.1 Steel Pipe

Except as modified herein, steel pipe shall be galvanized as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A 795/A 795M, ASTM A 53/A 53M, or ASTM A 135/A 135M. Pipe in which threads or grooves are cut or rolled formed shall be Schedule 40 or shall be listed by Underwriters' Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut or rolled formed. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2.5.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be galvanized steel conforming to ASME B16.9 or ASME B16.11. Fittings that sprinklers, drop nipples or riser nipples (sprigs) are

screwed into shall be threaded type. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

2.5.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer; segmented welded fittings shall not be used. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gaskets shall be of silicon compound and approved for dry fire protection systems. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

2.5.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type.

2.5.4.1 Bolts

Bolts shall be ASTM A 449, Type 1 and shall extend no less than three full threads beyond the nut with bolts tightened to the required torque.

2.5.4.2 Nuts

Nuts shall be hexagon type conforming to ASME B18.2.2.

2.5.4.3 Washers

Washers shall meet the requirements of ASTM F 436. Flat circular washers shall be provided under all bolt heads and nuts.

2.5.5 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM APP GUIDE and of the type suitable for the application, construction, and pipe type and size to be supported.

2.5.6 Valves

2.5.6.1 Control Valve and Gate Valve

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM APP GUIDE.

2.5.6.2 Check Valve

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM APP GUIDE. Check valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

2.6 DRY PIPE VALVE ASSEMBLY

The dry pipe valve shall be a latching differential type listed in UL Fire Prot Dir or FM APP GUIDE and shall be complete with trim piping, valves, fittings, pressure gauges, priming water fill cup, velocity drip check, drip cup, and other ancillary components as required for proper operation. The assembly shall include a quick-opening device by the same manufacturer as the dry pipe valve for systems over 500 gallons in capacity. Ensure that the valve assembly is externally resettable.

2.7 SUPERVISORY AIR SYSTEM

Provide an air supply system in accordance with NFPA 13. The connection pipe from the air compressor shall not be less than 1/2 inch in diameter and shall enter the system above the priming water level of the dry pipe valve. Install a check valve in the system supply air piping from the compressor. A shutoff valve of the renewable disc type shall be installed upstream of this check valve. The air supply system shall be sized to pressurize the sprinkler system to 40 psi within 20 minutes.

2.7.1 Air Compressor

Compressor shall be single stage oil-free type, air-cooled, electric-motor driven, equipped with a check valve, shutoff valve and pressure switch for automatic starting and stopping. Pressure switch shall be factory set to start the compressor at 30 psi and stop it at 40 psi. A safety relief valve, set to operate at 65 psi, shall be provided.

2.7.2 Air Pressure Maintenance Device

Device shall be a pressure regulator that automatically reduces supply air to provide the pressure required to be maintained in the piping system. The device shall have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1/16 inch restriction to prevent rapid pressurization of the system, and adjustment screw. The device shall be capable of reducing an inlet pressure of up to 100 psig to a fixed outlet pressure adjustable to 10 psig.

2.7.3 Air Supply Piping System

System shall be configured so that each dry pipe system is equipped with a separate pressure maintenance device, air compressor, shutoff valve, bypass valve and pressure gauge. Piping shall be galvanized steel in accordance with ASTM A 795/A 795M or ASTM A 53/A 53M.

2.7.4 Low Air Pressure Alarm Device

Each dry pipe valve trim shall be provided with a low air pressure switch. Upon reduction of sprinkler system pressure to approximately 10 psig above the dry valve trip point pressure, the low air pressure switch shall signal the Fire Alarm Control Panel. Restoration of system pressure shall cause the low-air alarm signal to be terminated.

2.8 ALARM INITIATING AND SUPERVISORY DEVICES

2.8.1 Sprinkler Pressure (Waterflow) Alarm Switch

Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches and a 1/2 inch NPT male pipe thread. The switch

shall have a maximum service pressure rating of 175 psi. There shall be two SPDT (Form C) contacts factory adjusted to operate at 4 to 8 psi. The switch shall be capable of being mounted in any position in the alarm line trim piping of the dry pipe valve.

2.8.2 Low Air Pressure Supervisory Switch

The pressure switch shall supervise the air pressure in system and shall be set to activate at 10 psi above the dry pipe valve trip point pressure. The switch shall have an adjustable range between 5 and 80 psi. The switch shall have screw terminal connection and shall be capable of being wired for normally open or normally closed circuit.

2.8.3 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

2.9 FIRE DEPARTMENT CONNECTION

Fire department connection shall be projecting type with cast brass body, matching wall escutcheon lettered "Auto Spkr" with a chromium plated finish. The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) in accordance with NFPA 1963.

2.10 SPRINKLERS

Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed coverage limitations. Areas where sprinklers are connected to or are a part of the dry pipe system shall be considered unheated and subject to freezing. Temperature classification shall be ordinary. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Extended coverage sprinklers shall not be used.

2.10.1 Pendent Sprinkler

Pendent sprinkler heads shall be the dry pendent type, unless otherwise indicated. Pendent sprinkler shall be of the fusible strut or glass bulb type, quick-response type with nominal 1/2 inch orifice. Pendent sprinklers shall have a polished chrome finish. Assembly shall include an integral escutcheon. Maximum length shall not exceed the maximum length indicated in UL Fire Prot Dir.

2.10.2 Upright Sprinkler

Upright sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch orifice.

2.11 DISINFECTING MATERIALS

2.11.1 Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

2.11.2 Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

2.12 ACCESSORIES

2.12.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

2.12.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

2.12.3 Pipe Escutcheon

Escutcheon shall be 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 set screw.

2.12.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located in electrical room.

2.12.5 Identification Sign

Valve identification sign shall be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

2.13 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. 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. Provide manifold for forward-flow testing backflow prevention assembly.

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 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 31 00 00 EARTHWORK.

3.3 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein.

3.4 INSPECTION BY FIRE PROTECTION SPECIALIST

The Fire Protection Specialist shall inspect the sprinkler system periodically during the installation to assure that the sprinkler system installed in accordance with the contract requirements. The Fire Protection Specialist shall witness the preliminary and final tests, and shall sign the test results. The Fire Protection Specialist, after completion of the system inspections and a successful final test, shall certify in writing that the system has been installed in accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

3.5 ABOVEGROUND PIPING INSTALLATION

3.5.1 Protection of Piping Against Earthquake Damage

Seismically protect the system piping against damage from earthquakes. This requirement is not subject to determination under NFPA 13. Install the seismic protection of the system piping, including sway bracing as required, in accordance with UFC 3-310-04, NFPA 13 and Annex A. Include the required features identified therein that are applicable to the specific piping system.

3.5.2 Piping in Exposed Areas

Exposed piping shall be installed so as not diminish exit access widths, corridors, or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

3.5.3 Pendent Sprinklers Locations

Sprinklers installed in the pendent position shall be of the listed dry pendent type, unless otherwise indicated. Dry pendent sprinklers shall be of the required length to permit the sprinkler to be threaded directly into a branch line tee. Hangers shall be provided on arm-overs to drop nipples supplying pendent sprinklers when the arm-over exceeds 12 inches for steel pipe or 6 inches for copper tubing. Dry pendent sprinkler assemblies shall be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space. Pendent sprinklers in suspended ceilings shall be a minimum of 6 inches from ceiling grid. Recessed

pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

3.5.4 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

3.5.5 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings and fittings shall be from the same manufacturer. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.5.6 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.5.7 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve in accordance with NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

3.5.8 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

3.5.9 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected to the remote branch line; a three-way test valve located approximately 5 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

3.5.10 Drains

Provide main drain piping to discharge at a safe point outside the building. Auxiliary drains shall be provided as indicated and as required by NFPA 13. When the capacity of trapped sections of pipe is less than 3 gallons, the auxiliary drain shall consist of a valve not smaller than 1/2 inch and a plug or nipple and cap. When the capacity of trapped sections of piping is more than 3 gallons, the auxiliary drain shall consist of two 1 inch valves and one 2 x 12 inch condensate nipple or equivalent, located in an accessible location. Tie-in drains shall be provided for multiple adjacent trapped branch pipes and shall be a minimum of 1 inch in diameter. Tie-in drain lines shall be pitched a minimum of 1/2 inch per 10 feet.

3.5.11 Installation of Fire Department Connection

Connection shall be mounted on the exterior wall approximately 3 feet above finished grade. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

3.5.12 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

3.6 UNDERGROUND PIPING INSTALLATION

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 3 feet. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of Section 33 11 00 WATER DISTRIBUTION.

3.7 ELECTRICAL WORK

Except as modified herein, electric equipment and wiring shall be in accordance with Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Section 28 31 00.00 98 FIRE DETECTION AND ALARM SYSTEM.

3.8 DISINFECTION

After all system components are installed and hydrostatic test(s) are completed, the entire sprinkler system shall be disinfected. Flush all sprinkler system piping with potable water until any entrained dirt and other foreign materials have been removed before introducing chlorinating material. Remove the flushing fitting of each cross main and of each grid branch line and then back-flush through the sprinkler main drain.

a. The water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652. Feed either a hypochlorite solution (using a hypochlorinator) or liquid chlorine (using a solution-fed chlorinator and booster pump) into the system at a constant rate of 50 parts per million (ppm) until the entire system is filled.

b. Monitor the chlorine residual level in the water at six hour intervals for a period of 24 hours. If the residual chlorine is below 25 ppm in any interval sampled, flush all piping and repeat the chlorination procedure. Open and close each valve in the system several times during this 24 hour period to ensure its proper disinfection. Following the 24-hour period, verify that no less than 25 ppm chlorine residual remains in the system. After the chlorine residual level is successfully maintained at or above 25 ppm for a 24 hour period, flush the system with water from the distribution system until the residual chlorine is reduced to less than one ppm.

c. Take additional samples of water at locations specified by the Contracting Officer in disinfected containers for bacterial examination. Test these samples in an approved laboratory for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with EPA Standard Method SM9223, Total Coliforms-PA Test.

d. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in two separate test samples taken 24 hours apart. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.9 PIPE COLOR CODE MARKING

All automatic sprinkler system piping, valves, and appurtenances shall receive two coats of enamel in accordance with Section 09 90 00.00 98 PAINTING AND COATING, Color No. 11120 (red) in accordance with MIL-STD-101 and FED-STD-595.

3.10 PRELIMINARY TESTS

The system, including the underground water mains and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, complete certificates as specified in paragraph SUBMITTALS.

3.10.1 Underground Piping

3.10.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less that the calculated maximum water demand rate of the system.

3.10.1.2 Hydrostatic Testing

New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints, regardless of pipe diameter.

3.10.2 Aboveground Piping

3.10.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

3.10.2.2 Air Pressure Test

As specified in NFPA 13, an air pressure leakage test at 50 psi shall be conducted for 24 hours. There shall be no drop in gauge pressure in excess of 1.5 psi for the 24 hours. This air pressure test is in addition to the required hydrostatic test.

3.10.2.3 Backflow Prevention Assembly Forward Flow Test

The Contractor is responsible for conducting the forward flow test. Each backflow prevention assembly shall be tested at system flow demand as specified in NFPA 13. Provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5 inch diameter hoses, playpipe nozzles, calibrated pressure gauges, and pitot tube gauge. Provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. A metal placard shall be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate. The pressure drop shall be compared to the manufacturer's data.

3.10.3 Testing of Alarm Devices

Each alarm initiating device, including pressure alarm switch, low air pressure switch, valve supervisory switch, and electrically-operated switch shall be tested for proper operation. Water motor alarm shall be tested. The connecting circuit to the building fire alarm system and to the base-wide fire report system shall be inspected and tested.

3.10.4 Trip Tests of Dry Pipe Valves

Each dry pipe valve shall be trip-tested by reducing normal system air pressure through operation the inspector's test connection. Systems equipped with quick opening devices shall be first tested without the operation of the quick opening device and then with it in operation. Test results will be witnessed and recorded. The object of the test is to receive a steady stream of water at the test connection within 60 seconds after activating the test connection. Test results shall include the number of seconds elapsed between the time the test valve is opened and tripping of the dry valve; trip-point air pressure of the dry pipe valve; water pressure prior to valve tripping; and number of seconds elapsed between time the inspector's test valve is opened and water reaches the orifice.

3.10.5 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

3.11 FINAL ACCEPTANCE TEST

Final Acceptance Test shall begin only when the Preliminary Test Report has been approved. The Fire Protection Specialist shall conduct the Final Acceptance Test and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. Each system shall be completely drained after each trip test. The system air supply system shall be tested to verify that system pressure is restored in the specified time. In addition, the Fire Protection Specialist shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received. After the system has been tested and drained, the system shall be drained periodically for at least 2 weeks until it can be assured that water from the system has been removed.

3.12 ONSITE TRAINING

The Fire Protection Specialist and Manufacturer's Representative shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 4 hours of normal working time and shall start after the system is functionally complete and after the Final Acceptance Test. The Onsite Training shall cover all of the items contained in the approved Operating and Maintenance Instructions.

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PUMP STATION

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/HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Measurements and Allowable Values
ANSI B16.1	(2005) Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
ANSI S2.19	(1999; R2004) Mechanical Vibration - Balance Quality Requirements of Rigid Motors - Part 1: Determination of Possible Unbalance, Including Marine Applications

ASTM INTERNATIONAL (ASTM)

ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
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 B 148	(1997; R 2009) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B 505/B 505M	(2008a) Standard Specification for Copper-Base Alloy Continuous Castings

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; CORR 2009) Quality Management Systems- Requirements

NSF INTERNATIONAL (NSF)

NSF 61	(2009) Drinking Water System Components - Health Effects

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10	(2007) Near-White Blast Cleaning

1.2 SYSTEM DESCRIPTION

The W-5 Pump Station includes three high-service pumping units and two jockey pumping units as specified herein and shown on the drawings. The jockey pumping units provide water to water towers shown on the drawings.

The Contractor shall furnish and install all pumping units as defined above. Each pumping unit shall include pump, motor, shaft coupling and guard, base, and all other items necessary for a complete and properly operating pumps.

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

Shop Drawings; G
Composite Installation Drawings; G

In accordance with the paragraph entitled "SHOP AND COMPOSITE INSTALLATION DRAWINGS."

SD-06 Test Reports

Factory testing results, including pump hydrostatic testing, pump hydraulic performance testing, pump vibration testing, motor testing, and all other factory testing required. For each pumping unit to be furnished, all required factory testing shall be performed and 5 certified copies of all test results and guaranteed performance curves and data shall be submitted and reviewed by the Contracting Officer before shipment of the units.

Field testing results for all field tests required.

SD-07 Certificates

Certification of the qualifications required per sub-section titled MANUFACTURER/SUPPLIER QUALIFICATIONS.

Manufacturers' certifications of the quality assurance requirements per sub-section titled QUALITY ASSURANCE.

Pump manufacturer's certification per sub-section titled INSTALLATION REQUIREMENTS.

Manufacturers' certifications of compliance with the specified reverse speed requirements.

SD-08 Manufacturer's Instructions

Installation Instructions

1. Storage and handling instructions/requirements.

2. Installation/Startup/Instruction Personnel:

Submit the name and experience record of the manufacturer's/supplier's personnel proposed to provide field services for installation, startup, training/instruction of Government's personnel, and other services as specified herein.

3. Installation instructions for all items furnished, including:

Pumping unit bases.
Pumps.
Electric motors.
Shaft couplings.
All connections to pumps.
Pump seal water system.

SD-10 Operation and Maintenance Data

Operation and maintenance manuals shall be furnished specifically for this installation and shall include all product information, drawings, performance data, certifications and test results, equipment and parts lists/descriptions, operation and maintenance instructions, and all other information necessary to instruct operation and maintenance personnel unfamiliar with such equipment. As a minimum, submit operation and maintenance information for the following equipment.

1. Pumps, including mechanical seals.
2. Shaft couplings.
3. Electric motors.

1.4 SHOP AND COMPOSITE INSTALLATION DRAWINGS

Shop drawings shall include:

Manufacturer's descriptive literature, performance curves and data, equipment drawings (including principal dimensions, space and clearances required), diagrams, bills of materials, materials of construction, types of finishes, weights of equipment, piping and electrical connections and requirements, controls, installation instructions, warranty, and other pertinent information.

A lateral and torsional analysis of the pumping units as specified herein.

Certified shop and erection drawings showing all important details of construction, dimensions, and anchor bolt locations.

Composite Installation Drawings

Submit complete composite installation drawings at a scale of not less than 1/2 inch equals 1 foot showing the following:

1. Pumps and motors.

2. Pump suction and discharge piping (pipe, fittings, valves, and appurtenances) and associated supports to be installed within the pump room.

3. Pump seal piping and supports.

4. Stuffing box drainage piping and supports.

5. Pumping unit base drainage piping and supports.

6. Pressure gauges and interconnecting sensing lines and supports.

7. All electrical and control items and connections including conduit layout and supports.

8. Pumping unit base, anchor bolts, and required support pad geometry and elevations. Elevation of the top of pump support pad shall be referenced to elevations shown on the drawings.

9. Manufacturer's recommended spare parts list for each item of equipment.

1.5 QUALITY ASSURANCE

To ensure unity of responsibility, each complete pumping unit shall be supplied, tested, and warranted by the pump manufacturer.

The components of the pumping units furnished shall be standard products of reputable manufacturers and shall have at least 5-years operating history proving successful performance and reliability.

The manufacturer of the pumping units shall have a quality management system in place and shall be ISO 9001 certified.

1.6 Qualifications

The pump manufacturer shall have at least 15 years of successful experience in the designing and manufacturing/supplying of pumping units of the type, size, and complexity specified. The pump manufacturer shall have supplied such pumping units on not less than 3 waterworks projects in the USA, and the pumping units shall now be in operation and shall have been operating continuously and successfully for at least 5 years; furthermore, at least one such pumping unit shall have the same pump model, impeller model, and operating speed as the pumping units to be furnished under this project.

The pump manufacturer or his authorized supplier shall have a permanent organization ready and able to provide technical and field service for the pumping units furnished. Field service personnel shall be factory authorized and experienced in the installation, startup, operation, and servicing of the pumping units furnished. The service organization shall be maintained in a manner such that the Government can request service at any time and the necessary service personnel shall be able to arrive onsite within 48 hours after placement of the request.

1.7 Installation Requirements

The equipment provided by the Contractor must be capable of being installed, operated, and serviced in the locations shown and in conformance with the limitations of the arrangements shown and described on the drawings and in the specifications, including all piping, architectural, structural, mechanical, electrical, instrumentation, and clearance dimensions for operation and maintenance access. The Contractor's Bid Prices shall include the cost of all additional engineering and

construction required (if any), including piping, architectural, structural, mechanical, electrical, and instrumentation necessitated by the installation of pumping units requiring engineering and/or construction modifications to the design indicated on the drawings and in the Specifications.

The pump manufacturer shall certify that the pumping units being proposed/provided are suitable for the proposed piping system and for the water being conveyed. The Contractor shall include such certification in the pump submittal and shall coordinate the pump submittal with the piping system submittal.

1.8 WARRANTY

The warranty shall extend for 24 months from the date of Substantial Completion.

PART 2 PRODUCTS

2.1 MATERIALS

The pumping units provided under this section shall be supplied by one manufacturer. All high-service pumping units and their appurtenances/accessories shall be identical. All jockey pumping units and their appurtenances/accessories shall be identical.

All components that will come into contact with the water being pumped shall conform to NSF 61.

Both the high-service pumping units and the jockey pumping units shall be manufactured and supplied by the same manufacturer. Pumps shall be manufactured and supplied by Patterson Pump Company, Toccoa, Georgia, or Contracting Officer-approved equal, with motors manufactured by U.S. Electrical Motors. The high service pumps shall be Model 8x6 MI-I and the jockey pumps Model 5x4x12 SSC.

Pump rotating assemblies shall be balanced in accordance with the requirements of ANSI S2.19, balance quality grade G6.3, or better.

2.1.1 General Operating Conditions and Requirements

All high-service pumps and all jockey pumps will pump from a common suction header connected to the ground storage tank.

Each pumping unit shall be capable of operating for an indefinite length of time from the published characteristic curve run-out point up to the specified allowable sustained minimum flow at the specified maximum operating speed (provided that NPSH available is greater than or equal to NPSH required), without detrimental effect on pumping unit performance or wearing parts and without pressure or flow pulsation, cavitation, excess noise, or vibration. In addition, each unit shall be capable of operating for brief periods (during startup and shutdown sequences) from the specified allowable sustained minimum flow at the specified maximum operating speed up to shutoff on the characteristic curve.

Unfiltered RMS vibration amplitude in any plane measured on the pump bearing housings at any pump speed shall be not more than 75% of the Hydraulic Institute Standard for vibration (ANSI/HI 9.6.4). Pumps shall be tested throughout the full speed range. The Contractor shall provide the

manufacturer's services, equipment, and materials as necessary to measure the vibration of the installed units and correct vibration in excess of the specified requirements.

The pump head-versus-flow characteristic curve shall rise continuously from the run-out point to the shutoff head without flat spots or reverse curvature. The pump horsepower requirement shall not exceed the continuous power rating (not including service factor) of the motor/drive at any point within the whole flow range at rated speed.

Each pumping unit (including pump, motor, and shaft coupling) shall be designed and constructed to operate under reversed rotation (reverse flow) conditions at 125% rated speed.

If the specified rated condition point capacity, total head, speed, efficiency, and NPSH values, and all other specified values noted as "guaranteed" are not met in factory and field testing, the units will be rejected.

2.1.2 Pumpage Characteristics

Liquid Pumped: Potable water disinfected with sodium hypochlorite.

Temperature: 65 to 85°F.

pH: 7.6 to 8.2.

Dissolved oxygen concentration: 0.5 to 12 mg/L.

Conductivity: 279 to 768 micromhos/cm.

Chloride residual: 0.5 to 4.0 mg/L.

2.2 PUMP PERFORMANCES

2.2.1 High-Service Pumps

Number of Pumps	Three (3)
Pump Model	8x6 MI-I
Primary design condition (each)	
Capacity	1,600 gpm
Total head	186 feet
Minimum pump efficiency	82%
Secondary design condition No.1 (each)	
Capacity	1,280 gpm
Total head	199 feet
Minimum pump efficiency	80%

Secondary design condition No.2 (each)	
Capacity	2,100 gpm
Total head	150 feet
Minimum pump efficiency	82%
Allowable Sustained Minimum Flow	not more than 800 gpm
Allowable Sustained Maximum Flow	not less than 2,500 gpm
Shut-off Head	217 feet
Maximum Motor Horsepower	100 HP
Maximum Operating Speed	1,775 rpm
Pump Discharge Flange Size	6-inch
Pump Suction Flange Size	8-inch
Pump Casing Rated Working Pressure	150 psig minimum
Pump Casing Hydrostatic Test Pressure	225 psig minimum

2.2.2 Jockey Pumps

Number of Pumps	Two (2)
Pump Model	5x4x12 SSC
Primary design condition (each)	
Capacity	485 gpm
Total head	128 feet
Minimum pump efficiency	75%
Secondary design condition No.1 (each)	
Capacity	700 gpm
Total head	98 feet
Minimum pump efficiency	70%
Secondary design condition No.2 (each)	
Capacity	582 gpm
Total head	116 feet
Minimum pump efficiency	75%
Allowable Sustained Minimum Flow	not more than 320 gpm
Allowable Sustained Maximum Flow	not less than 750 gpm

Shut-off Head	150 feet
Maximum Motor Horsepower	25 HP
Maximum Operating Speed	1,775 rpm
Pump Discharge Flange Size	4-inch
Pump Suction Flange Size	5-inch
Pump Casing Rated Working Pressure	150 psig minimum
Pump Casing Hydrostatic Test Pressure	225 psig minimum

2.3 PUMP CONSTRUCTION

2.3.1 Pump Casing

The pump casing shall be cast ductile iron, ASTM A 536 GR 65-45-12 or cast iron, ASTM A 48/A 48M - CL40. The casing shall be horizontally-split, single-volute type with the suction and discharge flanges cast integrally with the lower half in order that the upper part may be removed for inspection of the rotating element without disturbing pipe connections or pump alignment. Pump mounting feet shall be cast integrally into the lower half-casing with the mounting surface completely machined. The joint between the casing halves shall be heavily flanged and bolted, and provided with dowel pins to insure accurate alignment. The upper half-casing flange shall have tapped holes for jackscrews. The casing interior shall be smooth and free from surface defects (e.g., gas porosity, foreign material inclusions, and other defects which would be detrimental to pump performance/longevity or prevent proper preparation, application, and performance of the casing's coating system). All interior surfaces of the pump casing shall be coated with fusion bonded epoxy; the fusion bonded epoxy system shall be as recommended by the pump manufacturer for the intended service application and pumpage characteristics as specified herein.

Diameter, facing, and drilling of pump suction and discharge flanges shall be per ANSI B16.1, Class 125.

Drilled and tapped pressure gauge connections (1/4-inch NPT) shall be provided on both sides of the suction and discharge, and located on the horizontal centerline (two connections for one side). A threaded ductile iron plug shall be installed in each unused gauge connection.

Pump casing shall be drilled and tapped for venting of volute and suction chambers, mechanical seal cooling water supply, and drain connections. A threaded ductile iron plug shall be installed in the casing drain connection.

The venting taps for the volute and suction chambers shall be located to remove all entrapped air in the pump. The venting taps shall be 3/4-inch NPT for high service pumps and jockey pumps.

Suitable lifting lugs or eyebolts shall be provided to facilitate level hoisting and handling of the upper half-casing and the entire pump.

Surfaces at all holes for bolts, studs, and other fasteners shall be machined or spot faced to provide flat/full bearing contact for fastener components.

2.3.2 Impeller

The impeller shall be a double-suction enclosed type, one-piece construction made entirely of ASTM B 148-958 nickel aluminum bronze and finished smooth all over. The impeller shall have ample strength and stiffness for long life and maintaining maximum pump hydraulic performance.

The impeller shall be statically and dynamically balanced and shall be keyed to the shaft and securely held in axial position on the shaft by means of 316 stainless steel shaft sleeves extended through the stuffing boxes. Rotation of the shaft sleeves shall be prevented by the impeller key, which shall extend beyond the impeller hub and into the shaft sleeves on both sides of the impeller. Each shaft sleeve shall be held in position by a locking shaft sleeve nut located outside of the stuffing box and shall have an O-ring seal between the sleeve and the nut to prevent passage of air or liquid between the shaft and sleeve. Shaft sleeves shall have sufficient length so that the mechanical seal anchorage bears on the sleeve and not on the sleeve nut or shaft. Sleeves which are threaded onto the pump shaft are not acceptable.

2.3.3 Wear Rings

Wear rings shall be provided on both the casing and impeller at the running joint between the suction and discharge chambers.

The casing rings shall be a one-piece construction ASTM B 505/B 505M-952 aluminum bronze, positioned in the casing and locked against rotation by the upper half of the casing. The casing rings shall be made to limit gauges, so that they may be renewed without fitting.

The impeller rings shall be of ASTM B 505/B 505M-954 aluminum bronze, so fastened that they cannot rotate or become loose when the pump is subjected to reversed rotation. The impeller rings shall be made to limit gauges, so that they may be renewed without fitting.

2.3.4 Pump Shaft

The shaft shall be a single-piece construction made from AISI 1141 and of such dimensions that the maximum combined stress due to bending and torsion shall not exceed 8,000 pounds per square inch under the most severe conditions of operation.

The shaft shall be accurately ground and polished over its entire length.

The shaft shall be protected from wear at the stuffing boxes and from contact with the mechanical seals by renewable shaft sleeves as described in the impeller section of these specifications. Threads on the pump shaft shall be located outside of the stuffing box.

The first critical speed of the rotating assembly shall occur at not less than 150% of the rated speed.

2.3.5 Stuffing Boxes and Shaft Seals (Mechanically Sealed)

Stuffing boxes shall be provided with mechanical shaft seals.

Stuffing boxes shall accept packing or mechanical seals without modification to the stuffing box.

Mechanical seals shall be furnished with a carbon seal ring, ceramic mating ring, viton elastomers and 316 stainless steel metal parts.

Mechanical seals shall be rated for 250 PSIG pressure. The elastomers shall be rated for temperatures ranging from -20 degrees F to 400 degrees F.

Pump shaft sleeves shall be furnished with a pre-machined groove designed to accept a setting ring, which shall eliminate the need for set collars or stop collars. Seals requiring stop or set collars with set-screws are not acceptable.

The rotating seal ring shall be provided with a 360 degree rubber encasement to provide a positive drive for the seal face without the need for metal drive notches which may cause face distortion or notch wear. The seal rings shall be permanently fixed in place and full flatness maintained by a precision crimp in the outer seal case.

The mechanical seal shall be of a convoluted design which permits free movements providing constant adjustment for shaft endplay and seal face wear. Positive face contact with the stationary seat shall be maintained at all times.

To insure positive sealing by free movement of the seal head, the seal shall feature a hex style outer shell and drive band which shall absorb start-up and running torque and shall eliminate stress on the diaphragm. Metal components shall freely engage and shall not be subject to lock down due to friction wear.

Suitably valved connecting lines or passages shall be provided on the upper half casing leading from the discharge volute to the stuffing box for lubricating the stuffing boxes with the liquid being pumped.

2.3.6 Other Wetted Pump Parts

Other metallic wetted pump parts whose materials of construction have not been specified elsewhere herein shall be 300-series stainless steel suitable for the intended service application and pumpage characteristics as specified herein.

Wetted elastomeric parts shall be constructed of Viton or EPDM, formulated to be suitable for the intended service application and pumpage characteristics specified herein.

2.3.7 Pump Bearings

The pump shaft and impeller assembly shall be supported by ring oil lubricated ball bearings of sufficient size to carry all radial and axial loads. Bearings shall be of the anti-friction grease lubricated ball.

The bearing configuration shall consist of one single-row deep-grooved ball bearing on the inboard side and two single-row deep-grooved ball bearings mounted back to back on the outboard side. The inboard bearing shall be designed to take the radial loads. The outboard bearings shall be designed to take a combination of loads, both radial and axial, and hold the rotor in axial alignment.

Bearings shall have an AFBMA B-10 rated service life of at least 80,000 hours throughout the pump's operating range as defined by the operating

conditions and requirements specified herein. The bearing housings shall be cast iron construction, dust-tight, and split horizontally with removable caps. Oil rings shall be made of brass. Oil reservoirs shall be designed/sized to provide proper cooling of the oil. The internal surfaces of the bearing housings and oil reservoirs shall be painted with an oil resistant paint. Oil reservoirs shall be equipped with sight gauges having brass cases to provide oil level indication.

The bearing housings shall be rigidly supported by suitable brackets, which shall be machined with the pump casings for accurate shaft alignment and shall be cast integrally with the lower half of the pump casing. The brackets shall form drip pockets for collecting stuffing box leakage and shall have tapped drain connections; drainage shall be piped to the building drain system.

At the inner end of each bearing housing, the shaft shall be equipped with a stainless steel slinger type water deflector assembly fastened to the shaft with set screws to prevent water from the stuffing box entering the bearing housing. Over the stuffing box and supported by the bearing brackets shall be provided readily removable polished cast brass or cast aluminum spray guards so designed and fabricated that any water spray from the stuffing boxes or shaft shall be deflected into the drip pockets.

2.3.8 Shaft Coupling

A flexible shaft coupling shall be provided between the pump shaft and the motor shaft. The coupling shall be selected by the pump manufacturer and shall be suitable for the service application. As a minimum, the coupling shall be rated to transmit all imposed loads (excluding service factor), including pump operation at any point throughout the pump's operating range, including backspinning, as defined by the operating conditions and requirements specified herein. The coupling shall be balanced as recommended by the pump manufacturer. The coupling shall be sized to transmit the maximum required horsepower with a service factor of at least 1.5.

The coupling shall be Martin Quadra-flex or approved equal with type S flanges and elastomeric sleeves of Hytrel, EPDM or similar material.

Each shaft coupling shall have a removable coupling guard to provide protection with respect to the rotating coupling and shafts. The guard shall be made entirely of 300-series stainless steel. The guard shall be rigidly supported from its mounting pad on the pumping unit base and anchored with cap screws. The guard shall comply with OSHA requirements.

2.3.9 Pump Unit Base

The pump and motor shall be mounted on a continuous steel base. The base shall be of welded heavy-duty construction and fabricated from ASTM A 36/A 36M steel. The base shall be of box-type construction with internal web reinforcing for rigidity and designed for epoxy grouting. The base shall have suitable lifting lugs or eyebolts to facilitate level hoisting and handling. All parts of the base which are flame cut shall be ground smooth to remove the flame cutting marks. All welded joints shall be continuous or seal welded and shall be ground smooth. All edges and corners shall be rounded. Bent metal or formed bases are not acceptable.

The base shall have a drip rim to collect condensation moisture from the pump. The drip rim shall extend along the sides of the base from the motor

driver to the pump end with a slope not less than 1/8 inch per foot. The depth of the drip rim shall be not less than 1/2 inch. At the lowest point of the drip rim, located at the pump end, there shall be 3/4 inch pipe tap for drainage piping connection.

The base shall include heavy steel mounting pads for mounting all items of equipment, including coupling guard. All mounting pads shall have machined surfaces. The equipment shall be anchored to the mounting pads with cap screws; through bolts are not acceptable. Cap screws shall be sufficiently strong for all loads which will be imposed on them during pumping unit operation and shall be installed with the pump manufacturer's recommended anti-seize thread compound designed to prevent corrosion of the threaded connection. If shims are required under the mounting feet of the equipment for alignment and leveling purposes, they shall be full-faced cut to the contour of the equipment feet. The mounting pads shall be such that, after final alignment, the supporting feet of the equipment can be doweled to the mounting pads. Jacking type dowel pins shall be furnished by the equipment manufacturer.

The base shall be of such design and have sufficient grout holes to facilitate filling of all spaces/voids with the specified grout after equipment is leveled and aligned. The Contractor shall coordinate and include in the pumping unit submittal the grout manufacturer's confirmation of the adequacy of the proposed grout holes with respect to this requirement for the grout to be used.

The base shall be supplied with sufficient anchor bolt assemblies for holding/anchoring the base accurately in position. Anchor bolt assemblies shall be supplied by the pump manufacturer and shall include anchor bolts, pipe sleeves, washers, and heavy hex nuts. Anchor bolt assemblies shall be of the configuration shown on the drawings and shall be sufficiently strong for all loads which will be imposed on them during pumping unit operation. Anchor bolt assemblies shall be designed and manufactured for the concrete foundation geometry and reinforcing details shown on the drawings, and anchor bolts shall fit the base mounting holes with a maximum clearance of 1/8 inch.

2.3.10 Pump Nameplate

Each pump shall have a stainless steel nameplate securely attached to the pump in a readily visible location which shall contain, as a minimum, the following information:

a. Manufacturer's name and address.
b. Size/model number.
c. Serial number.
d. Capacity, total head, and rpm at rated condition.
e. Pump impeller information.

2.3.11 Electric Motor

The electric motors for the pumps shall provide the horsepower required and shall be the premium efficiency design. The motor shall be designed for 480-volt three-phase 60Hz service. The motor shall conform to the following requirements:

a. Motor NEMA Code Letter: G.

b. The rotor shall be aluminum and the motor shall be rated for a

degrees F rise.

c. Minimum NEMA Nominal Efficiency at full load: 95.0%.

d. Minimum NEMA Guaranteed Efficiency at full load: 94.1%.

e. Rated Maximum Ambient Temperature: degrees F.

f. Maximum Noise Level: 87 dBA at 1 Meter.

g. Service Factor based on a pure sine wave source: 1.15.

h. Service Factor based on inverter source: 1.00.

i. Inverter Duty Rated for variable torque operation with operation up to a 3:1 speed turndown.

j. Motors shall be designed for premium efficiency with at least the nominal efficiency as specified herein.

k. Provide integral space heaters operable at 120-volts AC.

2.3.12 Instrumentation

See Section 40 95 00 PROCESS CONTROL SYSTEM

2.3.13 Factory Painting

All interior ferrous metal surfaces of the pump casing shall be factory coated as specified in the pump casing section of these specifications.

All interior ferrous metal surfaces of the pump bearing housings and oil reservoirs shall be factory painted as specified in the pump bearings section of these specifications.

The exposed ferrous metal surfaces of all components of the pumping units and ancillary items, as well as all surfaces of each pumping unit base, shall be factory prepared and primed for subsequent field painting as specified below. Final painting shall be performed by the Contractor after installation as specified herein under Field Painting. The Contractor shall coordinate all paint materials and work to ensure compatibility and paint system performance. The Contractor shall coordinate and obtain confirmation from the grout manufacturer that the paint system to be used on pumping unit base surfaces which will come in contact with the base grout complies with the grout manufacturer's recommendations for the grout to be used; such confirmation shall be included in the pumping unit submittal.

Paint System Description:

Surface Preparation: SSPC SP 10.

Primer Coat(s): 1 coat at 3.0 mils DFT (2.5 mils DFT minimum to 3.5 mils DFT maximum).

Paint System Manufacturer and Product(s): Tnemec Series 90-97 (primer coat).

2.4 FACTORY TESTING

Upon completion at the factory, each pumping unit shall undergo testing at the pump manufacturer's testing facility to determine and certify compliance with the requirements specified herein and to demonstrate the proper mechanical operation of the unit. As a minimum, testing shall include pump hydrostatic testing; pump hydraulic performance testing; pump and motor vibration testing. Testing shall be performed in accordance with Hydraulic Institute Standards.

Pump hydraulic performance testing shall be performed at the synchronous speed minus slip due to load for the electric motor being furnished with that particular pump. As a minimum, testing shall be performed at specified rated total head (TH), specified minimum operating total head, shut off head (SOH), and six additional test points evenly distributed throughout and defining the pump's allowable operating range. Power input to the pump shall be measured by a calibrated electric or torsional dynamometer. Factory testing results shall be used to guarantee the capacity, TH, brake horsepower (BHP), pump efficiency, and net positive suction head required (NPSHR) at the specified rated condition point and to guarantee the values of all other parameters noted as "guaranteed" in the specified secondary condition points. Test results shall be recorded/documented in both tabular and graphic form.

As a result of the performance testing, guaranteed performance curves and data for each pumping unit shall be prepared and certified to present the unit's performance at the specified rated speed and at 70% of the rated speed. Performance curves shall include plots of total head, pump brake horsepower, pump efficiency, net positive suction head required, and motor input power versus capacity. Data shall include a tabulation of the points used to plot all performance curves.

All factory testing shall be performed and 5 certified copies of all test results and guaranteed performance curves and data for each pumping unit shall be submitted and reviewed by the Contracting Officer before shipment of the units.

2.5 SPECIAL TOOLS, SPARE PARTS, AND LUBRICANTS

The Contractor shall provide all special tools, including lubricating devices, required for normal inspection, maintenance, and service of the pumping units, including those required for:

Pump disassembly and assembly (including 4 guide pins for upper half-casing removal/installation and 2 spanner wrenches for removal/installation of sleeve nuts).

Bearing removal and replacement.

Wearing ring removal and replacement.

Checking of wearing ring clearances.

Each special tool shall be delivered to the Government in a heavy duty storage case designed to protect the tool during handling and long term storage. Each case shall be permanently labeled with a description of its contents.

The following spare parts shall be provided:

One set of pump casing wearing rings.

One set of pump impeller wearing rings.

One impeller key.

One set of pump shaft sleeves with O-rings.

Two pump shaft mechanical seals (complete assemblies).

One pump inboard (radial) bearing and associated seals.

One pump outboard (thrust) bearing and associated seals.

Two shaft coupling keys.

Five pump casing gaskets.

Five sets of miscellaneous gaskets and seals required for disassembly and reassembly pumps and shaft couplings.

All spare parts shall be tagged for identification including the part numbers as shown on the assembly drawings in the operation and maintenance manuals furnished.

Spare parts shall be delivered to the Government in a chest designed to protect the parts during handling and long term storage. The chest shall have a hinged cover, lifting handles, and padlocking arrangement. The chest shall be painted with 2 coats of paint matching the paint specified for the pumps and shall have stenciled on the cover in 2-inch black letters "Spare Parts for High Service Pumps" or "Spare Parts for Jockey Pumps" and the designating numbers of the pumps to which the parts in the chest apply.

With each pumping unit there shall be supplied and delivered to the Government a quantity of the equipment manufacturer's recommended lubricant for each piece of the equipment sufficient for not less than two lubrication changes. Containers shall be tagged for the lubricant service. Lubricants shall include those needed for lubrication of the pumps, electric motors, and shaft couplings. This supply of lubricants is for Government's use after project acceptance; quantities of lubricants necessary to prepare equipment for startup and for equipment operation prior to project acceptance shall be supplied by the Contractor in addition to the Government's quantity.

PART 3 EXECUTION

3.1 SHIPMENT, DELIVERY, HANDLING, AND STORAGE

Products shall be properly protected during shipment and delivered to the project site undamaged. Handling and storage shall be in accordance with the manufacturer's written instructions and recommendations. Handling and storage shall be done in such a manner as to prevent damage and deterioration of any items.

Products shall be shipped factory-assembled to the greatest extent practical. After pumping unit factory testing, the electric motor may be

removed from the pumping unit base for shipment.

After testing, pumps shall be drained and shipped completely free of any entrapped water. Shaft seals and shaft couplings shall be prepared for subsequent shipping/storage per their manufacturer's instructions and recommendations.

Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

All openings on equipment (e.g., connection points on pumps, ventilation openings on electric motors, etc.) shall be properly covered/protected to prevent entry of foreign material. Pump suction and discharge connections shall be covered by securely attached wooden or metal blanks.

Shipping containers shall be marked to show weight in addition to a description of the contents.

3.2 INSTALLATION

Installation shall be in accordance with the pump manufacturer's written instructions and recommendations. The initial startup/operation of each pumping unit shall be by the pump manufacturer's field service engineer as specified herein. Pumps shall not be started in a dry condition - pumps shall be primed and shaft seals properly wetted and supplied with seal cooling water prior to pump starting.

The concrete foundations for the pumping units shall have attained the cure time and strength per the requirements of the Contracting Officer and grout manufacturer prior to placement of units on the foundations. Anchor bolts and nuts shall be assembled with the pump manufacturer's recommended anti-seize thread compound designed to prevent corrosion of the threaded connection.

The pumping units shall be installed, aligned, and grouted under the supervision of the pump manufacturer's field service engineer. This supervision shall include making up the suction and discharge flange joints to ensure that no piping strains are placed on the pumps and preliminary alignment prior to grouting. Shims used for equipment alignment shall be full-face cut to the contour of the equipment feet.

Following preliminary alignment, grouting work shall be performed using non-shrink epoxy machinery grout and as specified in 03 63 00 GROUTING-NON-SHRINK EPOXY MACHINERY GROUT. After the grout has fully cured, the base anchor bolts tightened, the pump suction and discharge piping connections completed, and before the unit is placed in initial operation, the alignment shall be checked by the pump manufacturer's field service engineer. As a minimum, alignment shall be in conformance with the pump manufacturer's specifications and the Hydraulic Institute Standards.

The pumping units shall be inspected, lubricated, started, and placed in initial operation by the pump manufacturer's field service engineer; the electric motor manufacturer's field service engineer shall also be present at these times to provide similar service and assistance with respect to the motors. The pump manufacturer shall obtain and pay for such services of the motor manufacturer's field service engineer. The pump manufacturer's field service engineer shall certify that the pumping units have been correctly installed, are in alignment, and are ready for continuous operation.

After the pumping units are put into service, each unit shall be operated for at least 5 days with at least 5 starts and at least 100 hours run time after which the pump manufacturer's field service engineer shall check the alignment. Immediately following realignment adjustments and achieving final alignment, the pump and motor shall be doweled to their mounting pads (with the jacking type dowel pins furnished by the equipment manufacturer) under supervision of the pump manufacturer's field service engineer.

The pump manufacturer's field service engineer shall certify that the pumping units have received and passed final installation inspection, are in alignment as doweled, and are ready for continuous operation.

3.3 FIELD PAINTING

Field painting shall be in accordance with Section 09 90 00.00 98 PAINTING AND COATING. Final painting of the factory-primed exposed ferrous metal surfaces (specified herein under Factory Painting) shall be performed by the Contractor after installation in accordance with Section 09 90 00.00 98 PAINTING AND COATING. The Contractor shall coordinate all paint materials and work to ensure compatibility and paint system performance.

3.4 FIELD TESTING

Following successful completion of the installation of the high service pumping units, pumping system startup and field testing shall be performed as specified in the project.

3.5 MANUFACTURER'S FIELD SERVICE

Manufacturer's field service shall be provided in accordance with the requirements in Division 01.

The manufacturer of the pumping units shall provide the services of qualified field service engineers and representatives for the services specified in these specifications, as a minimum. If difficulties or non-compliance are encountered with respect to the design, manufacture/fabrication, installation, or operation of the equipment, additional services shall be provided as necessary to remedy the issue(s) at no additional cost to the Government.

Training/Instruction of Government's Personnel: Following successful completion of all field testing of the pumping system, training and instruction of the Government's personnel shall be provided by the manufacturer's field service engineer for the following equipment:

1. Pumps, motors, and shaft couplings.

2. Instruction shall include actual demonstration of the following:

   Pump bearing cap removal and bearings inspection.

   Pump upper half-casing removal and impeller and wearing rings inspection.

   Pump shaft coupling breakdown and inspection.

3. Additional instruction shall include the following:

Lubrication.

Replacement of lubricants.

Pump shaft mechanical seal replacement and adjustment.

Wearing ring replacement.

Bearing replacement.

How to detect impending problems.

Other practical considerations.

Training/instruction of Government's personnel shall be conducted at the project site, as scheduled by the Government, and shall be for a period of not less than 3 days.

3.6 OPERATIONS AND MAINTENANCE

Provide operations and maintenance requirements as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.7 FORMS

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

_____ Installed in accordance with Manufacturer's recommendations.

_____ Inspected, checked, and adjusted.

_____ Serviced with proper initial lubricants.

_____ Electrical and mechanical connection meet quality and safety standards.

_____ All applicable safety equipment has been properly installed.

_____ System has been performance tested, and meets or exceeds specified performance requirements (when complete system of one manufacturer).

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment, and (iii) authorize the make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer: _____

By Manufacturer's Authorized Representative:

_____
(Authorized Signature)

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION TESTING AND INSTRUCTION

OWNER

PROJECT

CONTRACT NO.

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

_____
(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

Installed for the subject project has have been installed in a satisfactory manner, has have been satisfactorily tested, is/are ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the units on Date:

_____ Time: _____.

CERTIFIED BY: _____ DATE: _____
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGEMENT OF MANUFACTURER'S INSTRUCTION

I/We the undersigned, authorized representatives of the _____ and/or Plant Operating Personnel have received classroom and hands on instruction on the operation, lubrication, and maintenance of the subject equipment and am are prepared to assume normal operational responsibility for the equipment:

_____ DATE: _____

_____ DATE: _____

_____ DATE: _____

-- End of Section --

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SECTION 22 12 23.13

PACKAGED HYDROPNEUMATIC TANK SYSTEM

PART 1 GENERAL

1.1 GENERAL DESCRIPTION

The hydropneumatic tank system includes one 15,000-gallon hydropneumatic tank, tank's accessories, air supply, and air supply control as specified in this Section and as shown on the drawings.

1.2 SCOPE OF WORK

Ensure that the hydropneumatic tank manufacturer furnishes materials, equipment, and incidentals necessary for the hydropneumatic tank system specified in this Section and as shown on the drawings.

Overall supply and quality of all the items specified in this Section and shown on the drawings is the responsibility of the hydropneumatic tank manufacturer.

Testing, start-up, troubleshooting, and personnel training of the hydropneumatic tank system is the responsibility of the hydropneumatic tank manufacturer as specified in this Section and as shown on the drawings.

Install the hydropneumatic tank system specified in this Section and as shown on the drawings.

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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B1.20.1	(1983; R2001) Pipe Threads, General Purpose (Inch)
ANSI B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ANSI B36.10	(2004; R2010) Welded and Seamless Wrought Steel Pipe

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA D102	(2006) Coating Steel Water-Storage Tanks

ASME INTERNATIONAL (ASME)

ASME BPVC	(2007) Boiler and Pressure Vessel Codes
ASME BPVC SEC VIII	(2007; Addenda 2008) Boiler and Pressure Vessel Codes: Section VIII Rules for

Construction of Pressure Vessels, Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 90/A 90M	(2009) Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM A 105/A 105M	(2009) Standard Specification for Carbon Steel Forgings for Piping Applications

NSF INTERNATIONAL (NSF)

NSF 61	(2009) Drinking Water System Components - Health Effects

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10	(2007) Near-White Blast Cleaning

1.4 RELATED WORK

Section 01 33 00 SUBMITTAL PROCEDURES.
Section 09 90 00.00 98 PAINTING AND COATING.
Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS.
Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.
Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.
Section 26 28 01.00 10 COORDINATED POWER SYSTEMS PROTECTION.
Section 33 11 00 WATER DISTRIBUTION
Section 40 95 00 PROCESS CONTROL.

1.5 INTENDED FUNCTIONALITY

The intended functionality of the hydropneumatic tank system is expressed by the description and requirements presented throughout the drawings and specifications.

Ensure that the Contractor and the hydropneumatic tank system manufacturer acknowledge that a requirements for final acceptance of the hydropneumatic tank system is the fitness of the system and each of its parts to perform the intended functions as set forth in the contract documents. The drawings and specifications do not purport to provide the "total" description of every components or miscellaneous function of the hydropneumatic tank system. The drawings and specifications include that information necessary to identify the requirements of the system as it compares to systems of its type so that a knowledgeable person may determine system requirements. The lack of specific inclusion in the drawings and specifications of any component necessary for completeness or for proper functioning/operation of the system shall not be construed as license or justifiable cause for its exclusion.

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

Submit shop drawings (G) in accordance with the paragraph entitled "SHOP DRAWINGS."

SD-03 Product Data

Provide product information and descriptive literatures for the following components:

Hydropneumatic tank; G

Sight glass; G

Safety relief valve; G

Solenoid valve; G

Vacuum relief valve; G

Air compressor unit; G

Air supply control panel; G

Drexelbrook Universal III™; G

1.7 SHOP DRAWINGS

Shop drawings shall include the following:

Tank design notes and calculations
Certified drawings
Performance curves
Foundation and installation plans
Wiring and piping schematics

PART 2 PRODUCTS

2.1 HYDROPNEUMATIC TANK

Ensure that the hydropneumatic tank has a nominal capacity of 15,000 gallons and design working pressure of 100 psig at 150 degree F. Design, fabricate, test, inspect, and stamp in accordance with ASME BPVC. Provide 1/8-inch corrosion allowance in addition to calculated thickness.

The following components are integral parts of the hydropneumatic tank:

a. Standard dished heads.

b. Lifting lugs.

c. Two 6-inch high support saddles welded to the tank shell as shown on the drawings.

d. One 24-inch diameter manway.

e. Two 6-inch flanged outlets as shown on the drawings.

f. One 4-inch flanged outlet as shown on the drawings.

g. Standard threaded connections (NPT) as shown on the drawings.

All flanges shall be 150-pound ANSI standard type, faced and drilled 125-pound ANSI standard.

Paint the hydropneumatic tank in accordance with the following:

a. Tank Interior: Factory prepare surfaces with abrasive blast or centrifugal wheel blast (SSPC SP 10), factory prime with polyamid anticorrosive, epoxy primer (one coat, 3MDFT), factory finish with NSF 61 approved high build polyamid epoxy meeting AWWA D102 (two coats, 12 MDFT), Tnemec Series 20.

b. Tank Exterior: Factory prepared and prime, and field finished in accordance with Section 09 90 00.00 98 PAINTING AND COATING.

2.2 TANK ACCESSORIES

An ASME nameplate shall be permanently attached to the tank.

2.2.1 Safety Relief Valve

Heavy duty, high capacity air/gas bronze release valve with brass time and Teflon seating, 300 psig working pressure, single piece construction, top guided disc, wave spring retained disc guide, manual open lift lever, 2-inch male threaded NPT inlet and 2-inch threaded NPT female outlet, built in accordance with ASME BPVC SEC VIII and certified capacity by National Board of Boiler and Pressure Vessel Inspectors. The safety relief valve shall be factory adjusted to release 200 scfm minimum at 130 psig.

2.2.2 Sight Glass and Level Detector Holder

Ernst Model EFI 23-350 1/2-inch water gauge with isolation valves with 5/8-inch sight glass and with the lower end to be provided with a drain valve.

1-1/2-inch stainless steel pipe (Level Detector Holder) with the lower end to be provided with 1-inch drain valve and with the upper end to be provided with a reducing bushing to 3/4-inch NPT for connection to level probe.

1-inch isolation valves with ball check feature and 1-inch pipe unions between the Tank and the Level Detector Holder.

2.2.3 Vacuum Relief Valve

One-piece bronze body weather resistant construction, 2-inch FNPT inlet, 2-inch MNPT outlet, and vibration resistant soft seat.

2.3 AIR SUPPLY

Air supply includes an air compressor unit and air discharge line piping.

2.3.1 Air Compressor Unit

The air compressor unit includes air compressor, air tank, and motor.

Ensure that the air compressor is lubricated, 2-stage, 2-piston, V-belt driven, air-cooled with cast iron cylinders, spin-on oil filter, a reversible oil pump, and aftercoolers.

Power the air compressor by dual 5.0 HP minimum 460/3/60 T.E.F.C electric motors with a 1.15 service factor.

Mount the compressor and motor on an 80-gallon ASME 200 psi tank.

2.3.2 Air Discharge Line Piping

Included with the air discharge line piping is a 3.0 micron filter, air add solenoid valve, air vent solenoid valve, low air pressure switch, inline check valve, and isolation valves. Connect the piping as shown on the drawings.

2.3.3 Solenoid Valve

Ensure that a two-way type solenoid valve for normally closed operation is designed for not less than 150 psi water working pressure. Ensure that the valve has forged brass bodies, NPT threaded ends, stainless steel wetted parts, Buna N seals/disks, and NEMA 4X solenoid enclosures. Ensure that the valve operates on 120 VAC power, has threaded conduit hubs and does not require a minimum operating pressure differential for steady operation.

2.3.4 Air Piping Material - Galvanized Steel

Pipe: Steel piping shall conform to the requirements of ASTM A 53/A 53M, Type S, Grade B, and ANSI B36.10, Schedule 40 as indicated on the drawings.

Fittings: Forged steel conforming to ASTM A 105/A 105M and ANSI B16.11, Class 2000.

Joints: Threaded conforming to ANSI B1.20.1.

Galvanizing: Conform to ASTM A 90/A 90M.

2.4 AIR SUPPLY CONTROL

2.4.1 General

All instrumentation, control, and electrical components provided under this section shall be of industrial quality, equal to the components specified in Section 40 95 00 Process Control System and Division 26 Electrical, except as noted otherwise.

The instrumentation and controls systems specified in this Section shall operate on single phase, 120 VAC, 60 Hz electric power. Provide an appropriately sized control power transformer to achieve the necessary control power if the supply power is different.

2.4.2 Air Supply Control Panel Enclosure

Provide and install an enclosure to house the operator interface and control devices necessary to operate the air compressors and the

hydropneumatic tank air volume control system. The enclosure shall be stainless steel, NEMA 4X rated with 3-point latch suitable for wall or free-standing mounting

This enclosure shall house the air compressor and hydropneumatic tank air volume control, including the following, at a minimum:

1. Air compressor motor starters, full-voltage, non-reversing
2. Main, motor feed, and control circuit breakers
3. Miscellaneous electrical devices (e.g., Relays, terminal strip, pilot devices, meters, etc.)

Power feed to the enclosure shall be 480-Volt, 3-phase.

2.4.3 Operator Controls and Indicators

Provide the following operator controls and indicators:

Operator Controls

Lead Selector pilot switch (Comp No. 1/Comp No.2/Alt)
Compressor No. 1 HAND/OFF/AUTO pilot switch
Compressor No. 2 HAND/OFF/AUTO pilot switch
Air-Add Solenoid OPEN/AUTO/CLOSED pilot switch
Air-Vent Solenoid OPEN/AUTO/CLOSED pilot switch
Alarm Horn SILENCE
Alarm RESET

The OPEN/AUTO/CLOSED switches shall be spring return to center (AUTO) position.

Status Indicators

Control Power ON pilot light (white)
Compressor No. 1 RUN pilot light (Red)
Compressor No. 1 Elapsed Time Meter
Compressor No. 2 RUN pilot light (Red)
Compressor No. 2 Elapsed Time Meter
Air-Add Solenoid OPEN/CLOSED pilot light
Air-Vent Solenoid OPEN/CLOSED pilot light

Fault/Alarm Indicators

Compressor No. 1 FAIL pilot light (amber)
Compressor No. 2 FAIL pilot light (amber)
Tank Level HIGH pilot light (amber)
Tank Level LOW pilot light (amber)
System FAULT Alarm Beacon
System FAULT Alarm Horn

2.4.4 Functional Requirements

Continuously RUN the compressor whenever the associated HAND/OFF/AUTO switch is in the HAND position. STOP the compressor whenever the HAND/OFF/AUTO switch is in the OFF position.

Maintain the air pressure contained within the receiver within an adjustable limit (HIGH/LOW) by operating the air compressors selected for AUTO operation. Alternate between the compressors whenever both are

selected for AUTO operation. Run the LEAD compressor whenever the air pressure falls below the LOW set point value. Continue running the compressor until the air pressure exceeds the HIGH set point value.

Maintain the Air-Add or Air-Vent solenoids OPEN whenever the associated OPEN/AUTO/CLOSED switch is in the OPEN position. Maintain the Air-Add or Air-Vent solenoids CLOSED whenever the associated OPEN/AUTO/CLOSED switch is in the CLOSED position.

In AUTOMATIC mode, operate the Air-Add or Air-Vent solenoids to maintain the hydropneumatic water level and charge pressure to adjustable set point values.

OPEN the Air-Add solenoid whenever the following conditions exist:

Tank pressure is below the pressure set point value.
Tank water level is above the level set point value.

OPEN the Air-Vent solenoid whenever the following conditions exist:

Tank pressure is above the pressure set point value.
Tank water level is below the level set point value.

In AUTOMATIC mode, operate the compressors in an alternating, LEAD/LAG fashion to maintain the pressure in the air receiver within an adjustable range. When in 'ALT' mode, automatically alternate the LEAD compressor whenever both have STOPPED.

Activate the alarm beacon and horn whenever any of the following conditions occur:

High water level alarm.
Low water level alarm.
General compressor failure alarm (combined fail to start, low oil pressure, and high air temperature alarms).

Provide an independent discrete contact output for remote indication for each event.

2.4.5 Special Requirements

Provide and install an appropriately-sized combination Full-Voltage Non-Reversing (FVNR) motor starter for each compressor.

Provide and install a two-wire RF admittance type level element and transmitter with the following attributes:

4 to 20 mA signal, 13 to 30 Vdc, analog power requirement.
600 ohms maximum load resistance at 24 Vdc analog.
Accuracy plus or minus 1 percent of span.
Response time of 1 to 90 seconds programmable damping time.
NEMA 4X transmitter enclosure rating.
Direct acting/reverse acting fail safe.
Configurable using HART® protocol.

Mount the assembly with the element housed in a stilling well connected to the hydropneumatic tank. The unit shall be Drexelbrook Universal III™, or equal.

2.5 TOOL AND SPARE PARTS

Supply the air compressor with the following spare parts and special tools if required for the normal operation and maintenance of the unit:

a. Special tools if required.
b. One complete set of gaskets.
c. Two inlet filter elements.
d. Two oil filters.
e. One set of v-belts.

Pack all spare parts in containers clearly marked with their contents; duplicate parts shall be interchangeable.

Include in parts list and instructions an itemized list of all spare parts.

PART 3 EXECUTION

3.1 INSTALLATION

Install as shown and in compliance with manufacturer's instructions. Provide anchor bolt template and stainless steel fusion-bonded coated cast-in-place anchor bolts. Provide support for attached piping and accessories. Provide the initial charge of compressed air with portable compressor for testing and startup, unless directed by the Contracting Officer otherwise.

3.2 AIR PIPING PRESSURE TESTING

Conduct leak test on air supply piping shown on the drawings according to Section 33 11 00 WATER DISTRIBUTION.

3.3 OPERATIONS AND MAINTENANCE

provide operations and maintenance requirements as specified in Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

3.4 FORMS

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

_____ Installed in accordance with Manufacturer's recommendations.

_____ Inspected, checked, and adjusted.

_____ Serviced with proper initial lubricants.

_____ Electrical and mechanical connection meet quality and safety standards.

_____ All applicable safety equipment has been properly installed.

_____ System has been performance tested, and meets or exceeds specified performance requirements (when complete system of one manufacturer).

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment, and (iii) authorize the make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer: _____

By Manufacturer's Authorized Representative:

_____
(Authorized Signature)

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION TESTING AND INSTRUCTION

OWNER

PROJECT

CONTRACT NO.

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

_____
(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

Installed for the subject project has have been installed in a satisfactory manner, has have been satisfactorily tested, is/are ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the units on Date:

_____ Time: _____.

CERTIFIED BY: _____ DATE: _____
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGEMENT OF MANUFACTURER'S INSTRUCTION

I/We the undersigned, authorized representatives of the _____ and/or Plant Operating Personnel have received classroom and hands on instruction on the operation, lubrication, and maintenance of the subject equipment and am are prepared to assume normal operational responsibility for the equipment:

_____ DATE: _____

_____ DATE: _____

_____ DATE: _____

-- End of Section --

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SECTION 23 00 00

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS

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 A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 924/A 924M	(2009a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 117	(2009) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM B 766	(1986; R 2008) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C 553	(2008) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM D 1654	(2008) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 3359	(2009) Measuring Adhesion by Tape Test
ASTM D 520	(2000; R 2005) Zinc Dust Pigment
ASTM E 84	(2009c) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2007; Errata 2008) Standard for Motors and Generators
NEMA MG 11	(1977; R 2007) Energy Management Guide for Selection and Use of Single Phase Motors

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1650	(1998) Seismic Restraint Manual Guidelines for Mechanical Systems, 2nd Edition
SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition

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

40 CFR 82	Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 6	(2007) Standard for Electrical Rigid Metal Conduit-Steel
UL Bld Mat Dir	(2009) Building Materials Directory

1.2 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 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

Grilles
Air Conditioning Unit

SD-06 Test Reports

Performance Tests; G

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions
Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

Air Conditioning Unit

1.4 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.

1.4.1 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 A 123/A 123M for exterior locations and cadmium-plated in conformance with ASTM B 766 for interior locations.

1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.4.3 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.

1.4.4 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

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 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. "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. 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 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 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL. 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. 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.

2.3 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.

2.4 SEISMIC ANCHORAGE

Anchor equipment in accordance with applicable seismic criteria for the area and as defined in SMACNA 1650

2.5 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.

2.6 DUCT SYSTEMS

2.6.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification .

a. Provide square elbows with factory fabricated turning vanes.

b. Provide ductwork that meets the requirements of Seal Class A.

c. Choose sealants from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Ensure sealants 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 E 84.

2.6.2 Grilles

Provide factory-fabricated units of steel or aluminum that distribute the specified quantity of air evenly over space intended. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance.

2.6.2.1 Grilles

Provide units that are directional-control type, except provide return grilles that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Install grilles at least 6 inches below the ceiling unless otherwise indicated.

2.7 AIR SYSTEMS EQUIPMENT

2.7.1 Air Conditioning Unit

Provide air conditining unit as specified in 23 81 00.00 20 UNITARY AIR CONDITIONING EQUIPMENT.

2.8 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A 123/A 123M or ASTM A 924/A 924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. 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 D 520 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 paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

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).

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 Condensate Drain Lines

Provide water seals in the condensate drain from allunits. 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 sanitary waste system using an indirect waste fitting.

3.2.2 Equipment and Installation

Mount air conditioning unit as indicated. Anchor and fasten as recommended in manufacturer's published installation instructions.

3.2.3 Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified.

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 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.

3.3 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.

3.4 CLEANING

Thoroughly clean surfaces of 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. 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.

3.5 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. Build framed, prepared openings for square or rectangular 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. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C 553, 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 A 53/A 53M, Schedule 20.

b. Framed Prepared Openings: Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

c. 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 square and rectangular ducts 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.

3.6 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.

3.6.1 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 00.00 98 PAINTING AND COATING.

3.7 PERFORMANCE TESTS

Test the 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 1 day for the 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 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.

3.8 CLEANING AND ADJUSTING

Inside of air conditioning unit, 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 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.

3.9 OPERATION AND MAINTENANCE

3.9.1 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

3.9.2 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 2 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.

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UNITARY AIR CONDITIONING 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.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI DCUP	(Online) Directory of Certified Unitary Products
ANSI/AHRI 210/240	(2008) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 340/360	(2004) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2007; Std 15 Errata 2007, 2009, & Addenda a-f & h; Std 34 Errata 2007, 2008, Addenda a-v, x-ae) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 52.2	(2007; Addenda B 2008; Errata 2009) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 90.1 - IP	(2007; Supplement 2008; Errata 2009; Errata 2009; INT 1-3 2009) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM B 117	(2009) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM D 1654	(2008) Evaluation of Painted or Coated Specimens Subjected to Corrosive

Environments

ASTM F 1040	(1987; R 2007) Standard Specification for Filter Units, Air Conditioning, Viscous - Impingement and Dry Types, Replaceable

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS OO-A-373	(Rev D) Air Conditioners, Single Package Type

UNDERWRITERS LABORATORIES (UL)

UL 873	(2007; R 1995 thru 2010) Standard for Temperature-Indicating and -Regulating Equipment
UL 900	(2004; R 1995 thru 2009) Standard for Air Filter Units

1.2 RELATED REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS, applies 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 Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Air conditioners

Submit documentation for Energy Star qualifications or meeting FEMP requirements. Indicate Energy Efficiency Rating.

Thermostats

SD-06 Test Reports

Salt-spray tests

Start-up and initial operational tests

SD-08 Manufacturer's Instructions

Air conditioners

Filters

Thermostats

Posted Operating Instructions

SD-10 Operation and Maintenance Data

Air conditioners, Data Package 3

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 QUALITY ASSURANCE

1.4.1 Modification of References

Accomplish work in accordance with the referenced publications, except as modified by this section. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to "the Authority having jurisdiction," "the Administrative Authority," "the Owner," or "the Design Engineer" to mean the Contracting Officer.

1.4.2 Safety

Design, manufacture, and installation of unitary air conditioning equipment shall conform to ANSI/ASHRAE 15 & 34.

1.4.3 Posted Operating Instructions

Submit posted operating instructions for each packaged air conditioning unit.

1.4.4 Sizing

Size equipment based on Design Manual CS from the Air Conditioning Contractors of America; do not oversize.

1.5 REFRIGERANTS

Refrigerants shall have an Ozone Depletion Factor (ODF) of 0.05 or less. The ODF shall be in accordance with the "Montreal Protocol On Substances That Deplete The Ozone Layer," September 1987, sponsored by the United Nations Environment Programme. CFCs and Halons shall not be permitted. Refrigerant shall be an approved alternative refrigerant per EPA's Significant New Alternative Policy (SNAP) listing.

PART 2 PRODUCTS

2.1 AIR CONDITIONERS

2.1.1 Single Package Type

FS OO-A-373, except as modified herein; Type SP-A, Style B, Class 1. Additional requirements for various system components are specified in this article; however, the basic requirements for the system and system components are contained in FS OO-A-373. Provide factory packaged combination heating and cooling units. Provide units suitable for roof top installation. Provide units with suitable lifting attachments, roof curb

and flashing. Minimum energy efficiency shall be in accordance with ASHRAE 90.1 - IP, at a minimum. Units shall have a minimum SEER of 11 when tested in accordance with ANSI/AHRI 210/240 or ANSI/AHRI 340/360 as applicable. List units with capacities smaller than 135,000 Btu/hr in the AHRI DCUP; in lieu of listing in the ARI Directory, a letter of certification from ARI that the units have been certified and will be listed in the next Directory will be acceptable. Provide capacity, electrical characteristics, and operating conditions as indicated.

2.1.2 Single Zone Units

Provide single zone type units arranged to draw or blow through coil sections. Air may be blown or drawn through heating section.

2.1.3 Heaters

Provide as an integral part of the evaporator-blower unit. Provide electric open coils.

2.1.4 Compressors

Provide compressors with devices to prevent short cycling when shut down by safety controls. Device shall delay operation of compressor motor for at least 3 minutes but not more than 6 minutes. Provide reciprocating compressors with crankcase heaters in accordance with the manufacturer's recommendations.

2.1.5 Coils

On coils with all-aluminum construction, provide tubes of aluminum alloy 1100, 1200, or 3102; provide fins of aluminum alloy 7072; and provide tube sheets of aluminum alloy 7072 or 5052.

2.1.6 Condenser Controls

Provide start-up and head pressure controls to allow for system operation at ambient temperatures down to 40 degrees F.

2.1.7 Fans

Provide belt-driven evaporator fans with adjustable pitch pulleys; except for units less than 5 ton capacity, direct drive with at least two speed taps may be used. Select pulleys at approximately midpoint of the adjustable range.

2.1.8 Filters

Provide filters of the type specified in this section.

2.1.9 Thermostats

Provide adjustable type that conforms to applicable requirements of UL 873. Provide combination heating-cooling type with contacts hermetically sealed against moisture, corrosion, lint, dust, and foreign material. Design to operate on not more than 1.5 degrees Fdifferential and of suitable range calibrated in degrees F. Provide adjustable heat anticipation and fixed cooling anticipation. Provide two independent temperature sensing elements electrically connected to control the compressor and heating equipment, respectively. Accomplish manual switching for system changeover from

heating to cooling or cooling to heating and fan operation through the use of a thermostat subbase. Provide system selector switches to provide "COOL" and "OFF" and "HEAT" and fan selector switches to provide "AUTOMATIC" and "ON." Provide relays, contactors, and transformers located in a panel or panels for replacement and service.

2.1.9.1 Cooling

a. When thermostat is in "COOL" position with fan selector switch in "AUTO" position, compressor, evaporator fan, and condenser fan shall cycle together.

b. When thermostat is in "COOL" position with fan selector switch in "ON" position, compressor, and condenser fan shall cycle together and evaporator fan shall run continuously.

2.1.9.2 Heating

a. When thermostat is in "HEAT" position with fan selector switch in "AUTO" position, heater and supply air fan shall cycle together. Provide a separate thermostat to keep the fan running until the heater cools.

b. When thermostat is in "HEAT" position with fan selector switch in "ON" position, heater shall cycle and supply air fan shall run continuously.

2.1.9.3 Supply Air Fan

a. When fan selector switch is in "AUTO" position with thermostat in "OFF" position, fan shall not run.

b. When fan selector switch is in "ON" position, fan shall run continuously.

2.2 FILTERS

Provide filters to filter return air and locate as indicated. Provide replaceable (throw-away) type. Filters shall conform to UL 900, Class 1.

2.2.1 Replaceable Type Filters

ASTM F 1040 throw-away frames and pleated media, standard dust holding capacity, 500 fpm maximum face velocity, and one inch thick. Filters shall have a minimum efficiency reporting value (MERV) of 6 when tested in accordance with ASHRAE 52.2.

2.3 FINISHES

Provide steel surfaces of equipment including packaged terminal units, heat pumps, and air conditioners, that do not have a zinc coating conforming to ASTM A 123/A 123M, or a duplex coating of zinc and paint, with a factory applied coating or paint system. Provide a coating or paint system on actual equipment identical to that on salt-spray test specimens with respect to materials, conditions of application, and dry-film thickness.

2.4 SOURCE QUALITY CONTROL

2.4.1 Salt-Spray Tests

Salt-spray test the factory-applied coating or paint system of equipment including packaged terminal units, heat pumps, and air conditioners in accordance with ASTM B 117. Conduct test for 500 hours for equipment installed outdoors, or 125 hours for equipment installed indoors. Test specimens shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, evaluate and rate the coating or paint system in accordance with procedures A and B of ASTM D 1654. Rating of failure at the scribe mark shall not be less than six, average creepage not greater than 1/8 inch. Rating of the unscribed area shall not be less than 10, no failure.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

Install equipment and components in a manner to ensure proper and sequential operation of equipment and equipment controls. Install equipment not covered in this section, or in manufacturer's instructions, as recommended by manufacturer's representative. Provide proper foundations for mounting of equipment, accessories, appurtenances, piping and controls including, but not limited to, supports, vibration isolators, stands, guides, anchors, clamps and brackets. Foundations for equipment shall conform to equipment manufacturer's recommendation, unless otherwise indicated. Set anchor bolts and sleeves using templates. Provide anchor bolts of adequate length, and provide with welded-on plates on the head end embedded in the concrete. Level equipment bases, using jacks or steel wedges, and neatly grout-in with a nonshrinking type of grouting mortar. Locate equipment to allow working space for servicing including shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead lines. Provide electric isolation between dissimilar metals for the purpose of minimizing galvanic corrosion.

3.1.1 Unitary Air Conditioning System

Install as indicated, in accordance with requirements of ANSI/ASHRAE 15 & 34, and the manufacturer's installation and operational instructions.

3.2 AIR FILTERS

Allow access space for servicing filters. Install filters with suitable sealing to prevent bypassing of air.

3.3 FIELD QUALITY CONTROL

3.3.1 Start-Up and Initial Operational Tests

Test the air conditioning systems and systems components for proper operation. Adjust safety and automatic control instruments as necessary to ensure proper operation and sequence. Conduct operational tests for not less than 8 hours.

3.3.2 Performance Tests

Upon completion of evacuation, charging, startup, final leak testing, and proper adjustment of controls, test the systems to demonstrate compliance with performance and capacity requirements. Test systems for not less than 8 hours, record readings hourly. At the end of the test period, average the readings, and the average shall be considered to be the system performance. Record the following readings:

Return air temperature
Supply air temperature
Air temperature inside pump building
Ambient air temperature (outside pump building)

3.4 WASTE MANAGEMENT

Separate waste in accordance with the Waste Management Plan, placing copper materials in designated areas for reuse. Close and seal tightly all partly used adhesives and solvents; store protected in a well-ventilated, fire-safe area at moderate temperature.

-- End of Section --

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DIVISION 26 - ELECTRICAL

SECTION 26 00 00.00 20

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SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS

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 709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006; Errata 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48 2009) National Electrical Safety Code
IEEE C57.12.28	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

1.2 RELATED REQUIREMENTS

This section applies to certain sections of Division 02, EXISTING CONDITIONS. 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. This section has been incorporated into, and thus, does not apply to, and is not referenced in the following sections.

Section 26 12 19.00 40 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION

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 Std 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.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 13.8 kV primary, three phase, three wire, 60 Hz, and 480Y/277 volts secondary, three phase, four wire. Final connections to the power distribution system at the existing manhole shall be made by the Contractor as directed by the Contracting Officer.

1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.5.1 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.

1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

1.6 QUALITY ASSURANCE

1.6.1 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.

1.6.2 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.

1.6.2.1 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.

1.6.2.2 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.

1.7 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.

1.8 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.

1.9 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.

1.10 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections 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. 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.

1.11 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear 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 and pad-mounted SF6 switches, 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.

1.12 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.13 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 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 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.

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3.10 FIELD TESTING

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SECTION 26 05 00.00 40

COMMON WORK RESULTS FOR ELECTRICAL

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

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 480	(1981) Toggle Switches

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.28	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2003; R 2004) Standard for Accessible and Usable Buildings and Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA KS 1	(2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA RN 1	(2005) Standard for Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2003) Standard for Electrical Polyvinyl Chloride (PVC) Tubing and 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 6	(2002; R 2008) Standard for Wiring Devices - Dimensional Requirements
NEMA Z535.1	(2006) Standard for Safety Colors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 70E	(2009; Errata 2009) Standard for Electrical Safety in the Workplace

UNDERWRITERS LABORATORIES (UL)

UL 506	(2000; Rev thru May 2006) Standard for Specialty Transformers
UL 6	(2007) Standard for Electrical Rigid Metal Conduit-Steel
UL 651	(2005; R 2006 thru 2008) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
UL 797	(2007) Standard for Electrical Metallic Tubing -- Steel

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-01 Preconstruction Submittals

Submit Material, Equipment, and Fixture Lists for the following:

Conduits, Raceway sand Fittings
Wire and Cable
Splices, Connectors and Insulating Methods
Switches
Receptacles
Pull and Junction Boxes and Equipment Cabinets; G

SD-02 Shop Drawings

Field Fabricated Nameplates; G
Include specific text for each nameplate.

SD-03 Product Data

Submit manufacturer's technical data sheets for the following items:

Conduits, Raceways and Fittings; G
Wire and Cable; G
Splices, Connectors and Insulating Methods; G
Switches
Receptacles
Lamps and Lighting Fixtures
Dry-Type Distribution Transformers
Pull and Junction Boxes and Equipment Cabinets; G

SD-06 Test Reports

Continuity Test; G
Phase-Rotation Tests; G
Insulation Resistance Test; G

SD-08 Manufacturer's Instructions

Dry-Type Distribution Transformers; G

1.3 PREVENTION OF CORROSION

Protect metallic materials against corrosion. Provide equipment enclosures with the standard finish by the manufacturer when used for most indoor installations. Do not use aluminum when in contact with earth or concrete and, where connected to dissimilar metal, protect by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

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 Std 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.

1.5 GENERAL REQUIREMENTS

Submit Material, Equipment, and Fixture Lists for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Manufacturer's Instructions shall include special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

1.6 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.

1.7 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide field fabricated nameplates of laminated plastic for each equipment enclosure, switch, and device; as specified in the technical sections 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. 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. Nameplates shall have beveled edges and shall be fastened to equipment with stainless steel screws.

Provide the following information on each nameplate:
Line 1: Equipment Name
Line 2: Equipment Ratings - Voltage, Phases and Wires, Amperage
Line 3: Supplying Source Information including circuit number, if applicable.

1.8 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including pad-mounted transformers, pad-mounted and SF6 vault style switches 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 and pad-mounted and vault style SF6 switches, 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.

b. Provide arc-flash labels for all equipment required by NFPA 70 and NFPA 70E in accordance with Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

2.1.1 Rigid Steel Conduit

Rigid steel conduit shall comply with UL 6 and be galvanized by the hot-dip process. Rigid steel conduit shall be polyvinylchloride (PVC) coated in accordance with NEMA RN 1, where underground and in corrosive areas, or must be painted with bitumastic.

Fittings for rigid steel conduit shall be threaded.

Provide fittings, conduit bodies, bushings, locknuts and supports

constructed of hot dipped galvanized malleable iron or steel.

Gaskets shall be solid. 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.

Provide fittings, conduit bodies, bushings, locknuts and supports constructed of hot dipped galvanized malleable iron or steel.

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 AWG No. 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.

2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be in accordance with UL 797 and be zinc coated steel. Couplings and connectors shall be zinc-coated, raintight, gland compression with insulation throat. Crimp, spring, or setscrew type fittings are not acceptable.

2.1.3 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall comply with NEMA TC 2 and NEMA TC 3 with wall thickness not less than Schedule 40. Welding cement shall be less than 1-year old.

2.1.4 Plastic Conduit for Direct Burial

UL 651,Schedule 40 or Schedule 80 as indicated.

2.2 WIRE AND CABLE

Conductors installed in conduit shall be copper 600-volt type THHN/THWN. All conductors AWG No. 8 and larger, shall be stranded. All conductors smaller than AWG No. 8 shall be solid.

Equipment grounding conductors installed in PVC conduit shall be bare copper.

2.3 SPLICES, CONNECTORS and INSULATING METHODS

Make all splices in AWG No. 8 and larger with indentor crimp-type connectors. Above-ground joints shall be 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, 1-hole or 2-hole as required, standard barrel 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.

Underground insulation methods in manholes or hand-holes shall be utilize resin type, cold shrink, or heat shrink type insulation suitable for submersible wet location installations.

2.4 SWITCHES

2.4.1 Safety Switches

Safety switches shall comply with NEMA KS 1, and be the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, when the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and be so constructed that an external tool shall be used to open the cover. Make provisions to lock the handle in the "OFF" position, but the switch shall not be capable of being locked in the "ON" position.

Provide switches of the quick-make, quick-break type. Approve terminal lugs for use with copper conductors.

Safety color coding for identification of safety switches shall conform to NEMA Z535.1.

2.4.2 Toggle Switches

Toggle switches shall comply with EIA 480, control incandescent, mercury, and fluorescent lighting fixtures and be of the heavy duty, general purpose, noninterchangeable flush-type.

Toggle switches shall be commercial grade toggle type, single-pole, or two-position devices rated 20 amperes at 277 volts, 60 hertz alternating current (ac) only.

All toggle switches shall be products of the same manufacturer.

2.5 RECEPTACLES

Receptacles shall be commercial grade, 20A, 125 VAC, 2-pole, 3-wire duplex conforming to NEMA WD 6, NEMA 5-20R.

2.6 PULL AND JUNCTION BOXES AND EQUIPMENT CABINETS

Pull and junction boxes and equipment cabinets installed outdoors shall be NEMA 4X, Type 316 stainless steel with a continuous hinge and clamp cover.

Pull and junction boxes and equipment cabinets installed indoors shall be NEMA 1, galvanized or painted steel, without knock-outs, and with screw-fastened covers.

Cabinet boxes with terminal strips or components installed shall include hinged covers, latch, pad-lock provisions, and interior mounting panel. Cabinets housing meter enclosures shall include an additional hinged mounting panel with securing latches to serve as a dead-front to energized

parts mounted behind; mount meter display and controls on this hinged panel.

2.7 LAMPS AND LIGHTING FIXTURES

All lighting fixtures shall be LED-type lighting fixtures, equivalent to the fixtures specified in the drawings.

Manufacturers and catalog numbers shown are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, are acceptable. Provide lamps of the proper type and wattage for each fixture.

2.8 DRY-TYPE DISTRIBUTION TRANSFORMERS

Submit manufacturer's instructions for Dry-Type Distribution Transformers.

General purpose dry-type transformers with windings 600 volts or less shall be two-winding, 60 hertz, self-cooled in accordance with UL 506. Windings shall be copper and have a minimum of two 2-1/2-percent taps above and below nominal voltage.

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 115 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformer of 115 degrees C temperature rise shall be capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.

Provide NEMA 1 enclosures for indoor installations and NEMA 3R, Type 316 stainless steel enclosures for outdoor installations.

2.9 Specified Transformer Efficiency

Transformers, indicated and specified with: 480V primary, 80 degrees C or 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 15 to 500 for three phase, 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.

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

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 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 or be replaced.

3.1.1 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.

Provide all conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, with a flush coupling when the floor slab is of sufficient thickness. Otherwise,provide a floor box set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

Use grounding type bushings on rigid steel conduit connections to pad-mounted transformers, service equipment, and rigid steel conduit that transitions to rigid nonmetallic conduit; bond bushing using a 4/0 bare stranded copper conductor to the ground grid for the equipment.

3.1.2 Electrical Metallic Tubing (EMT)

EMT shall be grounded in accordance with NFPA 70, using pressure grounding connectors especially designed for EMT.

3.1.3 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 Conduit Cleaning

Existing conduit that is to be re-used shall be thoroughly cleaned before installation of power conductors. A standard flexible mandrel shall be pulled through each conduit to loosen and remove particles of any foreign material in the conduit.

3.2 WIRING

Feeder and branch circuit conductors shall be color coded as follows:

CONDUCTOR	COLOR 480/277VAC	COLOR 208/120VAC
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Neutral	White/Gray	White

Equipment Grounds Green or Bare as indicated for all voltages. Use bare copper equipment ground in rigid nonmetallic conduit.

Conductors up to and including AWG No. 2 shall be manufactured with colored insulating materials. Conductors larger than AWG No. 2 shall have ends identified with color plastic tape in outlet, pull, or junction boxes.

Splice in accordance with the NFPA 70. Splice between transformer secondary winding connections and the first over-current protection device are prohibited unless specifically indicated as required on the drawings. Provide permanent conductor identification within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each

conductor. Terminal and conductor identification shall match as indicated.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.

3.3 SAFETY SWITCHES

Securely fasten switches to the supporting structure or wall, utilizing a minimum of four 1/4 inch bolts. Do not use sheet metal screws and small machine screws for mounting. Do not mount switches in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be 4 feet above floor level, when possible.

3.4 WIRING DEVICES

3.4.1 Wall Switches and Receptacles

Install wall switches and receptacles so that when device plates are applied, the plates will be aligned vertically to within 1/16 inch.

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.4.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets shall be suitably marked, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Required marking shall consist of a self-adhesive label having 1/4 inch embossed letters.

Device plates for convenience outlets shall be similarly marked indicating the supply panel and circuit number.

3.5 BOXES AND FITTINGS

Furnish and install pullboxes where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Securely mount boxes and enclosures to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be in accordance with ICC A117.1 and as follows:

LOCATION	MOUNTING HEIGHT
Receptacles in offices	18 inches
Receptacles in shops & laboratories	48 inches

LOCATION	MOUNTING HEIGHT
Switches for light control	48 inches

3.6 LAMPS AND LIGHTING FIXTURES

Install new lamps of the proper type and wattage in each fixture. Securely fasten fixtures and supports to structural members and install parallel and perpendicular to major axes of structures.

3.7 DRY-TYPE DISTRIBUTION TRANSFORMERS

Connect dry-type transformers with flexible metallic conduit. Securely mount transformers to the building floor or equipment pad. Verify correct output voltage upon energizing.

3.8 IDENTIFICATION PLATES AND WARNINGS

Furnish and install identification plates for lighting and power panelboards. In addition all panelboards must be labeled indicating their voltage and source.

In accordance with Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION, perform fault current study and coordination study of system with selected equipment in order to produce an Arc Flash Study and affix labels to equipment per NFPA 70 110.16 and NFPA 70E.

All field mounted nameplates shall be fastened to equipment using stainless steel screws.

Any equipment with externally powered wiring shall be marked with a laminated plastic nameplate having 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Safety color coding for identification of warning signs shall conform to NEMA Z535.1.

3.9 MANDATORY INSPECTION POINTS (MIPs)

The Contractor shall provide the MIPs in the construction schedule so that arrangements can be made in advance for inspection of equipment prior to energizing. All submittals that require Government approval must be dispositioned as such prior to inspection. Any impacts resulting from the Contractor's inability to meet these requirements will be borne at no additional cost to the Government.

Coordinate with the Contracting Officer to provide MIPs within the contract with appropriate monitoring and scheduling for MIPs. MIPS shall be scheduled anytime a piece of equipment has been installed and is ready for service.

Government is to be notified at least two weeks in advance of planned equipment/system energization.

3.10 FIELD TESTING

Test applicable equipment in accordance with Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

Submit Test Reports in accordance with referenced standards in this section.

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.

Contractor shall provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

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 panel boards, 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 8AWG and smaller insulation resistance testing is not required.

Perform Insulation-Resistance Test on each dry-type transformer with respect to ground. Applied potential shall be 500 volts dc for up to 300 volt rated windings cable and 1000 volts dc for up to 600 volt rated winding. 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 windings and 100 Megohms for 600 volt rated windings.

Perform Continuity Test to insure correct cable connection (i.e correct phase conductor, grounded conductor, and grounding conductor wiring) end-to end. Any damages to existing or new electrical equipment resulting from contractor mis-wiring will be repaired and re-verified at contractor's expense. All repairs shall be approved by the CO prior to acceptance of the repair.

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. Perform and record test results prior to removing or modifying existing equipment and verify previous phase rotation prior to re-connecting existing distribution and utilization equipment.

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 CO.

-- End of Section --

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SECTION 26 05 13.00 98

MEDIUM VOLTAGE CABLE

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 C119.1	(2006) Electric Connectors - Sealed Underground Connector Systems Rated 600

ASTM INTERNATIONAL (ASTM)

ASTM D 746	(2007) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 386	(2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 48	(2009) Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
IEEE Std 404	(2006) Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V Through 500 000 V
IEEE Std 400.2	(2004) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

1.2 DEFINITIONS

Medium voltage power cables means all cables rated above 601 to 35,000 volts.

1.3 GENERAL REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL applies to work 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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Pulling Plan in accordance with the paragraph entitled, " Pulling Cables in Ducts and Manholes," of this section.

Pulling Plan; G

Submit Splicer/Terminator Certification in accordance with paragraph entitled "Qualifications" of this section.

SD-03 Product Data

Provide manufacturer's catalog data for the following items:

Cable Supports and Fittings; G

Cable Tags; G

Fireproof Tape; G

Splice Kits; G (including splice grounding)

Terminations; G

SD-06 Test Reports

Submit Test Reports in accordance with the paragraph entitled, "Field Testing," of this section.

KSC Medium Voltage Cable Test Form

SD-07 Certificates

Splicer/Terminator Certifications

SD-08 Manufacturer's Instructions

Provide manufacturer's instructions showing the recommended sequence and method of installation for the following:

Terminations; G

Splice Kits; G (including splice grounding)

1.5 QUALIFICATIONS

Verify personnel performing Medium Voltage (MV) splicing or terminations have 5 years minimum experience in cable splicing and 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 or termination of each type required by this contract for each cable splicer. Ensure the certification

identifies which splices and terminations it applies to. If the contractor does not have an individual with the manufacturer's certification as described,make provisions to require each individual, with the required 5 years medium voltage splicing and terminating who is to perform cable splicing or terminating, to perform a minimum of one splice or termination of each type in the presence of the manufacturers' representative. Submit each splice or termination 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 or terminations. Certification is not be required for load break elbows and dead break connectors.

Once a splice or termination has been started by a splicer, ensure the same splicer completes that particular splice, and that each termination and splice is started and completed in one continuous work period.

PART 2 PRODUCTS

2.1 INSULATED MEDIUM VOLTAGE CONNECTORS

IEEE Std 386. Provide connector with a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material Provide connectors as indicated.

a. 200 Ampere loadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 10,000 amperes rms, symmetrical for a time duration of 0.17 seconds.

b. 600 Ampere deadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 27,000 ampere rms, symmetrical for a time duration of 4.0 seconds.

c. Provide a "hot line voltage indicator" on each 600 ampere and 200 ampere terminator test point.

Ensure connections are compatible with equipment bushings.

2.2 SPLICES

Provide Splice kits which are the product of a single manufacturer, either heat shrink or cold shrink, meeting the requirements of the paragraph entitled "Splices and Terminations" under Part 3 of this specification.

2.3 TERMINATIONS

Provide Class 1 terminations per IEEE Std 48.

2.4 CABLE SUPPORTS AND FITTINGS

Provide cable supports, related fittings, and accessories for use in corrosive underground locations, such as manholes, provided with a factory applied coating of polyvinylchloride of at least 20 mils thick. Ensure polyvinylchloride (PVC) coated items have a uniform thickness and are free of blisters, breaks, and holidays. Use PVC compound conforming to ASTM D 746.

Ensure cable racks, rack arms, cable tray supports and related fittings are UL listed heavy-duty nonmetallic glass-reinforced nylon polycarbonate.

On existing galvanized cable racks, rack hooks shall be heavy duty, hot dipped galvanized, with rounded surfaces and the hook insulators shall be white glazed porcelain.

2.5 CABLE TAGS IN MANHOLES AND AT TERMINATIONS

Provide tags for each cable or wire located in manholes and at each termination. Tag all cables indicated to have tags.

2.5.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of4500 pounds per square inch; and that are 0.035-inch thick, non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 300 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 pound. Provide cable tags with block letters, numbers, and symbols1 inch high on a yellow background. Ensure letters, numbers, and symbols do not fall off or change positions regardless of the cable tags orientation.

2.6 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, nor deteriorates when subjected to oil, water, gases, salt water, sewage and fungus.

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 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.

Notify the Contracting Officer 14 working days prior to an outage that requires testing for phasing and phase rotation of 15 KV medium voltage electrical systems. The Institutional Services Contractor will identify and tag the phasing at equipment and will 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 cable in underground duct banks; in conduit above and below grade; inside buildings; by open wire method; on insulator hooks; on racks; in wall and ceiling mounted cable trays; in manholes; and by direct burial.

Cable or conductors of a primary distribution system will be rejected when installed openly in cable trays 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; or in a manner allowing 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.

3.2.2.2 Existing Fiber (Orangeburg) Duct

Push rod through duct. Pull a series of four 2 inch wire brushes back and forth through the duct. Progressively increase the size of the four wire brushes until four 4 inch wire brushes can be pulled back and forth, and all of the debris has been removed. Next pull a flexible mandrel with two 4 inch heavy duty wire brushes on each side through the duct. Ensure mandrel is not less than 12 inches long, and has a diameter that is1/2 inch to 1 inch less than the inside diameter of the duct. Next, pull a 5 foot section of sample cable, equivalent to what is being used. Finally, make the final cable pull on the same day the sample cable was pulled.

3.2.3 Pulling Cables in Ducts and Manholes

Provide a pull rope of plastic or flat pull line (bull line) in ducts, having a minimum tensile strength of 200 pounds.

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 will prevent 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. 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

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.

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.

Minimum bending radius during cable pulling operations is 30 inches. For permanent cable bending/racking the minimum bending radius is 12 times cable diameter.

Liberally coat cables with a suitable cable-pulling lubricant as it enters the tube guide or duct. Do not use grease 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.

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.

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

Make splices in manholes or direct buried cable as shown on the drawings. Make cable terminations at equipment specifically indicated. Expedite splicing and terminating of cables to minimize exposure and cable deterioration.

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 Std 404 for a 15kV rating and is rated by the manufacturer for use on 15 kV class feeder cable systems. Optionally, make the splice of a cold shrink design that does not require any additional heat source for installation. Use a Cold Shrink splice body with a molded design made of silicone rubber, and splice jacketing of a cold shrink EPDM rubber tubing. 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 Std 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 contaminant; physically protecting and supporting cables, and maintaining the insulation level of the cable.

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.

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.

Field fabricate cable splices from pre-molded or 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.

Install cable splices on cable racks or by other approved methods which will minimize 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.

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 in each manhole and at each termination as specified. Install cable tags over the fireproofing and position the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes and equipment.

3.3 FIELD TESTING

After the installation of power cables has been completed, including splices, joints, and terminations, and before the cable is energized, the Contractor shall 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 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 arrangement 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 megohmmeter 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.

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:

(1) Ensure test voltage duration is continuous duty for 30 minutes (non-interrupted)

(2) The Contractor shall provide the test equipment to test the cable capacity in microfarads and record on the KSC Medium Voltage AC Hi-pot test form (VLF).

(3) The Contractor shall 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 (rms voltage, KV)	Acceptance (phase to ground test values) (New cable) (peak voltage, KV)	Acceptance (phase to ground test values) (Existing cable spliced to new cable) (peak voltage, KV)
15	28	22; (EPR TO EPR)
15	15	15; (EPR TO NON-EPR)

(4) Ensure the sinusoidal test frequency is 0.1 Hertz.

Ensure Splices/terminations are clean, dry, and tested per IEEE Std 48 and IEEE Std 400.2.

Perform radiographic tests on all splices/terminations at the discretion of

the Contracting Officer to determine if voids exist in the splices/terminations. Rework unacceptable cable, splices or terminations at no additional expense to the Government.

Notify the Contracting Officer or the Contracting Officer's Technical Representative 48 hours prior to test start. All testing will be witnessed by the Government.

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LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES

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 877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13	(2008) Standard Requirements for Instrument Transformers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA AB 3	(2001) Molded Case Circuit Breakers and Their Application
NEMA C12.1	(2008) Electric Meters; Code for Electricity Metering
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; Errata 2002; R 2005; Errata 2006) Standard for Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 6	(1993; R 2006) Standard for Industrial Controls and Systems Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2008; AMD 1 2008) National Electrical Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 489 (2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

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

Prior to the beginning of construction, submit manufactures equipment and performance data for the following items including use life, system functional flows, safety features, and mechanical automated details.

Fuses

SD-02 Shop Drawings

Submit Connection Diagrams and Fabrication Drawings for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Submit installation drawings for the following items in accordance with the paragraph entitled, "Installation," of this section.

Control Devices
Protective Devices

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.

Circuit Breakers
Control Devices

SD-07 Certificates

Submit certificates for Circuit Tests on similar motor-control or submit motor-circuit protector (MCP) units under actual conditions in lieu of factory tests on the actual units provided. Also include dielectric tests.

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
Protective Devices

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for the following equipment:

Circuit Breakers

1.3 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

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, 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.

PART 2 PRODUCTS

2.1 CIRCUIT BREAKERS

Provide circuit breakers that conform to UL 489, NEMA AB 1, and NEMA AB 3.

2.1.1 Molded-Case Circuit Breakers

Provide molded case, manually operated, trip-free, circuit breakers, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Completely enclose circuit breakers in a molded case, with the calibrated sensing element factory-sealed to prevent tampering.

Locate thermal-magnetic tripping elements in each pole of the circuit breaker, and provide inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection. Provide instantaneous magnetic tripping element, that is adjustable and accessible from the front of the breaker on frame sizes larger than 100 amperes.

Size breaker as required for the continuous current rating of the circuit. Provide breaker class as required.

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. Provide circuit breaker interrupting capacities with a minimum of 10,000 amperes and that conform to NEMA AB 3.

Provide the common-trip type multipole 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 attached where required.

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.

2.1.2 Enclosed Molded-Case Circuit Breakers

For enclosed circuit breakers, provide thermal-magnetic molded-case circuit breakers in surface-mounted, nonventilated enclosures conforming to the appropriate articles of NEMA 250 and NEMA AB 1.

Provide enclosed circuit breakers in nonhazardous locations as follows:

Contain circuit breakers installed inside clean, dry locations in NEMA Type 1, general purpose sheet steel enclosures.

Contain circuit breakers installed in wet locations, in NEMA Type 4, watertight corrosion-resistant stainless steel enclosures constructed to prevent entrance of water.

2.2 FUSES

Provide a complete set of fuses for all switches and switchgear. Rate 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 nonrenewable cartridge type fuses for ratings 30 amperes, 125 volts or less. Provide renewable cartridge type fuses for ratings above 30 amperes 600 volts or less with time-delay dual elements, except where otherwise indicated. Conform to NEMA FU 1 for fuses.

Install special fuses such as extra-high interrupting-capacity fuses, fuses for welding machines, and capacitor fuses where required. Plug fuses are not permitted.

Label fuses showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, clearly list fuse information on equipment drawings.

Provide porcelain 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 for field installation.

2.3 CONTROL DEVICES

2.3.1 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 primary 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.

2.3.2 Control-Circuit Transformers

Provide control-circuit transformers within the enclosure of 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 24-volt) 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 fuses selected in accordance with NEMA ICS 6. Ground secondary winding of the control-circuit transformer in accordance with NEMA ICS 6.

2.3.3 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.

2.3.4 Pushbuttons and Switches

2.3.4.1 Pushbuttons

For pushbuttons for low-voltage ac full-voltage magnetic controllers, provide heavy-duty oiltight NEMA 250, Type 4X, 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.

2.3.4.2 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.

2.4 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.

2.5 FINISH

Protect metallic materials against corrosion. Provide equipment with the standard finish by the manufacturer when used for most 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.

3.2 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 dielectric tests on insulating oil in oil circuit breakers before the breakers are energized. Test oil in accordance with ASTM D 877, and provide breakdown voltage that is not less than 25,000 volts. Provide manufacturer certification that the oil contains no PCB's, and affix a label to that effect on each breaker tank and on each oil drum containing the insulating oil.

Field adjust reduced-voltage starting devices to obtain optimum operating conditions. Provide test meters and instrument transformers that conform to NEMA C12.1 and IEEE C57.13.

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."

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PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

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 A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM D 1535	(2008) 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) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D 924	(2008) Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids
ASTM D 97	(2009) Pour Point of Petroleum Products

FM GLOBAL (FM)

FM P7825b	(2005) Approval Guide Electrical Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006; Errata 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48 2009) National Electrical Safety Code
IEEE C37.90	(2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.12.00	(2006) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.28	(2005) Standard for Pad-Mounted Equipment

- Enclosure Integrity

IEEE C57.12.34 (2004; Errata 2005) Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 2500 kVA and Smaller—High-Voltage: 34 500 GrdY/19 920 Volts and Below; Low Voltage: 480 Volts and Below

IEEE C57.12.80 (2002) Standard Terminology for Power and Distribution Transformers

IEEE C57.12.90 (2006; INT 2009) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE C57.13 (2008) Standard Requirements for Instrument Transformers

IEEE C57.98 (1993; R 1999) Guide for Transformer Impulse Tests

IEEE C62.11 (2005; Amendment A 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

IEEE Std 386 (2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

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 C12.1 (2008) Electric Meters; Code for Electricity Metering

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2008; AMD 1 2008) National Electrical Code - 2008 Edition

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"

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) Standard for Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL 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 Std 100.

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 losses; G

Submit certification from the manufacturer indicating conformance with the paragraph entitled "Specified Transformer Losses."

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); G

Submit operation and maintenance data in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS 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 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

Do not use products manufactured more than 3 years prior to date of delivery to site, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

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, CT's, 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 THREE-PHASE PAD-MOUNTED TRANSFORMERS

IEEE C57.12.34, IEEE C57.12.28 and as specified herein.

2.1.1 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.

2.1.1.1 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, and ground pad.

a. Insulated high-voltage load-break connectors: IEEE Std 386, rated 15

kV, 95 kV BIL. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide a "hot line voltage indicator" on each 200 ampere terminator test point.

b. Bushing well inserts: IEEE Std 386, 200 amperes, 15 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise.

c. 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	

d. Provide bayonet type, oil-immersed, expulsion fuses in series with oil-immersed, current-limiting fuses. 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.

Bayonet fuse assembly: 150 kV BIL.

e. Surge arresters: IEEE C62.11, rated 10 kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide three arresters for loop feed circuits.

f. Parking stands: Provide a parking stand near each bushing well. Provide insulated standoff bushings for parking of energized load-break connectors on parking stands.

g. Protective caps: IEEE Std 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.

2.1.1.2 Low Voltage

Low-voltage compartment shall contain low-voltage bushings with NEMA spade terminals, accessories,CT's for metering, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

a. The low voltage bushings shall be equipped with removable 600 volt insulating covers molded from one piece EPDM rubber.

b. Accessories shall include drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

c. Current transformers: IEEE C57.13. Provide butyl-molded window type multi-ratio current transformers with 1.2 kV insulation, 30 kV BIL. Refer to Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Provide the appropriate current transformer (CT) as indicated on the drawings.

2.1.2 Multi-Function Circuit Monitor

Multi-function circuit monitor shall be Square-D CM-3250 with display, having the features and functions specified below. Each meter shall be provided with an Ethernet Communication Card (ECC) for communications as shown on the drawings. The device shall be UL recognized, CSA certified and also meet IEEE C37.90. Provide a NEMA 4X type 316 stainless steel enclosure for installing the circuit monitor in accordance with Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

2.1.2.1 Monitoring Functions

The device shall provide direct reading metered or calculated values of the items listed below and shall auto range between units, kilo-units, and mega-units for all metered values. Unit shall meet or exceed accuracy listed below. Accuracy indicated below to be of read or calculated values.

AC Amperes in each phase,0.2 percent accuracy.
AC Voltage, phase-to-phase, phase-to-neutral, 0.2 percent accuracy.
Watts, 0.2 percent accuracy.
Vars, 0.2 percent accuracy.
Power Factor, 0.2 percent accuracy.
Frequency, 0.2 percent accuracy.
Watt Demand (5, 10, 15, 30 minutes interval programmable or from

utility synchronizing pulse), 0.2 percent accuracy.
Watt Hours, 0.2 percent accuracy.
THD
Waveform Capture

2.1.2.2 Protective Functions

Protective Functions: Voltage phase loss, if any phase RMS is less than 50 percent of the nominal line voltage.

Current phase loss, if the smallest phase value is less than 1/16 of the largest phase value.

Line voltage phase unbalance, selectable from 5 to 40 percent of nominal in 5 percent increments.

Voltage phase reversal.

Overvoltage, selectable from 105 to 140 percent in 5 percent increments.

Under voltage, selectable from 95 to 60 percent in 5 percent increments.

Time delay (adjustable from 0 to 8 seconds in 1 second intervals) for overvoltage, undervoltage, and phase unbalance trip and alarm settings.

2.1.2.3 Inputs

Input ranges of the device shall accommodate external current transformers with ranges from 100/5 through 5000/5 amperes. Potential input transformer ratios shall be field settable. Synchronous pulse input shall be provided and when activated shall override the preset watt demand interval and let the utility control the demand window.

2.1.2.4 Outputs

Outputs shall have separate trip and alarm contacts with ratings of 10 amperes at 115/240 volts AC or 30 volt DC resistive. The contacts shall be Form C (NO/NC). In addition, provide a separate Form C (NO/NC) contact to provide a kilowatthour pulse output. KWH/pulse shall be field programmable. Provide communication output compatible with Square D "Powerlogic" communication system.

2.1.2.5 Test Blocks

Provide 10 pole current and potential test block, General Electric Type PK or Westinghouse Type FT in line after the circuit monitor for additional metering or testing.

2.1.3 Transformer

a. Less-flammable liquid-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type. Windings shall be copper.

b. Transformer shall be rated per transformer schedule as indicated on drawings. BIL rating shall be 95 kV.

c. Transformer voltage ratings per transformer schedule as indicated on drawings.

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 shall not be less than 5.5 percent or more than 6.0 percent at 85 degrees C on Three-Phase tranformers.

f. Audible sound levels shall comply with the following:

kVA	DECIBELS (MAX)
75	51
112.5	55
150	55
225	55
300	55
500	56
750	57
1000	58
1500	60

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.

2.1.3.1 Specified Transformer Losses

No-load losses (NLL) 300kVA and 500kVA units shall be 1363 watts at 20 degrees C and load losses (LL) shall be 8539 watts at 85 degrees C. Use the values for the specified losses for comparison with the losses determined during the routine tests. If the routine test values for no-load losses exceed the specified no-load losses by more than 10 percent, or the total losses exceed the specified total losses (sum of no-load and load losses) by more than 6 percent, the transformer is unacceptable.

2.1.4 Insulating Liquid

a. Less-flammable transformer liquids: NFPA 70 and FM P7825b 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.

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 percent

3. Trout toxicity: OECD Test 203, zero mortality of EPA 600/4-90/027F, pass

2.1.4.1 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.

2.1.5 Corrosion Protection

Entire transformer assembly, including tank and radiator, base, enclosure, and metering enclosure shall be fabricated of stainless steel conforming to ASTM A 167, Type 304 or 304L. Form enclosure of stainless steel sheets. Paint entire transformer assembly 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. After the final coating, on the bottom and bottom of sides up to 6 inches, a rubberized or coal tar protective coating at least 1/32 inch thick shall be applied on top of the final coating.

2.2 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.

Provide an arc-flash warning label for the enclosure of pad-mounted transformers. Locate this self-adhesive warning label on the outside of the high voltage compartment door warning of potential electrical arc flash hazards and appropriate PPE required. The required detailed label format and associated power system analysis required for determining arc flash hazard shall be per Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION.

2.3 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL and 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.4 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.

2.4.1 Pad-mounting Provisions

Provide a suitable concrete pad for the installation of the transformer. Enclosure base shall include any part of the switchgear enclosure that is within 3 inches of concrete pad.

2.5 SOURCE QUALITY CONTROL

2.5.1 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.

2.5.2 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.

2.5.3 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

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION. 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 AWG #4/0 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 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467 and NFPA 70, 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

NEMA C12.1.Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters. Provide three multi-ratio current transformers per power transformer with characteristics as indicated on the drawings. Meters shall be mounted as indicated on the drawings.

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 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount transformer on concrete slab. Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9

mesh, placed uniformly 4 inches from the top of the slab. Place the slab on a 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately 4 inches above finished grade with gradual slope for drainage. Edges above grade shall have 1/2 inch chamfer. Slab shall be of adequate size to project at least 8 inches beyond the equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.6 FIELD QUALITY CONTROL

3.6.1 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.

3.6.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

1. Compare equipment nameplate information with specifications and approved shop drawings.

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, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

4. Verify correct liquid level in tanks.

5. Perform specific inspections and mechanical tests as recommended by manufacturer.

6. Verify correct equipment grounding.

7. Verify the presence of transformer surge arresters.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

2. Verify that the tap-changer is set at specified ratio.

3. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

4. Perform insulation resistance tests on transformer windings using a 5000 volt test set. Readings shall be conducted every 15 seconds for the first minute and every minute thereafter for 10 minutes. Resistance between phase conductors and ground shall be no less than 125 megohms.

5. Perform insulation power factor (Doble) tests on transformer

windings in accordance with IEEE C57.12.90. Insulation power factor shall not exceed 0.5 percent.

c. Insulating liquid tests

1. Perform dielectric test in accordance with ASTM D 877. Breakdown voltage shall not be less than 33,000 volts.

2. Perform power factor tests per ASTM D 924 at 20 degrees C. Results shall not be greater than 0.5 percent at 20 degrees C.

3.6.1.2 Current Transformers

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify correct connection.

4. Verify that adequate clearances exist between primary and secondary circuit.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Verify that required grounding and shorting connections provide good contact.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2. Perform insulation-resistance test.

3. Perform a polarity test.

4. Perform a ratio-verification test.

3.6.1.3 Multi-Function circuit monitor

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify tightness of electrical connections.

b. Electrical tests

1. Verify that correct multiplier has been been programmed into the circuit monitor, where applicable.

2. Verify that current transformer secondary circuits are intact.

3.6.1.4 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.

3.6.2 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 --

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SECTION 26 13 00.00 20

SF6 INSULATED SWITCHGEAR

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 C37.72	(1987) Standard for Manually-Operated Dead-Front Pad Mounted Switchgear with Load Interrupting Switches and Separable Connections for Alternating-Current Systems

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM D 2472	(2000; R 2006) Standard Specification for Sulphur Hexafluoride

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006; Errata 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48 2009) National Electrical Safety Code
IEEE C37.60	(2003) Standard Requirements for Overhead, Pad-mounted Dry-Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Systems Up To 38kV
IEEE C57.12.29	(2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C62.11	(2005; Amendment A 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE Std 386	(2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing

Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-111	(2005) High Voltage Switchgear And Controlgear Part 111: Overhead, Pad-Mounted, Dry Vault, And Submersible Automatic Circuit Reclosers And Fault Interrupters For Alternating Current Systems Up To 38 Kv

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C37.72	(1987) Manually-Operated, Dead-Front Padmounted Switchgear with Load Interrupting Switches and Separable Connectors for Alternating-Current Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 70B	(2006; Errata 2007) Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Standard for Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL apply to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

1.3.1 Switched Way

A switched way is considered a three-phase circuit entrance to the bus through a switch. For single-phase switches, it is a single-phase entrance to the bus through a switch.

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

Switchgear Drawings; G including the following:

Nameplate Diagram; G

Single-Line Diagram; G for switch

Connection Diagram; G for overcurrent protection including CT/PT wiring, auxiliary power supplies, if any

Outline Drawing; G, showing plan and elevation views, with complete dimensions

Time-current coordination curves; G for all available trip settings, plotted on standard log-log coordination paper

SD-03 Product Data

Electronic Overcurrent Control Curves; G

SF6 Insulated Pad-mounted Switchgear; G

Insulated High-Voltage Connectors; G

Surge Arresters; G

Accessories; G

Vacuum Interrupters; G

Electronic Trip Units; G

Switch Enclosures; G, including material composition

Equipment Finish; G Paint Coating System - material and application description

Remote Operators

Each submittal shall include data on switches and associated accessories. Each submittal shall include manufacturer's information for each component, device and accessory provided with the equipment.

SD-06 Test Reports

Acceptance Checks and Tests; G

Switchgear design and production tests reports for switches shall be submitted and shall be in accordance with IEEE C37.60 and ANSI C37.72.
Basic Impulse Level (BIL)
One Minute Withstand Rating
Momentary and Fault Closing Rating, Asymmetrical and Symmetrical
Mechanical Operational Check
Leak Tests

SD-07 Certificates

Paint Coating System; G

SD-09 Manufacturer's Field Reports

Switchgear Acceptance Checks and Tests; G

SD-10 Operation and Maintenance Data

O&M Data shall include
Wiring Diagrams
Maintenance and testing schedules
Recommended Spare Parts List

SF6 Insulated Pad-mounted Switchgear Operation and Maintenance; G

SF6 Insulated Pad-mounted Switchgear; G

Accessories; G

Vacuum Interrupters; G

Electronic Trip Units; G

Installation Manual; G

Once equipment is approved and at least 30 days prior to field testing, request trip unit settings from the Government.

1.5 QUALITY ASSURANCE

1.5.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

a. Overall dimensions, weights, plan view, and front view

b. Ratings

c. Nameplate Diagram

d. Single-Line Diagram for switch.

e. Connection Diagram for overcurrent protection including CT/PT wiring, auxiliary power supplies, if any.

f. Outline Drawing, showing plan and elevation views, with complete dimensions.

g. Time-current coordination curves for all available trip settings, plotted on standard log-log coordination paper.

1.5.2 Paint Coating System

Submit IEEE C57.12.29 paint coating system performance requirement tests.

1.5.3 Electronic Overcurrent Control Curves

Provide time-current characteristic curves (on full size logarithmic paper) and instruction manuals for the electronic overcurrent control.

1.6 MAINTENANCE

Provide safety precautions, preventive maintenance plan and schedule, troubleshooting guides and diagnostic techniques, parts identification, warranty information, testing and performance data and contractor

information for the following:

SF6 Insulated Pad-Mounted Switchgear Operation and Maintenance

PART 2 PRODUCTS

2.1 SF6 INSULATED PAD-MOUNTED SWITCHGEAR

NEMA C37.72

2.1.1 Ratings and Test Requirements

The voltage rating of the switchgear shall be 15.5 kV. The corresponding ratings associated with the required switchgear voltage rating shall be as follows:

Load Interrupting Ways

Rated Maximum Voltage, kV	15.5
Rated Withstand Impulse Voltage, kV BIL	110
AC 1 Min. Withstand kV	34
DC 15 Min. Withstand kV	53
Fault close Current, kA Asym (3 times)	25
1 Sec. Rating sym., kA	16
Continuous and Load Interrupting Current, A	630
Short-Time Current, kA rms Sym	12
Short-Circuit interrupting Current, kA rms Sym	12
Momentary Current kA Asym	25

Fault Interrupting Ways

Rated Maximum Voltage, kV	15.5
Rated Withstand Impulse Voltage, kV BIL	110
AC 1 Min. Withstand, kV	34
DC 15 Min. Withstand, kV	53
Continuous and Load Interrupting Current, A	630
Interrupting Current, kA Asym	12

Switched ways shall be rated for the required continuous and load interrupting current. Short-circuit interrupting current rating applies to fault interrupting switched ways only.

2.1.2 Switchgear Construction

Switch contacts and cable entrance terminations shall be contained in an SF6 filled stainless steel tank. Switchgear shall be shipped factory filled with SF6 gas conforming to ASTM D 2472. Switchgear shall be configured with load interrupting and fault interrupting switched ways as indicated. Switchgear shall have front accessible terminations suitable for cables entering from below with the manual operating provisions mounted on the rear. Switch contact positions for switched ways shall be visible through viewing windows in the SF6 tank located adjacent to the manual operating provisions. Provide gas pressure gage in viewable location from switch operating handle. Each switched way shall have three position switch; Open, Closed, Ground.

2.1.2.1 Pad-mounting Provisions

Provide enclosed switchgear suitable for installation on a concrete pad. Switchgear support frame, enclosure base and enclosure shall be fabricated of ASTM A 167 type 304 or 304L stainless steel. Enclosure base shall include any part of the switchgear enclosure that is within 3 inches of concrete pad. Paint switchgear enclosure including base No. 70 light gray. Paint coating system shall comply with the manufacturer's standard equipment finish for highly corrosive areas and IEEE C57.12.29.

2.1.3 Load Interrupting Switched Ways

Load interrupter switched ways shall provide three-pole group operated switching.

2.1.4 Fault Interrupting Switched Ways

IEC 62271-111. Provide non-fused, non-reclosing, manual reset, vacuum interrupters consisting of vacuum bottles and a spring assisted operating mechanism. Each fault interrupting switched way shall utilize internally mounted current transformers and an electronic overcurrent control to provide three-pole ganged tripping for single-phase and three-phase faults. The electronic overcurrent control shall have provisions for a wide variety of field selectable time-current characteristic curves with ten field selectable trip levels through a current range of 600 amperes.

2.1.5 Dead-Front High-Voltage Bushings

IEEE Std 386. 15 kV, 95 kV BIL. Provide 600 ampere one-piece deadbreak apparatus bushings for each switched way as indicated.

a. Parking stands: Provide a parking stand near each dead-front bushing. Provide insulated standoff bushings for parking of energized load-break connectors on each parking stands.

2.1.6 Insulated High-Voltage Connectors

IEEE Std 386. Provide corresponding connector for each switched way. Connectors shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide a "hot line voltage indicator" on each 600 ampere terminator test point.

a. 600 Ampere deadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 40,000 rms symmetrical amperes for a time duration of 0.2 seconds, 27,000 rms symmetrical amperes for a time duration of 4.0 seconds. Connectors shall have 200 ampere bushing interface for surge arresters as indicated.

2.1.7 Surge Arresters

IEEE C62.11, rated 10 kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide arresters on switched ways as indicated.

2.2 SF6 Refill Cylinders

Provide two SF6 refill cylinders, minimum size of 6 pounds of SF6; include regulator, valves, and hose for connection to the fill valve of the switch.

2.3 SOURCE QUALITY CONTROL

2.3.1 Switchgear Acceptance Checks and Tests

Furnish reports which include results of design and production tests performed according to NEMA C37.72. Production tests shall be performed by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production.

2.3.2 Electronic Trip Units

Electronic trip units shall be solid-state, powered from the current transformers used for sensing or by means of internal potential transformers (PTs). Use of cable fault indicators in lieu of electronic trip units is not acceptable.

Trip units shall be capable of being set for true RMS single-phase or three-phase with neutral sensing capabilities. Trip units shall be capable of being set to provide protection curves including, but not limited to, standard "CO" type overcurrent relay curves and/or mimic the following fuse types: "E", "K", "KS", "QA", "EF", "T".

Trip settings shall be adjustable locally at the switch without requiring removal of the trip unit or the use of a computer or other external programming device. The trip settings shall be clearly visible from the front panel of the trip unit. The units shall not rely on volatile electronic memory to retain their trip settings.

The following trip functions shall be provided:

Time overcurrent
Instantaneous
Ground Fault

Trip units shall provide visible trip indication by phase, which shall remain after a trip event, until the unit is manually reset.

Trip units shall be capable of operating satisfactorily in a coastal, humid climate with temperatures from minus 10 degrees C to 65 degrees C.

If the trip unit is not a typical industry standard device (having standard bench testing capabilities), then one test kit shall be provided to provide for in-service functional testing of each trip function. The test kits shall be products of the trip unit manufacturer.

2.3.3 Switch Tank

The switch tank shall be a single tank, factory welded using a minimum 304L stainless steel. The switch tank shall be braced to withstand momentary and full load current duty. The following standard components shall be included:

Filling valve with gauge.
Lifting eyes.

Viewing windows to permit inspection of the switch contacts and means of seeing visible status indication of the vacuum interrupters.

Gas pressure gauge in viewable location from switch operating handle.

One line diagram and stainless steel nameplate fastened with stainless steel mechanical fasteners.

Provide a welded flange ready to accept a future gas pressure switch. Provide parking stands for each switched and interrupter way.

2.3.4 Accessories

Provide the following accessories for each switch.

2.3.5 Insulated Medium-Voltage Connectors

Insulated Medium-voltage connectors shall conform to IEEE Std 386. Connector shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide connectors as indicated.

a. 600 Ampere deadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 40,000 rms symmetrical amperes for a time duration of 0.2 seconds, 27,000 rms symmetrical amperes for a time duration of 4.0 seconds. Provide 200 Ampere interface connector (loadbreak reducing plug) for the indicated surge arrester.

b. Provide a "hot line voltage indicator" on each test point.

2.3.6 Remote Operators

Each switch shall have provisions and equipment necessary to enable operating any way of the switch from a distance of no less than 25 feet, not necessarily in a straight line from the switch. This remote operation feature may be achieved by either manual operation or remote electrical operation.

2.3.7 Other Operational Features

Fittings, lifting eyes, insulators, and other required operational features or tools, shall be provided with the switch as necessary.

2.3.8 Auxiliary Contacts

Auxiliary contacts to indicate switch/interrupter position status (for future SCADA connection) shall be provided and wired to terminal blocks external to the SF6 enclosure, but enclosed within the overall enclosure.

2.4 SWITCH ENCLOSURES

2.4.1 Pad-Mounted Switch Enclosures

Enclosures shall be in accordance with IEEE C57.12.29 and shall be equipped with a ground bus capable of carrying the rated fault current for one second for each way. Enclosures shall be sized such that the centerline of the apparatus bushing shall be a minimum of 36 inches above the base of the enclosure. Further, there shall be a minimum depth of 24 inches for the interior of the cabinet housing cable terminations.

The overall switch enclosure shall be made of a minimum grade of 304L stainless steel with suitable stiffeners. All flanges shall overlap and

interlock. Access to the switch and cable compartments shall be through hinged doors and a hood (if required). The door shall have stiffeners to prevent warping and miss alignment. The doors shall fit to the enclosure to provide a watertight seal. The roof of the enclosure shall be sloped from the center to the edge to prevent standing water.

Switch enclosures shall include:

Recessed or removable lifting provisions.
Padlocking provisions
Mounting provisions internal to the enclosure for anchoring to the pad.
Minimum 300 series stainless steel hardware.
Door stops and stays to prevent accidental closing.

PART 3 EXECUTION

3.1 INSTALLATION

Provide Installation Manuals for SF6 insulated switchgear. Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. Installation shall be in accordance with the manufacturer's requirements.

3.2 GROUNDING

Grounding shall be as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION and NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms. When work, in addition to that indicated or specified, is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.2 Switchgear Grounding

Connect #4/0 bare copper conductor ground loop, not less than 24 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide #4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.2.3 Connections

Make joints in grounding conductors and ground loop by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount switch on concrete slab. Slab shall be at least 12 inches thick, reinforced with a 6 x 6 - W2.9 x W2.9 mesh, placed uniformly 4 inches from

the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately 4 inches above finished grade. Edges above grade shall have 1/2 inch chamfer. Slab shall be of adequate size to project at least 3 inches beyond equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas.

3.4 FIELD QUALITY CONTROL

3.4.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.4.1.1 Switchgear

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Check for proper anchorage, alignment, required area clearances, and grounding.

(4) Perform mechanical operator tests in accordance with manufacturer's instructions.

(5) Verify that insulating SF6 gas pressure is correct.

(6) Inspect all indicating devices for proper operation.

(7) Inspect connections for tightness of bolted joints.

(8) Lubricate as required.

b. Electrical Tests

(1) Perform contact-resistance tests.

(2) Trip fault interrupters by operation of overcurrent.

(3) Perform insulation-resistance tests.

(4) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.

(5) Set fault interrupter overcurrent control in accordance with government provided settings. Request trip unit settings from the government, in writing, a minimum of 30 days prior to scheduling electrical tests.

3.4.1.2 Grounding System

a. Visual and Mechanical Inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

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. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

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.

3.4.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that devices are in good operating condition and properly performing the intended function. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times for checks and tests.

-- End of Section --

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PANELBOARDS

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 ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA PB 1	(2006; Errata 2008) Standard for Panelboards

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C, 2008) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 67	(2009) Standard for Panelboards

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Detail Drawings for the panelboards consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents. Include within drawings details of bus layout.

Ensure Outline Drawings for panelboards indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

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

Submit Detail Drawings and Outline Drawings for panelboards in accordance with paragraph entitled, "General Requirements," of this section.

SD-03 Product Data

Submit Manufacturer's catalog data for the following items:

Panelboards
Directory Card and Holder

SD-04 Samples

Ensure that keys are properly tagged and delivered to the Contracting Officer.

SD-06 Test Reports

Submit test reports for the following tests in accordance with the paragraph entitled, "Site Testing," of this section. Do not energize panelboards until the recorded test data has been submitted to and approved by the Contracting Officer.

Continuity Tests
Insulation Tests

SD-07 Certificates

Submit Statements in accordance with paragraph entitled, "General Requirements," of this section.

SD-08 Manufacturer's Instructions

Submit Manufacturer's instructions for Panelboards including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 PANELBOARDS

Totally enclose power-distribution panelboards and lighting and appliance branch-circuit panelboards in a steel cabinet, dead-front circuit breaker type with copper buses, surface- or flush-mounted as indicated. Ensure panelboards conform to NEMA PB 1 and NEMA AB 1. Branch circuit panels shall have buses fabricated for bolt-on type circuit breakers.

An outer door or cover, hinged on one side, shall be provided on surface-mounted panelboards to provide gutter space access. Provide a center door for circuit breaker/switch access only.

Voltage and current rating, number of phases, and number of wires shall be as indicated. Provide four-wire distribution panelboards and lighting and

appliance branch-circuit panelboards with an isolated full-capacity neutral bus. Ensure panelboards are rated for 120/208-volt, three-phase and 277/480-volt, three-phase, 60-hertz current.

Provide three-phase, 4-wire and single-phase, 3-wire distribution lighting and branch circuit panelboards with an isolated full-capacity bus providing spaces for single-pole circuit breakers/switches and spaces indicated as spare.

Provide panelboards with a separate grounding bus bonded to the enclosure. Grounding bus shall be a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Each panelboard, as a complete unit, shall have a short-circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or as indicated.

Ensure panelboards and main lugs or main breaker have current ratings as shown on the panelboard schedule.

Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Three-phase, four-wire busing shall be such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.

Mechanical lugs furnished with panelboards shall be cast copper or copper alloys of sizes suitable for the conductors indicated to be connected thereto.

Panelboard enclosures shall be NEMA 250, Type 1. Provide enclosures with hinged fronts and corrosion-resistant steel pin-tumbler cylinder locks. Key locks alike and provide two keys for each enclosure.

Finish panelboards with baked enamel. Finish color is to be No. 61 gray conforming to FED-STD-595.

2.2 CIRCUIT BREAKERS

Circuit breakers shall be the molded-case type as specified in Section 26 05 71.00 40 LOW-VOLTAGE OVERCORRENT PROTECTIVE DEVICES. Frame and trip ratings shall be as indicated.

Interrupting rating of circuit breakers shall be as indicated. If not shown, the interrupting rating for circuit breakers in 120/208-volt panelboards shall be not less than 10,000 amperes rms symmetrical, and that for breakers in 277/480-volt panelboards shall be not less than 65,000 amperes rms symmetrical.

Circuit breakers shall be bolt-on type. Plug-in type is not acceptable.

Provide shunt trips where indicated.

In branch circuit panelboards, branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the trip rating of the breaker to prevent repeated arcing shorts resulting from frayed appliance cords. Single-pole 15- and 20-ampere

circuit breakers shall be UL listed as "Switching Breakers" at 120 volts ac. Provide UL Class A (5-milliampere sensitivity) ground fault circuit protection on 120-volt ac branch circuit as indicated. This protection is an integral part of the branch circuit breaker that also provides overload and short-circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption is not to disturb the feeder circuit to the panelboard.

Ensure connections to the bus are bolt-on type.

When multiple wires per phase are specified, furnish the circuit breakers with connectors made to accommodate multiple wires.

Ensure circuit breaker spaces called out on the drawings are complete with mounting hardware to permit ready installation of the circuit breakers.

2.3 DIRECTORY CARD AND HOLDER

Mount a directory card on the inside of hinged fronts and doors 0.030-inch thick minimum plastic in a metal frame, with spaces for circuit numbers, outlets controlled, and room numbers. Where hinged fronts or doors are not required, provide the directory card 0.030-inch thick minimum plastic in a metal frame mounted on the left-hand side of the front trim. Directory card shall identify each branch circuit with its respective and numbered circuit breaker.

2.4 FACTORY TESTING

Test complete panelboards in accordance with UL 67.

2.5 PRECAUTIONARY LABEL

To ensure persons are aware of immediate or potential hazard in the application, installation, use, or maintenance of panelboards, each panelboard shall be conspicuously marked on the trim or dead front shield with the text (or equivalent) **DANGER** symbol. If the panel is supplied with a door, ensure the label is visible when the door is in the open position.

PART 3 EXECUTION

3.1 INSTALLATION

Install panelboards as indicated and in accordance with the manufacturer's instructions. Fully align and mount panels so that the height of the top operating handle does not exceed 72-inches above the finished floor.

Directory-card information shall be typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.

3.2 SITE TESTING

Each panelboard enclosure key shall be shown to operate the enclosure locks in the presence of the Contracting Officer.

Panelboards shall be given continuity and insulation tests after the installation has been completed and before the panelboard is energized.

Provide test equipment, labor, and personnel as required to perform the

tests as specified. Conduct Continuity tests using a dc device with buzzer.

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.

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MOTOR CONTROL CENTERS

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 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)

ASTM INTERNATIONAL (ASTM)

ASTM B 187/B 187M	(2006) Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar and Shapes
ASTM B 317/B 317M	(2007) Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, and Structural Profiles for Electrical Purposes (Bus Conductor)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13	(2008) Standard Requirements for Instrument Transformers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
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 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems General Requirements
NEMA ICS 2	(2000; Errata 2002; R 2005; Errata 2006) Standard for Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 -

	Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 4	(2005) Industrial Control and Systems: Terminal Blocks
NEMA ICS 6	(1993; R 2006) Standard for Industrial Controls and Systems Enclosures
NEMA ST 1	(1988; R 1997) Standard for Specialty Transformers (Except General Purpose Type)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 1063	(2006) Standard for Safety Machine-Tools Wires and Cables
UL 44	(2005; Rev thru Nov 2005) Thermoset-Insulated Wires and Cables
UL 489	(2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 845	(2005; Rev thru Aug 2006) Standard for Motor Control Centers

1.2 SYSTEM DESCRIPTION

These specifications include the design, fabrication, assembly, wiring, testing, delivery, installation and testing of the items of equipment and accessories and spare parts listed in the Schedule and shown on the drawings.

Within 30 calendar days after date of award, submit for the approval of the Contracting Officer six (6) copies of electrical equipment drawings, including all motor control units and protective devices. Provide a single-line diagram, equipment list and nameplate schedule.

Within 30 calendar days after date of award, submit for the approval of the Contracting Officer six (6) copies of electrical equipment drawings. Include within the NEMA Class II motor control center drawings a connection diagram with wire designations and schematic diagrams to illustrate operation of associated motor unit controls. Submit an individual wiring diagram for each motor control center. Wiring diagrams shall be in a form showing physical arrangement of the control center with interconnecting wiring shown by lines or by terminal designations (wireless). Provide a single-line diagram, equipment list and nameplate schedule for each motor control center.

1.2.1 Rules

The equipment shall conform to the requirements of NFPA 70 unless more stringent requirements are indicated herein or shown. NEMA rated and UL

listed equipment has been specified when available. Equipment must meet NEMA and UL construction and rating requirements as specified. No equivalent will be acceptable. Immediately notify the Contracting Officer of any requirements of the specifications or Contractor proposed materials or assemblies that do not comply with UL or NEMA. International Electrotechnical Commission (IEC) rated equipment will not be considered an acceptable alternative to specified NEMA ratings.

1.2.2 Coordination

The general arrangement of the motor control centers is shown on the contract drawings. Any modifications of the equipment arrangement or device requirements as shown on the drawings is subject to the approval of the Contracting Officer. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. Completely assemble all equipment at the factory. The motor control centers may be disassembled into sections, if necessary, for convenience of handling, shipping, and installation.

1.2.3 Standard Products

Material and equipment shall be standard products of a manufacturer regularly engaged in their manufacture and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. All materials shall conform to the requirements of these specifications. Materials are to be of high quality, free from defects and imperfections, of recent manufacture, and of the classification and grades designated. All materials, supplies, and articles not manufactured by the Contractor shall be the products of other recognized reputable manufacturers. If the Contractor desires for any reason to deviate from the standards designated in these specifications, he shall, after award, submit a statement of the exact nature of the deviation, and shall submit, for the approval of the Contracting Officer, complete specifications for the materials which he proposes to use.

1.2.4 Nameplates

Make nameplates of laminated sheet plastic or of anodized aluminum approximately 1/8 inch thick, engraved to provide white letters on a black background. Fasten the nameplates to the equipment in proper positions with anodized round-head screws. Lettering shall be minimum 1/2 inch high. Nameplate designations shall be in accordance with lists on the drawings, and as a minimum provide for the following equipment:

a. Motor Control Centers

b. Individual items of equipment mounted in the Motor Control Centers

Provide equipment of the withdrawal type with nameplates mounted on the removable equipment in locations visible when the equipment is in place.

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

Drawings; G

Shop Drawings; G

Within 30 calendar days after date of award, submit for the approval of the Contracting Officer six (6) copies of outline drawings of all equipment to be furnished under this contract, together with weights and overall dimensions. Drawings shall show the general arrangement and overall dimensions of the motor control centers. These drawings shall show space requirements, details of any floor supports to be embedded in concrete and provisions for conduits for external cables.

Motor Control Centers; G

SD-03 Product Data

Equipment; G

Within 30 calendar days after date of award submit for approval six (6) copies of such descriptive cuts and information as are required to demonstrate fully that all parts of the equipment will conform to the requirements and intent of the specifications. Data shall include descriptive data showing typical construction of the types of equipment proposed, including the manufacturer's name, type of molded case circuit breakers or motor circuit protectors, performance capacities and other information pertaining to the equipment. Submit six (6) sets of characteristic curves of the individual breaker trip element.

Factory Tests

Submit, within a minimum of 14 days prior to the proposed date of tests, six (6) copies of manufacturer's routine factory test procedures and production line tests for all motor control centers.

SD-06 Test Reports

Factory Tests

Submit six (6) complete reproducible copies of the factory inspection results and six (6) complete reproducible copies of the factory test results in booklet form, including all plotted data curves, all test conditions, a listing of test equipment complete with calibration certifications, and all measurements taken. Contractor's and Contracting Officer's Representatives must sign and date report.

SD-07 Certificates

Motor Control Centers

Submit certification of factory test reports. Certification shall be signed by official authorized to certify on behalf of the manufacturer, attesting that the motor control center meets the specified requirements. The statement must be dated after the award of this contract, must state the Contractors name and

address, must name the project and location, and must list the specific requirements which are being certified.

SD-08 Manufacturer's Instructions

Submit Manufacturer's instructions for the following including special provisions required to install equipment components and system packages. Detail within special notices hazards and safety precautions.

Motor Control Units

Protective Devices

1.4 DELIVERY, STORAGE, AND HANDLING

Ship the equipment as completely assembled and wired as feasible so as to require a minimum of installation work. Each shipping section shall be properly match marked to facilitate reassembly, and shall be provided with removable lifting channels with eye bolts for attachment of crane slings to facilitate lifting and handling. Any relay or other device which cannot withstand the hazards of shipment when mounted in place on the equipment shall be carefully packed and shipped separately. Mark these devices with the number of the panel which they are to be mounted on and fully identified. All finished painted surfaces and metal work shall be wrapped suitably or otherwise protected from damage during shipment. Prepare all parts for shipment so that slings for handling may be attached readily while the parts are in a railway car or transport truck.

1.5 MAINTENANCE

1.5.1 Accessories and Tools

A complete set of accessories and special tools unique to equipment provided and required for erecting, handling, dismantling, testing and maintaining the apparatus to be furnished by the Contractor.

1.5.2 Spare Parts

Furnish spare parts as specified below. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished.

a. 2 - Fuses of each type and size.

b. 1 - Circuit breaker auxiliary switch.

c. 2 - Operating coils for each size ac contactor.

d. 1 - Operating coil for each size dc contactor.

e. 2 - Complete sets of 3-pole stationary and moving contact assemblies for each size ac contactor.

f. 1 - Complete set of 2-pole stationary and moving contact assemblies for each size dc contactor.

g. 3 - Contactor overload relays of each type and rating, each relay with a complete set of contact blocks.

h. 1 - spare set of heater elements for each heater rating provided.

i. 2 - Indicating lamp assemblies of each type.

j. 1 - Control transformer of each type and rating.

k. 1 - Control relay of each type and rating.

l. 1 - Contactor auxiliary contact of each type.

m. 4 - One quart containers of finish paint for indoor equipment.

n. 2 - One quart containers of the paint used for the exterior surfaces of outdoor equipment.

o. 4 - Keys for motor control center door lock.

PART 2 PRODUCTS

2.1 CONNECTIONS

All bolts, studs, machine screws, nuts, and tapped holes shall be in accordance with ASME B1.1. The sizes and threads of all conduit and fittings, tubing and fittings, and connecting equipment shall be in accordance with ASME B1.20.1. All ferrous fasteners shall have rust-resistant finish and all bolts and screws shall be equipped with approved locking devices. Manufacturer's standard threads and construction may be used on small items which, in the opinion of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items and meet the above requirements.

2.2 MOLDED CASE CIRCUIT BREAKERS

Molded case circuit breakers shall conform to the applicable requirements of NEMA AB 1 and UL 489. The circuit breakers shall be manually-operated, shall be quick-make, quick-break, common trip type, and shall be of automatic-trip type unless otherwise specified or indicated on the drawings. Operate all poles of each breaker simultaneously by means of a common handle. The operating handles shall clearly indicate whether the breakers are in "On," "Off," or "Tripped" position and shall have provisions for padlocking in the "Off" position. Provide personnel safety line terminal shields for each breaker. The circuit breakers shall be products of only one manufacturer, and shall be interchangeable when of the same frame size.

2.2.1 Trip Units

Except as otherwise noted, the circuit breakers, of frame sizes and the trip unit ratings as shown on the drawings, shall be provided with combination thermal and instantaneous magnetic or solid state trip units. The Government reserves the right to change the indicated trip ratings, within frame limits, of the trip devices at the time the shop drawings are submitted for approval. The breaker trip units shall be interchangeable and the instantaneous magnetic trip units shall be adjustable on frame sizes larger than 150 amperes. Nonadjustable instantaneous magnetic trip units shall be set at approximately 10 times the continuous current ratings of the circuit breakers. Solid state trip units, where indicated, shall also have adjustable long time pick-up and delay, short time pick-up and

delay, and ground fault pick-up and delay.

2.2.2 480-Volt AC Circuits

Circuit breakers for 480-volt or 277/480-volt ac circuits shall be rated 600 volts ac, and shall have an UL listed minimum interrupting capacity of 22,000 symmetrical amperes at 600 volts ac.

2.2.3 120/208-Volt AC Circuits

Circuit breakers for 120-volt ac circuits shall be rated not less than 120/208 or 208 volts ac, and shall have a UL listed minimum interrupting capacity of 10,000 symmetrical amperes.

2.3 WIRING

All control wire is to 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. Give special attention 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.

2.4 TERMINAL BLOCKS

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 are to be no less than No. 10 in size and having sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement is 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. 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.

2.4.1 Types of Terminal Blocks

2.4.1.1 Short-Circuiting Type

Furnish short-circuiting type terminal blocks 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.

2.4.1.2 Load Type

Provide load terminal blocks rated no less than 600 volts and of adequate capacity 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.

2.4.2 Marking Strips

Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations. Make the wire numbers 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, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations. Prints of 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.

2.5 MOTOR CONTROL CENTERS

Design each motor control center for operation on 480-volts ac, 3-phase, 60-Hz system, and the ensure that equipment conforms to all the applicable requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 4, NEMA ICS 6, UL 845 and NFPA 70. List and label vertical sections and individual units under UL 845 where ever possible. In lieu of the UL listing, certification from any nationally recognized, adequately equipped, testing agency that the individual units and vertical sections have been tested and conform to the UL requirements of that agency will be acceptable when approved by the Contracting Officer. Provide NEMA Class II, Type B, motor control centers in accordance with NEMA ICS 2.

2.5.1 Enclosures

Each motor control center shall consist of the required number of vertical sections of 90 inches nominal height, bolted together, with steel channel sills and suitable for mounting against a wall. Vertical section shall be 20 inches deep and buses, control wiring, control transformers, small power transformers, terminal blocks, line terminals, cable supports, and clamps shall be accessible from the front. Enclosure shall be NEMA Type 12. Fabricate the control centers from smooth select steel sheets shaped and reinforced to form rigid free-standing structures. Metal thickness for enclosures shall be not less than specified in NEMA ICS 6 without exception. Fabricate and bolt vertical edges of sections exposed to view so that the joints will not pass a 1/16 inch gage. Design each structure for addition of future sections required. Isolate individual compartments from adjacent compartments. Make provisions for leveling the entire assembled motor-control center sections and bolting them together so that they form a contiguous structural enclosure.

Lifting angles shall be 7 gage, and shall be provided on the top of each section, and shall extend the entire width of the section, and shall be capable of supporting the entire weight of the motor-control center section without distortion. Provide base channels with holes to facilitate floor mounting and leveling.

2.5.1.1 Unit Compartments

Each operating unit shall contain equipment as shown on the drawings, mounted in an individual cell. The unit assembly, except main circuit breakers, panelboards and auxiliary control devices, shall be drawout type removed from the front, without rear access or disturbing other units in the control center assembly. All drawout type unit assemblies shall have positive guide rail system to ensure alignment of connection to vertical bus. Units shall be mechanically interlocked with the door to prevent removal while in the energized position. Each removable unit shall have provision for padlocking in a position in which it is disconnected from the vertical bus although not removed from the stationary structure. Provide all ventilating openings with corrosion-resistant insect-proof screens on the inside. Provide bus closing plugs for all unused openings in vertical bus barriers.

Compartments for future combination motor-control units shall be complete with hardware, buses, and hinged doors ready to receive future draw-out units. Compartments for spare combination motor-control units shall be complete with buses, hinged doors, and draw-out units but without load terminal connections. Spare spaces shall be complete with buses and screwed-on front cover plates.

2.5.1.2 Motor Control Center Doors and Covers

Provide each unit compartment, including blank compartments for future use, with either a flange-formed or a rolled-edge door. Mount each door on fully-concealed or continuous full-length piano-type hinges and provide with positive fasteners. Prevent door sag by proper alignment of hinges made of sufficiently strong material. Interlock the door fastenings to prevent opening when the equipment is energized. The external operating handle shall clearly indicate whether the equipment is in an "ON", "OFF" or "TRIPPED" position.

2.5.1.3 Sills

Channel iron foundations, complete with bolts and drilled holes for grouting and anchoring to the floor, shall be furnished for the complete length (front and rear) of each motor control center assembly. The channels shall be designed for flat mounting and maximum channel depth shall be 1-1/2 inches. Additional channel or substantial metal trim shall be provided flush with the end panels to completely enclose the bases across the ends of the equipment assemblies.

2.5.1.4 Shutters

Drawout units shall have shutters which close when the unit is withdrawn to isolate the vertical bus.

2.5.2 Buses

All buses shall be of tinned copper and shall be tin or silver-plated

throughout. Copper bars and shapes for bus conductors shall conform to the applicable requirements of ASTM B 187/B 187M and ASTM B 317/B 317M. All splices for field assembly shall be bolted with at least two bolts and shall employ the use of "Belleville" washers in the connection. The bus ratings shall be based on a 65 degree Celsius maximum temperature rise in accordance with UL 845 requirements. Bus shall have a short-circuit current rating of not less than 42,000 RMS symmetrical amperes. Support all bus work on wet process porcelain insulators, glass polyester, or suitable molded material.

2.5.2.1 Horizontal Bus

Provide each control center assembly with a three-phase main horizontal bus, with a continuous current rating not less than 800 amperes, located across the top of each vertical section. Drill the ends of horizontal buses for future extensions.

2.5.2.2 Vertical Bus

Provide each vertical section with a three-phase vertical bus with a continuous current rating of 600 amperes connected to the horizontal bus by brazing, welding, or bolting. Where the incoming feeder breakers are located at the bottom of a control center, rate the vertical bus in that section the same as the main horizontal bus. Extend vertical buses from the horizontal bus to the bottom of the lowest available unit mounting space. Isolate the vertical bus from wireways and equipment in compartments.

2.5.2.3 Ground Bus

Provide a tin-plated copper ground bus full width at the bottom of the motor control center line-up. Provide a full clamp-type solderless copper or copper alloy lug for No. 3/0 AWG stranded copper cable at each end of the bus for connection to the station grounding system. Ground bus shall be capable of carrying the rated short-circuit current available in the motor-control center.

2.5.2.4 Neutral Bus

Furnish a half rated neutral bus continuous through the control center. Lugs of appropriate capacity will be furnished.

2.5.3 Combination Starters

Combination motor controller units shall contain molded-case circuit breakers, auxiliary and pilot devices and a magnetic contactor with thermal overload relays and reduced voltage starter where indicated on the drawings. The ratings of air circuit breakers, contactors, motor controllers and other devices shall be as shown on the drawings. All combination motor controller units shall have short circuit ratings equal to 25,000 AIC or greater. Where control push-buttons, indicating lamps, "Hand-Off-Automatic" switches, and similar control devices are associated with a unit, mount them on the unit compartment door. Door-mounted components shall not interfere with access within the compartments. Molded case circuit breakers for use in combination starters shall meet the requirements of paragraph MOLDED CASE CIRCUIT BREAKERS.

2.5.3.1 Magnetic Contactors

Magnetic contactors shall be of the NEMA sizes indicated on the drawings. The rating, performance and service characteristics shall conform to the requirements of NEMA ICS 2 for contactors with continuous current ratings for the duty indicated. Contactors for motor control shall be rated for full-voltage starting (Class A controllers). Contactors shall be suitable for at least 200,000 complete operations under rated load without more than routine maintenance. Minimize the interruption arc and flame by suitable arc chutes or other means so that no damage will be done to other portions of the device. The arc chutes, if provided, shall be easily removable without removing or dismantling other parts. The contacts shall be easily removable. All current-carrying contact surfaces shall be silver-surfaced or of other approved material to prevent the formation of high resistance oxides. The contactor shall operate without chatter or perceptible hum while energized. Coils shall be suitable for continuous operation 480-volt ac circuits. Alternating-current contactors shall be three-pole, except where otherwise noted, and shall be insulated for 600 volts ac and of the electrically- operated, magnetically-held type. Direct-current contactors shall be two-pole, suitable for controlling circuits operating at 125 volts dc, insulated for 250 volts dc, electrically-operated, magnetically-held type and adequate for full-voltage motor starting service.

2.5.3.2 Reduced Voltage Starters

Solid State soft-start starters shall be three phase SCR controlled for stepless reduced voltage starting of induction motors. Current transformers shall provide feedback signal to regulate torque during start up and to prevent overload conditions while motor is running. Starter shall have starting current of 300 percent of full load amps for thirty seconds, bypass/isolation contactor, and three phase thermal overload relay.

2.5.3.3 Auxiliary Contacts

Each controller shall be provided with a minimum of three auxiliary contacts which can be easily changed from normally open to normally closed. Where indicated on the drawings, provide a fourth auxiliary contact and red and green indicating lights.

2.5.3.4 Overload Relays

Except as otherwise indicated, each controller shall be provided three NEMA Class 20 thermal overload relays with external manual reset. Prior to shipment of the control centers, the Contracting Officer will furnish the ratings of the heater elements to be installed in the relays by the Contractor.

2.5.3.5 Individual Control Transformers

Where 120 volt ac control of contactors is indicated or required, provide an individual control transformer on the line side of the unit disconnect. The control transformers shall be rated 480-120 volts and shall conform to the requirements for control transformers in NEMA ST 1. Control transformers shall have adequate volt-ampere capacity for the control functions indicated. Install transformers with primary fuses. Except as otherwise indicated on the drawings, provide each control transformer with a fuse in one secondary lead and have the other secondary lead grounded.

2.5.3.6 Voltage Fault Protection

Where shown, provide starters with protection against voltage faults, phase unbalance, phase loss, phase reversal, undervoltage and overvoltage. Upon sensing one of these faults, the protector shall de-energize the starter. The protector shall use a combination of voltage and phase-angle sensing to detect phase loss even when regenerated voltages are present. Connect the protector to the load side of the motor circuit disconnect. The protector shall have an adjustable line voltage trip level, adjustable trip delay, automatic reset and manual reset by an external normally closed push-button, and Double Pull Double Throw (DPDT) output contacts. Protector operation shall have repeatability of +1 percent of set point, maximum, and a dead band of 2 percent maximum. Protector shall have green indicator to show normal status and red indicator to show tripped status. Indicators will be visible through the compartment door, when LED's are used cover the protector with a clear unbreakable cover, when lamps are used they shall have nameplates and be grouped with other indicating lights.

2.5.3.7 Control Circuit Disconnects

Disconnect control circuit power when the unit compartment is opened.

2.5.4 Molded Case Circuit Breakers in Unit Compartments

Molded case circuit breakers for installation in unit compartments shall meet the requirements of paragraph MOLDED CASE CIRCUIT BREAKERS above.

2.5.5 Wiring for Motor Control Centers

All wiring shall meet the requirements of paragraph WIRING above. Provide heavy-duty clamp type terminals for terminating all power cables entering the control centers.

2.5.5.1 Contractor's Wiring

Form wiring into groups, suitably bound together, properly supported and run straight horizontally or vertically. There shall be no splices in the wiring. The manufacturer's standard pressure-type wire terminations for connections to internal devices will be acceptable. Add terminal blocks for wiring to devices having leads instead of terminals. Use ring tongue indented terminals on all wires terminated on control terminal blocks for external or interpanel connections and at shipping splits. All stud terminals shall have contact nuts and either locking nuts or lockwashers.

2.5.5.2 External Connections

Power and control cables will enter the control centers at the bottom.

2.5.5.3 Terminal Blocks

Terminal blocks shall meet the requirements of paragraph TERMINAL BLOCKS above. In no case shall the terminals provided for circuit breakers or contactors accommodate less than the number or size of conductors shown on the drawings. Give special attention 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.

2.5.6 Accessories and Control Devices

Control accessories shall be provided, and shall be suitable for mounting on the front of, or inside, the control centers as indicated on the drawings. Control accessories shall meet the applicable requirements of NEMA ICS 2. Mount relays and other equipment that mechanical vibration will not cause false operation.

2.5.6.1 Control Stations

Push-button stations and selector switches shall conform to NEMA ICS 2, shall be of the heavy-duty, oil-tight type, rated 600 volts ac, and have a contact rating designation of A600. Provide switches with escutcheon plates clearly marked to show operating positions.

2.5.6.2 LED Indicating Lights

Furnish red and green LED's where shown on the drawings, indicating contact "open" and "closed" position. The LED's shall be accessible and replaceable from the front of the control center through a finished opening in the compartment door. The LED assemblies shall be of the heavy duty oiltight, watertight, and dusttight type.

2.5.6.3 Control Relays

Control relays shall be of the electrically operated, magnetically held, self-reset, open type, suitable for mounting inside the starter compartments, and shall be 120-volt ac. Contacts shall be as indicated on the drawings and shall have a contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2.

2.5.6.4 Timing Relays

Timers shall be pneumatic type. They shall be suitable for mounting inside the control center and shall be rated 120 volts ac, 60 Hz. Provide instantaneous and time delay contacts as indicated on the drawings, and have a contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2. Provide means for manual adjustment over a range as indicated on the drawings.

2.5.6.5 Elapsed-Time Meters

Hour-indicating time meters shall have 6- digit registers with counter numbers at least 1/4 inch high. White numbers on black backgrounds shall provide hour indication with the last digit in contrasting colors to indicate tenths of an hour. The enclosure shall be 3-1/2 inches square and dust resistant. Operating voltage shall be 120 volts ac. They shall be of the nonreset type.

2.5.7 Feeder Tap Units

Provide feeder tap units as indicated on the drawings. Feeder tap units shall include externally operable molded-case circuit breakers in combination motor-control unit enclosures for the protection of non-motor loads or remotely located magnetic motor-controllers. Not more than two molded-case circuit breakers shall be contained in feeder tap units.

2.5.8 Metering Section

Provide metering section with instruments as indicated on the drawings.

2.5.8.1 Instrument Transformers

All transformers used for metering shall meet the requirements of NEMA C12.11 and IEEE C57.13. Protect voltage transformers with removable primary and secondary fuses. Install fuses in each ungrounded lead and located adjacent to the transformers in an easily accessible place. If cable connections to current transformer primary are required, furnish terminals of an approved solderless type and proper size. If current transformers are connected to buses, furnish proper connections, complete with bolts, nuts, washers and other accessories.

2.6 PAINTING

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. Prime exterior surfaces, fill where necessary, and give no less than two coats baked enamel with semigloss finish. Equipment located indoors shall be ANSI Light Gray. All touch-up work shall be done with manufacturer's coatings as supplied under paragraph SPARE PARTS.

2.7 FACTORY TESTS

Each item of equipment supplied under this contract shall be given the manufacturer's routine factory tests and tests as specified below, to insure successful operation of all parts of the assemblies. All tests required herein shall be witnessed by the Contracting Officer unless waived in writing, and no equipment shall be shipped until it has been approved for shipment by the Contracting Officer. Notify the Contracting Officer a minimum of 14 days prior to the proposed date of the tests so that arrangements can be made for the Contracting Officer to be present at the tests. The factory test equipment and the test methods used shall conform to the applicable NEMA Standards, and shall be subject to the approval of the Contracting Officer. Reports of all witnessed tests shall be signed by witnessing representatives of the Contractor and Contracting Officer. Bear the cost of performing all tests and include in the prices bid in the schedule for equipment.

2.7.1 Motor Control Centers Tests

2.7.1.1 Dielectric Tests

Each motor control center shall be completely assembled and given dielectric tests in accordance with NEMA ICS 1.

2.7.1.2 Operational Tests

The correctness of operation of each air circuit breaker and magnetic contactor and of all control devices, accessories and indicating lamps, shall be checked. These checks shall be made at rated voltage with power supplies to the main buses. All magnetic contactors shall also be checked for proper operation with power at 90 percent of rated voltage.

2.7.1.3 Short Circuit Tests

If the unit is not UL labeled for the specified short circuit, the Contractor may submit design tests demonstrating that satisfactory short-circuit tests, as specified in NEMA ICS 2, have been made on a motor control center of similar type of construction and having the same available short circuit current at the motor terminals, including any motor contributions, as the motor control centers specified to be furnished under these specifications.

PART 3 EXECUTION

3.1 INSTALLATION

Complete assembly shall be electrically and mechanically connected and assembled from coordinated subassemblies shipped in complete sections from the manufacturer. Installation shall be aligned, leveled, and secured to the supporting construction in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

Motor-control centers shall be subjected to continuity and insulation tests after the installation has been completed and before the motor-control center is energized.

Provide test equipment, labor, and personnel to perform the tests required. Conduct continuity tests using a dc device with bell or buzzer.

Motor-control centers shall be completely isolated from extraneous electrical connections. Substation feeder breakers, circuit breakers in switchboards, and other disconnecting devices shall be used to isolate the motor-control center under test.

Conduct insulation tests on 600-volt motor-control centers using a 1,000-volt insulation-resistance test set. Record readings every 15 seconds for the first minute and every minute thereafter for 10 minutes. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Conduct insulation tests on motor-control centers 480 volts or less using a 500-volt insulation-resistance test set. Record readings every 15 seconds for the first minute and every minute thereafter for 10 minutes. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Prior to final acceptance the motor control center shall be energized and loaded (to the maximum load possible, but not less than 10 percent of expected full load)for a minimum of 10 minutes and the temperature measured, with a non-contact device, to verify connection integrity. The temperature detector shall be accurate within 0.5 degrees C. Each phase temperature of 3 phase circuits and individual connections compared to other similarly loaded connections shall be within 3 degrees C of each other. Temperatures outside these values warrant investigation.

Conduct phase-rotation tests on all three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to motors and other connected equipment shall be clockwise.

Record test data and include location and identification of motor-control centers and megohm readings versus time.

Final acceptance shall depend upon the satisfactory performance of the motor-control centers under test. No motor-control center shall be energized until recorded test data have been approved by the Contracting Officer. Provide final test reports to the Contracting Officer. Reports shall have 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 --

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COORDINATED POWER SYSTEM PROTECTION

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 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 1584	IEEE Guide for Performing Arc Flash Hazard Calculations

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 Z535.1	(2006) American National Standard for Safety--Color Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 70E	(2009; Errata 2009) Standard for Electrical Safety in the Workplace

1.2 SYSTEM DESCRIPTION

The power system covered by this specification consists of:
Drawing No. 79K38755 Sheets through 34.

The analysis shall include all new protective devices installed, the first existing upstream supplying protective device, and the first downstream feeder device for all new protective devices installed.

New protective device settings shall be provided for all new low voltage equipment (up to 600 Volts AC). Protective device settings for medium

voltage equipment will be provided by the Government; however, the Contractor shall provide all required protective device data for the Government to analyze and determine the settings required.

The Government will provide the short circuit values for the following connection points on the electrical system:
13.2kV or 13.8kV primary terminals at each existing transformer and LBS/VFI involved in the project.

The Government will provide the existing protective device settings for the following devices on the electrical system:
Each C5 and Orsino substation feeder or existing upstream VFI involved in the project.

The Government will provide the existing protective device time-current curves for the above devices.

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

Fault Current and Arc Flash Analysis
Protective Device Coordination Study

The study along with protective device equipment submittals. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government shall not be held 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.

Review and final submittals shall consist of 5 bound copies and a PDF file submitted on Compact Disc (CD). Also provide on a final submittal CD, all power system analysis software data files necessary to restore and edit the model.

Equipment

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.

System Coordinator

Verification of experience and license number, of a registered Professional Engineer with at least 3 years of current experience in the design of coordinated power system protection. Experience data shall include at least five references for work of a magnitude comparable to this contract, including points of contact, addresses and telephone numbers. This engineer must perform items required by this section to be performed by a

Florida registered Professional Engineer.

Protective Relays

Data including calibration and testing procedures and instructions pertaining to the frequency of calibration, inspection, adjustment, cleaning, and lubrication.

Installation

Procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment.

1.4 QUALITY ASSURANCE

1.4.1 System Coordinator

System coordination, recommended ratings and settings of protective devices, and design analysis shall be accomplished by a Florida 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

Calibration, testing, adjustment, and placing into service of the protective devices shall be accomplished by a manufacturer's product field service engineer or independent testing company.

1.4.3 Power System Analysis Document Design Reviews

The completed fault current and arc flash analysis and protective device coordination study documents shall be reviewed at a KSC location and implemented as follows:

90 percent document and review meeting at KSC: Study is complete except for disposition of Government comments.

100 percent document: Incorporates approved Government comments and submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES. Setting sheets from this document are to be used to implement protective device settings.

Installation field change document and review meeting at KSC: Required if setting changes in protective devices are required due to discrepancies between the 100 percent setting sheet documents and the available setting selections on the protective device. All applicable portions of the fault current and arc flash analysis and protective device coordination study document shall be changed and annotated to reflect the impacts of the setting changes.

As-Built document: Incorporates as-installed protective device settings Government comments and submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

PART 2 PRODUCTS

2.1 Arc-Flash Labels

Provide detailed arc flash warning labels for all electrical equipment as required by NFPA 70 and NFPA 70E, including, medium voltage switches, transformers, switchgear main breakers, switchgear bus-tie breaker, switchgear feeder breakers, switchgear cable compartments, switchboards, panelboards, 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.

a. Label format is to be NFPA 70E detailed format type and samples will be provided at the time of award. Format includes different colors and formatting per ANSI Z535.1 for different hazard levels and the following information:

i) Flash hazard boundary
ii) Incident energy
iii) Hazard Category and PPE
iv) Shock Voltage
v) Minimum insulated glove rating
vi) Limited approach boundary distance
vii) Restricted approach boundary distance
viii) Prohibited approach boundary distance

b. The arc flash label content shall be based on the operational scenario, fault location, and fault type (arcing or bolted) that results in the highest incident energy.

2.2 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. They shall include a fault current and arc flash analysis, and a protective device coordination study. The studies shall be performed 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.

Perform short circuit studies, coordination studies, and arc-flash hazard analysis in accordance with NETA ATS and as specified herein.

2.2.1 Scope of Analyses

The fault current and arc flash analysis, and protective device coordination study shall begin at: the existing power supply connection points indicated and extend down to all electrical equipment shown on Drawings indicated in Paragraph 1.2 SYSTEM DESCRIPTION.

2.2.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. Coordinate with the Government Lead Electrical Design Engineer for fault current availability at the site.

Review protective device submittals, perform field surveys, make notations on submittals, and coordinate with equipment vendor as required to obtain all new device data necessary for the coordination study.

2.2.3 Single Line Diagram

A single line diagram shall be prepared 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. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown. Location of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating. Include on the single line names of equipment as indicated on the drawings or provide a table cross-referencing node numbers to equipment names on the drawings.

2.2.4 Fault Current Analysis

2.2.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE 242 and IEEE 399.

Analysis shall utilize specialized computer aided engineering software designed for the purpose including the following capabilities.

a. Short circuit analysis with asymmetrical and symmetrical values for different fault times.

b. Time current curve plotting.

c. Arc-flash energy calculation for both arcing and bolted fault current levels.

Analysis shall be performed and separate study reports generated for each operational scenario including:

a. Single-ended substation source operation
b. Double-ended substation source operation
c. Generator source operation

2.2.4.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedance shall be those proposed. Data shall be documented in the report.

2.2.4.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

2.2.5 Coordination Study

The study shall demonstrate 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. The study shall include a description of the coordination of the protective devices in this project. A written narrative shall be provided describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2.2.6 Study Report

a. The report shall include a cover sheet and table of contents. Separate sections with all applicable content shall be provided for all operating scenarios.

b. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

c. The report shall include single-line line diagram(s); reference 2.14.3, Single Line Diagram.

d. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, time-current curves, and definition of the fixed or adjustable features of the existing or new protective devices.

e. The report shall document existing power system data including time-current characteristic curves and protective device ratings and settings.

f. The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to substantiate all protective devices settings and to ensure coordinated power system protection between protective devices or equipment. Provide separate curves for phase and ground fault currents. The report shall include recommended ratings and settings of all protective devices in tabulated form.

g. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided. 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 current levels), and motor starting study results.

h. The report shall include protective device setting sheets including recommended changes to existing protective device settings and settings for all new protective devices. All information to field install the settings,

including settings or features not used or turned off, shall be provided. Setting sheets shall be separate pages, suitable for use by installing technicians, and not include other report analysis and data.

i. The report shall include tabulated arc-flash data for all equipment and all modified equipment requiring arc-flash warning labels in accordance with IEEE 1584. Label format is to be NFPA 70E (most recent edition) detailed format and include the following information:

Flash Hazard Boundary.
Incident Energy.
Hazard Category and PPE.
Shock Voltage
Limited Approach Boundary Distance
Restricted Approach Boundary Distance
Prohibited Approach Boundary Distance

PART 3 EXECUTION

3.1 INSTALLATION

Install protective device settings in accordance with the manufacturer's published instructions and in accordance with protective device coordination study protective device setting sheets.

Affix detailed arc flash warning labels to all electrical equipment as required by NFPA 70E (most recent edition).

3.2 FIELD TESTING

3.2.1 General

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL applies to this section, with the additions and modifications specified herein.

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

Circuit breakers shall be visually inspected. Current ratings shall be verified 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.

3.2.5 Protective Relays

Protective relays shall be visually inspected. Relay settings shall be

implemented in accordance with the coordination study.

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LIGHTNING PROTECTION SYSTEM

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 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)Normal Measurements

JOHN F. KENNEDY SPACE CENTER (KSC)

KSC-STD-E-0012E	(Rev E; 2001) Standard for Facility Grounding and Lightning Protection

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 780	(2007) Standard for the Installation of Lightning Protection Systems

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-52913	Splice Connectors

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Standard for Grounding and Bonding Equipment
UL 96	(2005) Standard for Lightning Protection Components
UL 96A	(2007) Standard for Installation Requirements for Lightning Protection Systems

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.

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.

Comply with KSC-STD-E-0012E

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

Overall lightning protection system; G

Each major component; G

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Air Terminals

Main and Secondary Conductors

Ground Rods

Clamp-Type Connectors

Lightning Protection Components

Hardware

Accessories

SD-06 Test Reports

Grounding system test; G

Lightning protection system inspection; G

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. 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.

b. Submit detail drawings for each major component to include manufacturer's descriptive and technical literature, catalog cuts, and installation instructions.

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.

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, increase the conductor size to compensate for the hazard 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).

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 I, Class II, or Class II modified materials as applicable.

Size of conductors shall not be less than specified in NFPA 780.

2.1.2 Copper

For Class I materials (structures not exceeding 75 ft in height), provide copper main conductors that do not weigh less than 187 pounds per thousand feet, have a cross section area of not less than and minimum strand size of not less than 17 AWG. Provide loop conductors that are comprised of copper conductors not smaller than No. 4/0 AWG.

2.1.3 Aluminum

For Class I materials (structures not exceeding 75 ft in height), provide aluminum main conductors that do not weigh less than 95 pounds per thousand feet, have a cross section area of not less than and minimum strand size of not less than 14 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 5/8-inch aluminum with length and location as indicated. Fasten air terminals to an aluminum 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 made of solid copper conforming to UL 467. Provide ground rods that are not less than 3/4 inch in diameter and 20 feet in length. Do not mix ground rods of copper-clad steel, stainless steel, galvanized ferrous, or solid copper on the same job.

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, clips, and fasteners that conform to UL 96 classes as applicable.

2.3 MAIN AND SECONDARY CONDUCTORS

Conductors shall be in accordance with NFPA 780 and UL 96 for Class I. Materials shall be aluminum.

Weight of copper conductors shall be not less than 187.5 pounds per thousand feet, and the size of any wire of this cable shall be not less than AWG No. 17. Copper tube or solid-section conductors of copper shall weigh not less than 187.5 pounds per thousand feet, and no tube wall shall be less than AWG No. 20. Thickness of any copper ribbon or strip shall be not less than AWG No. 16. Copper conductors used for counterpoise shall be not smaller than AWG No. 4/0.

Do not allow aluminum to contact or touch the earth, dissimilar metals, or constructions where rapid deterioration of the metal could result. Observe precautions at connections with dissimilar metals. Aluminum cable conductors shall be electrical conductor-grade aluminum and weigh not less than 95 pounds per thousand feet. Size of any wire of the cable shall be not less than AWG No. 14. Aluminum conductors for bonding and interconnecting metallic bodies to the main cable shall be at least equivalent to strength and cross-sectional area of a AWG No. 4 aluminum wire. Aluminum strip conductors for interconnecting metallic bodies to the main conductor cable, when void of perforations, shall be not less than 14 gauge and at least 1/2-inch wide. When perforated, the total cross-sectional area shall not be reduced from that of an unperforated conductor.

Rooftop conductors shall be aluminum. Transition down conductors from aluminum to copper via a bi-metallic conductor after the down conductor leaves the roof.

2.4 CLAMP-TYPE CONNECTORS

Clamp connectors for splicing conductors shall conform to UL 96 and FS A-A-52913, Class 2 noninsulated, style and size as required for the installation. Connectors shall be of corrosion-resistant material and shall afford protection against electrolysis.

2.5 LIGHTNING PROTECTION COMPONENTS

Lightning protection components, such as bonding plates, air terminal supports, 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. 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 or 20 feet in spacing of air terminals less than 2 feet high. 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 of the intersection of imaginary lines dividing the surface into rectangles having sides not exceeding 50 feet in length. 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.

Air terminal tips on buildings used for manufacturing, processing, handling, or storing explosives, ammunition, or explosive ingredients shall be a minimum of 2 feet above the ridge parapet, ventilator or perimeter.

Air terminals shall be a minimum of 5 feet above the opening on open or hooded vents emitting explosive dusts or vapors under natural or forced draft.

Air terminals shall extend a minimum of 15 feet above vent opening on open stacks emitting explosive dusts, gases, or vapor under forced draft.

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. 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

All down conductors shall wrap around the eave of the building. No penetrations of the roofing material shall be allowed.

Make down conductors electrically continuous from 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 Schedule 80 PVC conduit for a minimum distance of 72 inch above finished grade level.

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. Provide welds (including exothermic) for continuation. Provide a ground connection for each down conductor. Attach down conductors to ground rods by welding (including exothermic), brazing, or 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. Extend driven ground rods into the existing undisturbed earth for a distance of not less 20 feet. Set ground rods not less than 2 feet nor more than 10 feet, from the structure. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE Std 81. Maximum resistance of a driven ground rod shall be 10 ohms, under normally dry conditions. For ground loop, provide continuous No. 4/0 bare stranded copper cable or equivalent material having suitable resistance to corrosion. Lay ground loop around the perimeter of the structure in a trench not less than 18 inches below grade, at a distance not less than 2 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 Steel Frame Building

Make the steel framework of the building electrically continuous. Electrical continuity may be provided by bolting, riveting, or welding unless another specific method is indicated. 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 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. Bond all metal piping entering and exiting the building. Bond all underground concrete reinforcing steel. 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 Exterior Pipe Lines

Bond all pipes and conduits that enter the building, preferably to building grounds at points where pipes enter the building. Where a separate ground is provided, bond the pipes to the building ground at points where the pipes are closest to the ground connections. In addition, bond pipes to any metallic masses that are within 6 feet of the pipe.

3.4 SEPARATELY MOUNTED SHIELDING SYSTEM

3.5 RESTORATION

Where sod has been removed, place sod as soon as possible after completing the backfilling. Restore to original condition the areas disturbed by trenching, storing of dirt, cable laying, and other work. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging or mulching in any restoration. Maintain disturbed surfaces and replacements until final acceptance.

3.6 FIELD QUALITY CONTROL

3.6.1 Grounding System Test

Test the grounding system to ensure continuity and that resistance to ground is not in excess of 10 ohms. Test the ground rod for resistance to ground before making connections to the rod. Tie the grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Include in the written report: locations of ground rods, resistance, and soil conditions at the time that measurements were made. Submit results of each test to the Contracting Officer.

3.6.2 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.

3.7 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.

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LOW-VOLTAGE MOTORS

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 1999) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990; R 2000) Load Ratings and Fatigue Life for Ball Bearings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 112	(2004) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ACCEPT	(2003) The NETA Acceptance Testing Specifications
NETA MAINT	(2005) Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; Corrigendum 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerance - International Restrictions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2007; Errata 2008) Standard for Motors and Generators

U.S. DEPARTMENT OF ENERGY (DOE)

DOE CI-1	(2001) How to Buy a Premium Energy-Efficient Electric Motor

1.2 GENERAL 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; 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

Outline drawings for Motors shall indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

SD-03 Product Data

Equipment and performance data shall be submitted for Motors 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.

Submit Manufacturer's Catalog Data in accordance with paragraph entitled, "Equipment," of this section

For Electric Motors rated over 25 and those specified to meet a special vibration class in accordance with NEMA MG 1 indicate number of:

Rotor Bars
Stator Slots
Rotational Speed
Cooling Fan Blades
Bearing Manufacturer
Bearing Style
Bearing Type
Balls/Elements
Commutator Bars
Commutator Brushes
SCR Firing Frequencies (for variable speed motors)

SD-07 Certificates

Certificates shall be submitted for the following tests showing conformance with the referenced standards contained in this section. Certified copies of previous test reports on identical motors may be submitted in lieu of factory test reports.

Factory Test Results
Efficiency
Power-Factor
Service Factor
Temperature Rating
Noise
Full-Load
Locked-Rotor
Insulation Resistance
Winding Resistance

High-Potential Tests

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted for Motors including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

1.4 DESIGN REQUIREMENTS

The following motor design data shall be provided prior to final turnover-number of motor rotor bars, Stator slots, rotational speed; number of cooling fan blades; RPM of motor; bearing manufacturer, bearing type, bearing style and number of balls/elements; number of commutator bars and commutator brushes; and SCR firing frequencies.

PART 2 PRODUCTS

2.1 EQUIPMENT

Submit manufacturer's catalog data for motors and enclosures.

Design, fabrication, testing, and performance of motors shall be in accordance with NEMA MG 1 and ISO 1940-1 and shall meet or exceed the requirements as specified herein.

Testing and performance of polyphase induction motors shall be in accordance with IEEE Std 112, Method B.

Efficiency labeling shall be in accordance with NEMA MG 1.

Allowable balance limits shall be in accordance with ISO 1940-1, Table 1

2.1.1 Efficiency

Motors shall have efficiencies in accordance with the recommended levels specified in DOE CI-1.

2.2 MOTOR TYPES

Motor shall be marked to show the index letter, which shall be the letter shown or a letter that indicates a higher efficiency.

Motors shall be of the following types:

1/3 HP and smaller, single phase - capacitor start

1/2 HP and larger, three-phase - induction squirrel-cage type, NEMA Design B, having normal starting torque and low starting current

Motors shall be designed for across-the-line starting and shall be designed with torque characteristics to carry the specified rated starting load.

Motors shall have factory-sealed ball bearings with an L-10 rated life of not less than 80,000 hours in accordance with ABMA 9 or ABMA 11.

2.3 SIZES OF MOTORS

2.3.1 Motors

Motors shall be of a sufficient size for the duty to be performed and shall not exceed the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions.

2.3.2 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, adjustments shall be 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. Control and protective devices shall be in accordance with Section 26 05 71.00 40.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.4 VOLTAGE RATINGS

Motors shall have 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

2.5 TEMPERATURE RATING AND INSULATION

Motors shall be designed for continuous operation at the rated full load in an ambient temperature of 104 degrees F.

Insulation level shall be at least Class F.

2.6 MOTOR ENCLOSURES

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 shall be the totally enclosed type, with either of the following:

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.

Motors installed in outdoor, nonhazardous locations shall have waterproof enclosures.

2.7 SERVICE FACTOR

Service factor of general purpose and other open ac motors shall be in accordance with NEMA MG 1.

Totally enclosed ac motors shall have a service factor of 1.15.

2.8 FACTORY TESTS

Factory test all motors in accordance with the requirements of NEMA MG 1. Polyphase induction motors shall be factory-tested in accordance with IEEE Std 112, Method B. Tests shall consist 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. Routine tests on wound-rotor induction motors shall include the measurement of wound-rotor open-circuit voltage across the slip rings under locked-rotor conditions. Electrical tests shall consist of 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

Motors shall be installed, aligned, and connected in accordance with the equipment manufacturer's instructions.

Motors shall be bolt mounted. Motor feet shall be coplanar within 0.001 inch. Base mounting points shall be accessible and adjustable to enable machine alignment. Motors over 25 hp shall have alignment jack bolts installed to enable alignment.

Alignment of motors shall be rechecked and adjusted as required after the motor has been in operation for not less than 48 hours.

3.2 ALIGNMENT

Before attempting alignment, the contractor will 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. Values must be compensated for thermal growth. Limited movement of the motor or load (commonly known as bolt-bound) must be corrected to ensure alignment capability. Hold down bolts shall not be undercut in order to perform adjustment.

Shims shall be commercially die-cut, without seams or folds, and be made of corrosion resistant stainless steel. No more than four shims shall be used at any single point.

Motor and load shall be aligned 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

Speed(RPM)	Close-Coupled Offset (mils)	Close-Coupled Angle(mils/in.)	Spool Piece Angle (mils/in. @ coupling pt.)
1800	3.0	0.5	1.0
3600	1.5	0.4	0.5
7200	1.0	0.3	0.4

Motor/load alignment shall be performed under the direction of the manufacturer's representative.

Final alignment settings shall be provided 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. Insulation tests on 480-volt and 600-volt motors shall be conducted using a 1000-volt insulation test set. Insulation tests on motors rated less than 480-volts shall be conducted using 500-volt insulation test set.

Test data shall include the location and identification of motors and megohm readings versus time. Test data shall be recorded at 15, 30, 45 seconds, and in 1 minute increments thereafter up to 10 minutes. Megohm readings shall not be less than 25 megohms for each phase and each phase reading shall be within 10 percent of the other two.

Perform inspections and test procedures on all motors in accordance with NETA ACCEPT 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. The polarization index shall be greater than 1.25. Any values lower shall be rejected and the motor returned to the factory.

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COMMUNICATIONS OPTICAL BACKBONE CABLING

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 C 338	(1993; R 2008) Standard Test Method Softening Point of Glass
ASTM D 4976	(2006) Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 455-25C	(2002) FOTP-25 Repeated Impact Testing of Single-Mode Fiber Optic Cables and Cable Assemblies
EIA 455-33B	(2005) FOTP-33 Fiber Optic Cable Tensile Loading and Bending Test
EIA 455-41A	(1993; R 2001) FOTP-41 Compressive Loading Resistance of Fiber Optic Cables
EIA 455-80C	(1998) FOTP-80 Cutoff Wavelength of Un-cabled Single-Mode Fiber by Transmitted Power
EIA 455-82B	(1992) FOTP-82 Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006; Errata 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48 2009) National Electrical Safety Code

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-87-640	(2006) Fiber Optic Outside Plant Communications Cable

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

EIA/TIA 455-165A	(1993) Standard for Mode-Field Diameter Measurement by Near-Field Scanning Technique
TIA-455-104-A	(1993; R 2005) Standard for FOTP-104 Fiber Optic Cable Cyclic Flexing Test
TIA-455-175-B	(2003) FOTP-175 IEC-60793-1-42 Optical Fibres - Part 1-42: Measurement Methods and Test Procedures - Chromatic Dispersion
TIA-455-78	(2002B) FOTP-78 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation
TIA-526-14-A	(1998) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-526-7	(2002; R 2008) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant OFSTP-7
TIA-568-C.1	(2009) Commercial Building Telecommunications Cabling Standard
TIA-568-C.3	(2008e1) Optical Fiber Cabling Components Standard
TIA-590-A	(1997) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant
TIA-758-A	(2004) Customer-Owned Outside Plant Telecommunications Cabling Standard
TIA/EIA-472DAAA	(1993) Detail Specification for All Dielectric Fiber Optic Communications Cable for Outside Plant Use Containing Class 1a 62.5 Um Core Diameter/125 um Cladding Diameter/250 um Coating Diameter Fiber(s).
TIA/EIA-4750000-C	(1996) Generic Specifications for Fiber Optic Connectors (ANSI)
TIA/EIA-598-B	(2001) Optical Fiber Cable Color Coding
TIA/EIA-604-3A	(2000) FOCUS 3 Fiber Optic Connector Intermateability Standard

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-188-176	(Notice 1) Standardized Profile for Asynchronous Transfer Mode (ATM)

MIL-STD-2042 (Rev B; Notice 1) Fiber Optic Cable Topology Installation Standard Methods for Naval Ships

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Fiber optic cable shall consist of optical fibers, strength members, and jacketing. Associated components shall include optical fiber connectors, optical patch panels, terminal bay cabinets, and splice closures as indicated. Install fiber optic cables in inner duct in the existing cable duct and manhole system and/or directly buried to the facility. Locate fiber optic terminal in existing facility buildings.

References in this section to cable shall refer to fiber optic cable.

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

Submit the following preconstruction submittals to the Contracting Officer for approval and approved 30 calendar days prior to installation.

Quality Assurance Plan

SD-02 Shop Drawings

Fiber Optic System; G

Identify the length, number of fibers, splice tray and termination panel locations, and the general routing for each application.

SD-03 Product Data

Submit manufacturer's product data for the following items. Data shall include a complete list of parts, special tools, and supplies with current unit prices and source of supply.

Fiber Optic Cable, including Media Types; G

Pre-Connected Cable Assembly

Splice Trays and Organizers; G

Fiber Optic Terminations and Connectors Material Data; G

SD-06 Test Reports

Submit contractor test reports for approval to the Contracting Officer not later than 14 calendar days after the completion of each test.

Single-mode OTDR Test

End-to-End Attenuation Tests

End-to-End Bandwidth Tests

1.4 QUALITY ASSURANCE PLAN

Contractor shall prepare and submit a quality assurance plan which provides a detailed outline of all testing to be accomplished. Quality assurance plan shall address whether cladding modes have been stripped prior to testing, source wavelength (peak), spectral width full width/half maximum (FWHM), mode structure, fiber end preparation, and bandwidth measurements of fiber links both greater and less than 1 kilometer. Quality assurance plan shall include, as a minimum, a schedule of when tests will be performed relative to installation milestones, specific test procedure that will be used, a list of test equipment that will be used including manufacturer, model number, range, resolution accuracy and shall conform to the specified requirements.

Submit the test plan to the Contracting Officer for approval at least 30 calendar days before the start of testing.

1.4.1 Fiber Optic System

Provide drawings for the fiber optic cable and pathway system. Provide single line schematic details of the fiber optic and pathway media, splices, and associated construction materials. Drawings shall be in AUTOCAD.DXF or compatible format. Provide Registered Communications Distribution Designer (RCDD) approved drawings of the fiber optic system. Include drawing details of fiber optic terminations. System drawings shall show final configuration, including location, fiber pair count, pathway innerduct arrangement, and pathway assignment of outside plant. FO system shall be compatible with MIL-STD-188-176. Design Pier FO systems for compatibility with MIL-STD-2042 and NAVSEA drawings.

1.4.2 Fiber Optic Cable Installer and Splicer Qualifications

Technicians installing FO media, splices and performing system tests shall be certified and trained in accordance with an approved manufacturers training program. Technicians shall have a minimum of 5 years FO experience in installing equivalent FO systems. Submit FO technician qualifications for approval 30 days before splices are to be made on the cable. Certification shall include the training, and experience of the individual on specific type and classification of FO media to be provided under this contract.

1.4.3 Fiber Optic Field Tests Plan

Prepare and provide technicians and test equipment for field tests of FO media. Conduct OTDR reel tests at the job site prior to installation. Perform OTDR and end to end tests of all installed media. Conduct tests on single mode fiber in accordance with TIA-526-7 for single mode fiber and EIA TIA/EIA-526-14A for multi mode fiber.

1.5 DELIVERY, STORAGE, AND HANDLING

Ship media to job site on factory reels or in factory cartons. Radius of

the reel drum shall not be smaller than the minimum bend radius recommended by the manufacturer for the media. Wind cable on the reel so that unwinding can be done without kinking the cable. Two meters of cable at each end of the reel must be readily accessible for testing. Provide a permanent label on each reel showing length, media, identification number, and date of manufacture. Provide water resistant label and ink on the labels. Apply end seals to each end of the media after testing and before terminating to prevent moisture from entering the cable while stored at the job site. Reels with cable shall be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from zero to 100 percent. Equipment, other than FO media, delivered and placed in storage shall be stored with protection from weather, humidity and temperature variation, dirt and dust, or other contaminants.

Exercise care in handling materials during construction. Contractor shall ensure that the buried cable is fed through the plow into the ground at zero tension. Do not allow tension to develop in the cable.

Whenever the plow is stopped, sufficient cable shall be unreeled to guard against sudden jerks when the plow is started.

Exercise caution to ensure that the plow is not backed up while the blade is in the ground. Cable can be severely damaged by the plow backing up even a slight amount. During the plowing operation, the plow may strike a buried object or rock that would stop the equipment and necessitate removal of the plow from the ground. When this occurs, remove the plow carefully without backing up. When it is necessary to back the plow, uncover the cable a sufficient distance back from the plow for inspection by the Contracting Officer to determine if there is any damage. Immediately report any damage to the Contracting Officer. Repair or replace damages as directed by the Contracting Officer.

1.6 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

PART 2 PRODUCTS

2.1 FIBER OPTIC CABLE DESIGN

2.1.1 Fiber Optic Media Types

FO media shall meet all performance requirements of TIA-568-C.1, TIA-568-C.3 and the physical requirements of ICEA S-87-640 and TIA/EIA-598-B.

2.1.1.1 Single Mode Fiber Media

Provide FO single mode media with outer sheath jacket, strength member, ripcords, water blocking material, core tube, and core fibers as installed in a permanent underground pathway system as shown on the construction drawings. Media shall have all glass, dual window, graded index material with a core diameter of 8.7 microns. Coat fiber with a cladding material which is concentric with the core. Fiber cladding diameter shall be nominal 125 microns. Media shall have a transmission window centered at 1300 and 1550 nanometer wavelengths, attenuation at 1550 nanometers shall be less than 0.5 dB per kilometer. FO media shall comply with TIA/EIA-472DAAA,and TIA-758-A.

2.1.2 Cable Length

Cable shall be manufactured continuous with no factory splices.

2.1.3 Materials and Construction

Materials used within a given cable shall be compatible with all other materials used in the same cable when such materials come into intimate contact. All cable components used shall have no adverse effect on optical transmission or on the mechanical integrity characteristics of the fiber placed in the cable. All materials used shall be non-toxic, non-corrosive, and present no dermal hazard.

Minimum required material components applied to fiber optic cable construction shall be central core member, color-coded optical fiber, color-coded loose tube buffer, with gel-free waterstop, inner jacket, pulling strength members, and outer jacket. Variations in sequence and construction structural components will be considered when necessary.

2.1.3.1 Central Core Member

Include a central core member to serve as a cable core foundation to reduce strain on the fibers but not to serve as a pulling strength member. Material of the central core member shall be non-metallic.

2.1.3.2 Optical Fibers

Two types of optical fibers, single-mode fiber and multi-mode fiber, shall be contained in the cable and shall be as follows:

Single-Mode (SM) fiber must be the equivalent step index optical glass. Core diameter of the fiber shall be approximately 8.7 micrometer. Cladding diameter shall be 125 plus or minus 3 micrometer. Core cladding offset shall be less than 1 micrometer. Minimum tensile strength of the fiber after primary protective coating shall be greater than 50,000 psi . Softening point of the clad material of the optical fiber shall be 1630 degrees C plus or minus 50 degrees C in accordance with ASTM C 338, or the optical fiber shall meet the requirements in paragraph entitled, "Splice Compatibility Test."

2.1.3.3 Fiber Primary Protective Coating

Coat optical fiber with suitable material to preserve the intrinsic high tensile strength of the glass fiber. Outside diameter of the coated optical fiber shall be 250 plus or minus 15 micrometer. Coating material shall be readily removable, mechanically or chemically, without damaging the optical fibers when the removal is desired.

2.1.3.4 Optical Fiber Color-Code Coating

Primary protective coated SM and MM fibers shall be coated with a color-code coating for individual fiber identification. Maximum outside diameter of color-code coated fiber shall be less than 300 micrometer.

2.1.3.5 Loose Tube Buffering

Surround color-code coated fibers with a loose tube buffering for protection from external mechanical and environmental influences. Provide

with gel-free waterstop material to prevent water migration. Color code loose tube buffering for the tube identification. Material of the buffering tube shall be PVC.

2.1.3.6 Colorants

Color concentrates or inks used to color code the optical fibers and the loose buffer tube shall not be susceptible to migration and chemical reaction with gel filling compound.

2.1.3.7 Number of Fibers Per Tube Per Cable

36-fiber cable and 72-fiber cable are required and shall be as follows:

36-fiber cable shall contain single mode fibers. Cable core configuration shall be comprised of six loose buffer tubes, each containing six fibers. Six fibers in each loose buffer tube shall be color coded using the first colors of the standard Munsell color code, Blue, Orange, Green, Brown, Slate, and White. Loose buffer tubes shall be color coded using the standard Munsell color code, Blue, Orange, Green, Brown and Slate. Sixth buffer tube shall be Pink. Consider single mode fibers last in configuration.

72-fiber cable shall contain single mode fibers. Cable core configuration shall be comprised of 12 loose buffer tubes, each containing six fibers. Six fibers in each loose buffer tube shall be color coded using the first colors of the standard Munsell color code, Blue, Orange, Green, Brown, Slate and White. Color code loose buffer tubes using the standard Munsell color code, Blue, Orange, Green, Brown, Slate, Red, Black, Yellow, and Violet. Eleventh and twelfth buffer tubes shall be Blue/White and Orange/White, respectively. Consider single mode fibers last in configuration.

2.1.3.8 Inner Jacket

Locate buffer tubes concentrically around the cable central core member and covered with a polyethylene inner jacket. Polyethylene inner jacket shall be high density polyethylene in accordance with ASTM D 4976. Space between the buffer tubes and inner jacket shall be filled with a gel-free compound to prevent air, moisture, or water intrusion in the inner jacket.

2.1.3.9 Pulling Strength Member

Use a ramid type material as pulling strength members in the cable to provide pulling strength of at least 400 pounds for the cable during installation.

2.1.3.10 Cable Outer Jacket

Black high density, high-molecular weight, polyethylene materials in accordance with ASTM D 4976 shall be applied longitudinally over all the inner jacket and sheathing strength member to form the cable outer jacket. Outer jacket shall be smooth, concentric, non-nutrient to fungus, and free from holes, splits, blisters, or other imperfections. Overall outside cable diameter shall not exceed 0.75 inch.

2.1.3.11 Metallic Armor

Provide a metallic armor shield for direct buried cable for additional

tensile strength, rodent protection, and high crush and moisture resistance. Material of the metallic armoring shall be metallic tube or steel corrugation-coated with anti-corrosion material, sealed at the longitudinal overlap.

2.2 CABLE IDENTIFICATION SYMBOL

First of three lines on the ID symbol employ 5 characters.

First and second characters, from left to right, shall denote the number of active optical fibers in the cable.

Third character shall be a slash.

Fourth and fifth characters shall denote optical transmission windows which the optical fiber can support. These windows are defined herein as follows:

Fourth character shall be an "A" or an "O." The "A" denotes a window at a wavelength of 850 nanometers (nm) with an attenuation of 4 dB/kilometer (km) and a bandwidth of 800 MHz-km. Character shall be an "O" if these requirements are not met.

Fifth character shall be a "B" or an "O." The "B" denotes a window at a wavelength of 1,300 nanometer (nm) with an attenuation of 1.0 dB/km and a bandwidth of 1,000 MHz-km. Character shall be an "O" if these requirements are not met.

Two lower lines of the cable ID symbol indicate multi-mode or single mode fibers, the cable number and the fiber count:

Example: 72/OB Identifies the number of optical fibers (72) and the optical transmission window (OB - See preceding paragraph).

FM05 : 61-120 Identifies Multi-Mode Fiber Cable 05 with MM Fibers 61 through 120.

and FS05 : 13-24 Identifies Single Mode Fiber Cable 05 with SM Fibers 13 through 24.

2.3 REPLACEMENT CABLE

In addition to the cable sections indicated, a reel of each size and type of the manufacturer's furnished cable, provide not less than 0.5 kilometers.

2.4 SPLICE TRAYS AND ORGANIZERS

Single mode fibers shall be fusion spliced with a protective sleeve covering and stored in an organizer with a minimum of 18 inches spare coiled buffer tubing.

Complete fiber splice of all fibers in the cable in an outer closure. Provide organizer assembly to hold the splice trays, each tray containing 12 fusion splices.

Fill space between the inner and outer closures with encapsulating fluid. Factory drill end plates to fit the cable(s) outer diameter.

2.5 PRE-CONNECTED CABLE ASSEMBLY

Contractor shall supply factory assembled pre-connectorized cable assembly to interface with the patch panel bulkhead feed-through receptacle. Contractor shall supply and install dust caps for all terminated fibers.

Single-mode fiber optic cable assembly shall be comprised of a single fiber connector terminated on the three (3) meter length of single fiber, single mode cable. Single fiber cable shall contain a buffered optical fiber and be the same as that provided in the multi-fiber cable. Return loss for single mode connectors shall be a minimum of minus 30dB.

Connector/cable interface on both the single and multi-mode cable assemblies shall be able to withstand a tensile force of 25 pounds without detrimental affects on the connector loss characteristics.

Each connectorized cable assembly shall have a loss of less than or equal to 0.5 dB.

2.6 OPTICAL AND MECHANICAL PERFORMANCE REQUIREMENTS

Fiber optical cable shall comply with the following optical and mechanical test requirements.

2.6.1 Optical Performance

2.6.1.1 Single-Mode Fibers in the Cable

Optical attenuation of each optical fiber in the cable (reeled) shall be no greater than 0.5 dB/Km at 1300 plus or minus 50 nm optical spectrum window. Measure attenuation on completed cable reel length, and normalized linearly to 1 Km. Measurement method shall be in accordance with TIA-455-78, at central wavelength 1300 nm nominal.

Pulse dispersion of each optical fiber in the cable (reeled) shall be no greater than 3.5 picosecond/nm-Km within the emissive region of 1285-1330 nm. Measurement method shall be in accordance with TIA-455-175-B.

Mode field diameter at 1300 nm optical spectrum window shall be within 10 plus or minus 1 micrometer. Measurement method shall be in accordance with EIA/TIA 455-165A at central wavelength 1300 nm nominal. When this requirement is not met, apply the fusion splice compatibility test.

Cut-off wavelength for 1300 nm optical spectrum window shall be within 1200 plus or minus 70 nm. Measurement method shall be in accordance with EIA 455-80C.

2.6.2 Mechanical Performance

2.6.2.1 Minimum Bend Radius

Cable shall be able to withstand bending to a minimum radius of 10 times the cable outer diameter without tensile load applied, and of 20 times the cable outer diameter with maximum tensile load applied (during installation), without damage to cable components or degradation of the optical fiber performance at room temperature.

2.6.2.2 Tensile Strength

Fiber optical cable shall withstand a pull force of at least 400 pounds to be applied to the pulling strength member during the installation, and a tensile load of at least 300 newtons during operation without incurring any damage or detriment to fiber optical cable and optical performance. Tensile strength test shall be in accordance with EIA 455-33B.

2.6.2.3 Flexing or Bending Cycles

Fiber optical cable shall withstand at least 20 bending cycles at minimum bend radius without damage to the fiber optic cable components or degrading optical performance. Cyclic flexing test shall be in accordance with TIA-455-104-A.

2.6.2.4 Crush Resistance

Minimum crush resistance of the fiber optical cable shall be greater than 650 newton/centimeter (cm) without damage to cable components or degrading optical performance. Crush resistance test shall be in accordance with EIA 455-41A.

2.6.2.5 Impact Resistance

Fiber optical cable shall be capable of withstanding 20 impacts, at five newton-meters force, without damage to cable components, or degradation of optical performance. Impact resistance test shall be in accordance with EIA 455-25C.

2.6.2.6 Fluid Penetration

Optical cable shall be capable of preventing the entry and axial migration of pressurized water when subjected to fluid penetration testing in accordance with EIA 455-82B.

2.7 TEMPERATURE ENVIRONMENT

Fiber optical cable shall comply with the mechanical performance requirements herein while used in duct applications where the temperature varies from minus 8 degrees C to plus 38 degrees C. Optical performance degradation shall be less than five percent of the optical performance requirements in the temperature range of minus 20 degrees C to plus 60 degrees C. Do not damage fiber optical cable in storage where the temperature may vary from minus 40 degrees C to plus 65 degrees C.

2.8 SPLICE COMPATIBILITY TEST

When the material of the optic fiber is different from Cornings' Class Code No. 1517 for multi-mode graded index fiber and No. 1528 for single-mode fiber, perform and document the Splice Compatibility Test as follows:

Vendor shall select fiber samples from a minimum of 3 different production lots of the fiber type proposed for the job.

Vendor shall fabricate and measure a minimum of 10 fusion splices using fiber from the different production lots and a sample of Corning fiber, Class Code No. 1517 and No. 1528, supplied by the Government.

Measure fusion splices using an Optical Time Domain Reflectometer

(OTDR) operating in the region of 1250 through 1350 nm. The insertion loss of the fusion splice shall be the average of two OTDR measurements, one taken with the OTDR installed on the Corning fiber, and the other with the OTDR installed on the vendor's fiber. Vendor's fiber and the Corning fiber shall each be a minimum of 1 Km in length throughout the testing.

Consider vendor's fiber compatible with the Corning fiber if the maximum splice insertion loss of each of 10 fusion splices tested measures less than 0.2 dB.

Vendor shall be allowed a maximum of three retries on any one splice to obtain a loss of 0.2 dB or less.

Perform these tests under Government supervision.

2.9 FIBER OPTIC TERMINATIONS AND CONNECTORS

FO connectors shall be SC type and comply with TIA/EIA-4750000-C and TIA/EIA-604-3A.

2.10 PREPARATION FOR DELIVERY

Ship media on reels. Provide 6 1/2 feet pigtails on each end of media accessible for testing. Reel drum shall comply with manufacturers recommended bend radius for the media. Wind media on reel so that unreeling can be done without kinking the media. Attach a permanent waterproof label with indelible text on reel showing the length, media type, bandwidth, attenuation, and date of manufacture.

2.11 FACTORY REEL TEST

Test 100 percent OTDR test of FO media at the factory prior to shipment in accordance with TIA-568-C.1 and TIA-568-C.3. Use TIA-526-7 for single mode fiber and EIA TIA/EIA-526-14A Method B for multi mode fiber measurements. Calibrate OTDR to show anomalies of 0.2 dB minimum. Provide digitized or photographic traces to the Contracting Officer.

2.12 MISCELLANEOUS ITEMS

2.12.1 FO Media Tags

Provide stainless steel, 1 5/8 inches in diameter 1/16 inch thick, and circular in shape.

2.12.2 Buried Warning and Identification Tape

Provide color, type and depth of tape as specified in paragraph "Buried Warning and Identification Tape" in Section 31 00 00 EARTHWORK, FO media must be marked and protected as required by TIA-590-A.

2.12.3 Grounding Braid

Grounding braid shall provide low electrical impedance connections for dependable shield bonding. Make braid from flat tin-plated copper.

PART 3 EXECUTION

3.1 FIBER SPLICES

Outside plant fiber splices shall be fusion type and made along the fiber route. Splices shall exhibit an insertion loss not greater than 0.2 dB. Make all splice measurements at 1300 nm, plus or minus 5 nm. Mount all splices in trays. Do not increase number of splices.

Cover completed splice with a protective sleeve heat shrink type to restore the protective properties of the fiber coating and buffering. Deviations to the splice, location and pulling plan will be permitted, upon approval by the Contracting Officer, and shall be provided at no additional cost to the Government.

All fiber colors shall be continuous from end to end. No switching or staggering of color scheme within the cable at splice points shall be allowed. Splice fibers in order with multi-mode fibers identified first and single mode fibers at the end.

Bring cables out of the manhole in a controlled environment to perform the fiber fusion splice operation. Complete splice by returning the cable to the manhole such that the excess cable does not impede future entrance and utilization. Secure cable at regular intervals.

3.2 INSTALLATION

Install and test the FO media in accordance with contract drawings, specifications, IEEE C2, NFPA 70, and TIA-590-A. Provide all necessary power, utility services, technicians, test equipment, calibration equipment as required to perform reel and final acceptance tests of the media. All media which fail the factory or reel tests or final acceptance field tests shall be replaced and re-tested at the contractors expense. Splices are not permitted unless shown on the construction drawings. Field test splices within 24 hours after splice installation. Test splices to demonstrate a maximum 0.2 dB loss. Provide a splice box for each field splice. Provide a minimum of 2 meters for routing and testing media. Protect media ends of unspliced FO media during splicing operations.

3.2.1 Contractor Damage

Promptly repair indicated utility and communications lines or systems damaged during site preparation and construction. Damage to lines or systems not indicated, which are caused by contractor operations, shall be treated as "Changes" under the terms of the Contract clauses. When Contractor is advised in writing of the location of a non-indicated line or system, such notice shall provide that portion of the line or system with "indicated" status in determining liability for damages. In every event, immediately notify the Contracting Officer of damage.

3.3 BURIED CABLE INSTALLATION

3.3.1 Location

Location of the cable splice overlaps shall be as indicated. Contractor shall ensure that all cable ends are sufficiently long before cutting.

3.3.2 Field Staking

When staking the cable plow or trench line, place stakes at least every 100 feet in level country and more frequently in rolling country or in dense vegetation, so that the construction force can sight at least two successive stakes at all times. Stakes should be placed at changes in direction, the beginning and end of all turns should be staked clearly. Where existing buried cable is encountered within 2 feet of the proposed line, decrease the distance between stakes to a minimum of 10 feet. When possible, stakes should project above the vegetation along the line. When a road or other crossings are involved, stakes should be placed at both extremes of the right-of-way.

A stake, with the appropriate number or explanation noted on it, should be used to show the location of each caution point, such as underground utility crossings and culverts; miscellaneous points, such as physical cable protection; and buried cable warning sign locations.

3.3.3 Method of Cable Placement

All direct buried cable shall have a warning tape placed above it as indicated.

Depth of buried cable in soil measured from the top of the cable to the surface of the ground shall be a minimum of 36 inches, when existing utilities are crossed, use hand excavation at a distance of no less than 4 feet on each side of the utility.

3.3.3.1 Open Trench Method

Contractor shall observe the following when placing cable by the open trench method:

Trench shall be free of all rock and debris.

Pull cable from cable reel truck or dolly and place in the trench by hand.

Place cable in trench as soon as practical and backfilled immediately to avoid cave-in, and ensure safe operational conditions.

An inspector shall walk closely behind the cable reel dolly and ensure that the cable lies flat on the trench bottom, and is placed at the required minimum depth.

Pull cable by hand on each end simultaneously, to remove excess slack, prior to backfilling.

Backfill trench in 6-inch lifts to ensure proper fill. Each backfill lift shall be compacted with hand tamp tools. First lift shall be hand tamped prior to placing the cable.

3.3.3.2 Direct Plow Method

Contractor shall observe the following when placing cable by the direct plow method:

Plow shall be clear of any obstruction which may damage cable and ensure that all rollers on the tractor and on the plow turn freely and

are properly located.

Cable shall be hand fed off the reel at all times to ensure that no damage is done to the cable due to excess tension.

An inspector shall walk closely behind the plow and inspect the cable for any blemish or damage, and ensure a free and continuous flow of the cable from the reel to the plow. Inspector shall ensure that the cable is plowed at the minimum required depth.

3.3.4 Compaction

Plow slot shall be compacted following the plowing in or trenching of wire or cable.

3.4 UNDERGROUND CABLE INSTALLATION

Inner duct assignment of individual cables shall be as indicated. Do not place cables in ducts other than those specified.

Exercise adequate care when handling and storing reels of cable to prevent damage to the cable. Cable with dents, flat spots, or other sheath distortions shall not be installed.

3.4.1 Securing Cable

Immediately after cable placement, a permanent identification tag as indicated shall be attached to visible cable sections. Check cables to ensure that the markings are intact.

Support and secure cables and equipment as indicated. Where the specific method of support is not shown, supports and fasteners shall be used to secure cables and equipment in position. Metallic supports and fasteners shall have a corrosion resistant finish. Rout all cables along the interior sides of manholes.

Two or more cable hooks shall be required per manhole.

Use clamps and straps as necessary to properly secure the cable.

3.4.2 Bending

Use caution when bending cable to avoid kinks or other damage to the sheath. Bend radius shall be as large as possible with a minimum of 10 inches. Increase minimum radius when necessary to meet cable manufacturer's recommendation. Do not rest cables against any sharp edges.

Pull and splice cable in the manner and at the locations shown.

3.4.3 Pulling

Attach pulling lines to both cable ends when cable is destined for bi-directional pull, and fitted with factory-installed pulling eyes. Cables not equipped with a pulling eye shall have the pulling line attached to the cable end by means of a cable grip. Do not use core hitches.

Locate and align cable reels so that the cable is paid out from the top of the reel into the duct or conduit in a long, smooth bend without twisting. Do not pull cable from the bottom of the reel. Use a cable feeder guide of

proper dimensions at the mouth to guide the cable into the duct or conduit.

Rigging shall be set up at the pulling end so that the pulling line and cable exit on a line parallel with the duct or conduit to prevent either from rubbing against the edge or mouth. Do not pull cable ends around sheave wheels. When the sheave or pulley cannot be positioned to obtain sufficient cable end slack for proper racking and splicing with the pulling line attached to the end of the cable, a split cable grip may be used to obtain the necessary slack.

3.4.4 Lubricant

Pulling lubricant, shall be used to minimize pulling tension and prevent sheath damage when pulling cables into ducts and conduits. Apply lubricant to the cable sheath with a lubricator. When pulling has been completed, the exposed cable ends shall be wiped clean of lubricant.

Lubricants shall be compatible with and intended for use with plastic-sheathed cables. Do not allow soap and grease type lubricants.

All equipment and the pulling set shall be checked to minimize interruptions once pulling begins. Pull cable without stopping until the required amount of the cable has been placed. When the pulling operation is halted before the pull is completed, the tension of the pulling line shall not be released. When pulling is resumed, the inertia of the cable shall be overcome by increasing the tension in small steps a few seconds apart until the cable is in motion. Cable shall be paid from the top of the reel by rotating the reel in the feed direction at the rate of pull. Cable shall not be stripped off the reel by pulling.

3.4.5 Damage and Defects

Contractor shall use a tension monitoring device to ensure that the maximum pulling tension that may be applied to the cable to be pulled into a conduit section is not exceeded. Any damage to the cable due to exceeding the maximum tension will require a new cable furnished by the Contractor.

Carefully inspect cable for sheath defects or other irregularities as it is paid out form the reel. When defects are detected, pulling shall stop immediately and the cable section shall be repaired or replaced at the discretion of the Contracting Officer. Maintain a system of communications between pulling and feed locations so that pulling can be stopped instantly, when required.

Hand guide cable through intermediate manholes and into the next duct section when making pull-throughs. Use proper rigging in the intermediate manhole to keep the pulling line and cable aligned with the exit duct to prevent the line or cable from rubbing against the edge of the duct. Cables in pull-through manholes shall be set up and racked before the cable ends in adjacent manholes are set up and racked.

Cable ends pulled into manholes, vaults, or terminal locations that are not to be racked or otherwise permanently positioned immediately shall be tied in fixed positions to prevent damage to the cables and provide adequate working space.

3.4.6 Seal

Ducts or innerduct in which cable is placed shall be sealed with urethane

foam duct seal. Insert this material between the cable and the duct or innerduct of which it is in, between the innerduct and the duct, and in all unused innerduct, in order to prevent damage to the cable sheath and to prevent the entrance of dirt or water into the manhole or vault.

Provide cables in continuous lengths as required to accomplish the required installation without splices from termination to termination, except where field splices are specifically shown.

3.5 CABLE INSTALLATION IN CABLE TRAYS

Do not install communication cables in the same cable tray with ac power cables.

Cables placed in cable trays shall be installed in a neat and orderly manner and shall not cross or interlace other cables except at breakout points.

Individually retain cables in vertical trays with straps at a maximum of 6 feet on center.

3.6 GROUNDING SYSTEMS

Ground cables at each termination point or as indicated.

3.7 DIRECT BURIAL SYSTEM INSTALLATION

Installation shall be in accordance with TIA-590-A. Under railroad tracks, paved areas, and roadways install cable in conduit encased in concrete. Slope ducts to drain. Excavate trenches by hand or mechanical trenching equipment. Provide a minimum cable cover of 24 inches below finished grade. Trenches shall be not less than 6 inches wide and in straight lines between cable markers. Do not use cable plows. Bends in trenches shall have a radius of not less than 36 inches. Where two or more cables are laid parallel in the same trench, space laterally at least 3 inches apart. When rock is encountered, remove it to a depth of at least 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 1/4 inch. Do not unreel and pull cables into the trench from one end. Cable may be unreeled on grade and lifted into position. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.7.1 Media Placement

a. Separate FO media crossing other cables or metal piping from the other cables or pipe by not less than 3 inches of well tamped earth. Do not install FO media under or above traffic signal loops.

b. Media shall be in one continuous length without splices except where splices are shown on the drawings.

c. Do not allow bends in media which exceed the manufacturers minimum recommended radii. Do not bend media to a radius less than 10 times the outside diameter of the media.

d. Leave a horizontal slack of approximately 3 feet in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought above ground. Where cable is

brought above ground, leave additional slack to make necessary connections.

3.7.2 Identification Slabs (Markers)

Provide a marker at each change of direction of the cable, over the ends of ducts or conduits which are installed under paved areas and roadways and over each splice. Identification markers shall be of concrete, approximately 20 inches square by 150 mm 6 inches thick and stake mounted warnings meeting the requirements of REA.

3.8 RECONDITIONING OF SURFACES INSTALLATION

3.8.1 Unpaved Surface Treatment

Restore unpaved surfaces disturbed during the installation of direct burial cable to their original elevation and condition. Carefully preserve existing sod and topsoil and replace after the back-filling is completed. Replace damaged sod with sod of quality equal to that removed. Where 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.

3.9 CABLE PULLING

Test duct lines with a mandrel and swab out to remove foreign material before the pulling of FO media. Avoid damage to cables in setting up pulling apparatus or in placing tools or hardware. Do not step on media when entering or leaving the maintenance holes. Do not place media in ducts other than those shown without prior written approval of the Contracting Officer. Roll cable reels in the direction indicated by the arrows painted on the reel flanges. Set up media reels on the same side of the maintenance hole as the pathway section in which the media is to be placed. Level the reel and bring into proper alignment with the pathway section so that the media pays off from the top of the reel in a long smooth bend into the duct without twisting. Under no circumstances shall the media be paid off from the bottom of the reel. Check the equipment set up prior to beginning the media cable pulling to avoid an interruption once pulling has started. Use a cable feeder guide of suitable dimensions between media reel and face of duct to protect media and guide cable into the duct as it is paid off the reel. As media is paid off the reel, lubricate and inspect media for sheath defects. When defects are noticed, stop pulling operations and notify the Contracting Officer to determine required corrective action. Stop media pulling if reel binds or does not pay off freely. Rectify cause of binding before resuming pulling operations. Provide media lubricants recommended by the cable manufacturer. Provide 3.3 feet of spare media in all manholes and enclosures for final termination and testing.

3.9.1 FO Media Tensions

Install FO media as shown on construction drawings. Provide devices to monitor media tension during installation. Do not exceed manufacturers recommended maximum FO tensions and bending radii during installation.

3.9.2 Pulling Eyes

Equip media 1-1/4 inches in diameter and larger with cable manufacturer's factory installed pulling-in eyes. Provide media with diameter smaller than

1-1/4 inches with heat shrinkable type end caps or seals on cable ends when using cable pulling grips. Do not beat rings to prevent grip from slipping into the cable sheath. Use a swivel grip of 3/4 inch links between pulling-in eyes or grips and pulling strand.

3.9.3 Installation of Media in Maintenance Manholes, Handholes, and Vaults

Do not install media utilizing the shortest route, 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 media on brackets and cable insulators at a maximum of 4 feet. In existing maintenance manholes, handholes, and vaults where new ducts are to be terminated, or where new media are to be installed, modify the existing installation of media, cable supports, and grounding as required with cables arranged and supported as specified for new media.

3.10 GROUNDING

Ground exposed non current carrying metallic parts of telephone equipment, media sheaths, media splices, and terminals.

3.11 HOUSEKEEPING

The Contractor shall be responsible for cleaning up work area and maintaining the work area in orderly condition.

3.12 CABLE DELIVERY

Deliver replacement cable reels to the Government as directed by the Contracting Officer.

3.13 TESTING

As a minimum, the Contractor shall test each fiber cable before and after installation for any faults or attenuations using an Optical Time Domain Reflectometer (OTDR). End-to-end attenuation tests shall also be conducted after complete installation.

All test equipment, test procedures, and testing techniques shall be specified in the quality assurance plan and will require approval prior to execution. Tests shall be conducted by the Contractor in accordance with the approved Quality Assurance Plan. Field tests shall be witnessed by the Contracting Officer. Contracting Officer shall be given at least 20 calendar days notice prior to performing each test.

Each test sheet shall have a sign-off blank for the Contractor as well as the Contracting Officer. Deliver copies of the completed test forms and test results as indicated.

Sequential cable markings along the cable, prior to and after each end of splice point, shall be recorded on the sequential cable form and submitted for approval.

Submit test results on all installed fiber cabling before and after each pre-connectorized cable assembly splice is completed.

Contractor shall maintain an accurate test record during all field tests.

3.13.1 Field Reel Tests

Perform the following tests on FO media at the job site before it is removed from the cable reel. For cables with factory installed pulling eyes, perform these tests at the factory and certified test results shall accompany the media. Perform OTDR tests with media on reels and compare factory and field test data.

3.13.1.1 Reel Test Results

Provide results of reel tests to the Contracting Officer at least 5 working days before installation is to commence. Results shall indicate reel number of the media, manufacturer, type and number of fiber tested, and recorded readings. When reel tests indicate that the media does not comply with factory reel test results remove the media from the job site and replace with compliant media.

3.13.2 Final Acceptance Tests

Perform end-to-end tests including power meter light source and OTDR tests. Perform OTDR measurements as required by TIA-568-C.1 and TIA-568-C.3. Test single mode fiber in accordance with TIA-526-7 (Optical Power Loss). Test multi mode fiber in accordance with TIA-526-14-A(Optical Power Loss).

3.13.2.1 Test Results

Provide results of final acceptance tests (attenuation tests, OTDR traces, etc.), to the Contracting Officer at least 5 working days after completion of tests.

3.14 TEST REQUIREMENTS

Test equipment used for verifying installation testing shall be calibrated by a certified testing company within 3 weeks of use.

3.14.1 Single-mode OTDR Test

The Optical Time Domain Reflectometer (OTDR) shall conform to the following minimum requirements:

Operating wavelengths: 1,300 plus or minus 20 nanometers

Attenuation Range (one way): minimum 15 dB at 1,300 nm

Attenuation Resolution: 0.01 dB

Accuracy: plus 0.5 dB.

OTDRs shall have digital readout capability and shall have a means of providing a permanent record in the form of a strip chart.

3.14.2 End-to-End Attenuation Tests

An attenuation measurement test set shall consist of an optical power meter and an optical power source. Attenuation measurement test set shall be in accordance with the applicable National Bureau of Standards (NBS) standards for a stable optical source. Meter may be analog or digital. Include end-to-end attenuation test reading on the test reference loss. Measurement test set shall conform to the following minimum requirements:

Operating wavelengths: 1,300 plus or minus 10 nanometers

Attenuation Range: at least 30 dB at 1,300 nm

Attenuation Resolution: 0.01 dB

Accuracy: The accuracy of the attenuation measurement test set shall be plus or minus 5 percent.

Optical source shall be capable of coupling sufficient power into the fiber so that the light received at the meter is within the meter delectability limits.

3.14.3 End-to-End Bandwidth Tests

Bandwidth test shall conform to the following minimum requirements:

Operating wavelengths: 1,300 plus or minus 10 nanometers

Bandwidth range: minimum 1000 megahertz

Bandwidth Resolution: 1 megahertz

Accuracy: plus or minus 0.5 megahertz

Measurement Method: Swept Frequency

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FIRE DETECTION AND ALARM

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

FM GLOBAL (FM)

FM P7825	(2009) Approval Guide

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

JOHN F. KENNEDY SPACE CENTER (KSC)

KSC-STD-F-0004F	(2010) Fire Protection Design, Standard for

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2009; Amd 09-1 & 09-2) Life Safety Code
NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 72	(2010) National Fire Alarm Code
NFPA 75	(2009) Protection of Information Technology Equipment
NFPA 90A	(2009) 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, 2008) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2006; Rev thru Sep 2009) Surge Protective Devices
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 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 464	(2009) Standard for Audible Signal Appliances
UL 497B	(2004; Rev thru Oct 2008) Protectors for Data Communication and Fire Alarm Circuits
UL 2196	(2006) UL Standard for Tests for Fire Resistive Cables, 1st Edition
UL Fire Prot Dir	(2009) 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 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

Software Programs

As-Built Record Drawings (hard copy and AutoCAD)

Fire Alarm System Acceptance Test Procedures

Fire Service Floor Plans

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

CRMS Reporting Equipment; G

Smoke Detectors; G

Manual Alarm Stations; G

Alarm Bells; G

Strobe Units; G

Water Flow Alarm Devices

Valve Tamper Switches

Remote Auxiliary Control Relays

Power Source

Line Voltage Surge Suppressors

Low Voltage Surge Suppressors

Wiring (Wire and Multi-Conductor Cable)

Paint

Indicate VOC content for each product used.

SD-05 Design Data

Design Analysis and Battery Calculations G

Submit list of parts and components for the installed system by manufacturer's name, part number, and nomenclature, and recommended stock level required for normal maintenance and unscheduled repairs.

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.

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 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 before starting work.

b. Submit Product Data (Catalog Data), Contractor's Certifications, and Quality Assurance Plan, within 30 days before starting work.

c. Submit connection drawings, module schematic drawings, design analysis and battery calculations within 30 days before starting work.

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 r ecord 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 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 b attery 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 n etwork software programs, battery calculations, completed final test p rocedures, 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 c alculations, 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, 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, dry pipe sprinkler risers, and all other equipment associated with the fire alarm system(s). Also, annotate 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 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, dry pipe sprinkler risers, and all other equipment associated with the fire alarm system(s). 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 size 18 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 paragraph entitled "Fire Alarm Control Panel" of this section.

Submit list of parts and components in accordance with the paragraph entitled "System Requirements," of this section.

1.4 SYSTEM REQUIREMENTS

Provide a non-addressable, modular type, microprocessor based, supervised, non-coded electrical fire alarm system with NFPA 72 Class A initiating device circuits,notification appliance circuits, and auxiliary control circuits. Provide NFPA 72 Class A signaling line circuits, Style 6, and Central Radio Monitoring System (CRMS) network reporting circuits, Style 7. 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.

Electrically connect the fire alarm system to report alarm, trouble, and supervisory signals to the CRMS; to sound the general alarm continuously; and to control auxiliary equipment such as dampers, air handling units, etc., upon operation of one or more initiating devices. For initiating, notification, signal, and auxiliary control circuits, use 24 V(DC).

Ensure the system conforms to all the applicable requirements of NFPA 70, NFPA 72, NFPA 75, NFPA 90A, NFPA 101, and KSC-STD-F-0004F.

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.

Components installed under this contract can not be more than one (1) year older than the date of installation.

Components installed under this contract cannot be more than one 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 it's 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 non-addressable FACP, of modular construction with solid state, microprocessor based electronics. Include non-volatile programmable operating system memory for all operating requirements in the panel.

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 FACP 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 device or zone in alarm and transmits an alarm condition to the remote CRMS. 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 non-addressable device network. Utilize network polling methods and provide two-way Class A, Style 6 supervised communications between the FACP and non-addressable smoke detectors and monitor, signal, or control non-addressable modules. 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 non-addressable device or zone in supervisory alarm and transmit a supervisory condition to the remote CRMS.

Provide FACP with all components necessary to operate and supervise the circuits for auxiliary power supplies indicated and auxiliary devices controlling equipment such as ventilating fans, air handling units, fan coil units, damper motors, solenoids, 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 by-pass switches for all auxiliary control devices in the FACP. Ensure by-pass switches are supervised to report supervisory signal when in the maintenance (by-pass) position. Provide switches used for by-pass 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, FACP enclosure open, 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 CRMS.

Provide alarm, supervisory, and trouble reset switches which reset a cleared device in alarm, supervisory, or trouble condition. Ensure alarm, supervisory, and trouble signals do not self-restore without activating the switch.

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 CRMS.

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 CRMS. 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 (when used), with a hinged cover and an integral pin-tumbler cylinder lock (Lock Cylinder No. Best Universal Lock Co. No. 5E7FICR704C31612R90626 or equal) 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.

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 for a provided battery disconnect switch.

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 where installed), in normal supervisory condition for 24 hours, minimum, then operate the system in the alarm mode for 10 minutes, minimum.

2.2 CRMS REPORTING EQUIPMENT

2.2.1 FACP Reporting

The FACP reports to the CRMS using radio frequency (RF) remote reporting to this central monitoring system.

2.2.2 Radio Based FACP Reporting

Provide AES/Intellinet Corporation Model 7788F transceiver with minimum eight (8) zone relays to provide general reporting as specified below:

FACP	Transceiver	Description
Relay 1	Zone 1	Summary Fire Alarm
Relay 2	Zone 2	Summary Supervisory
Relay 3	Zone 3	Summary Trouble
Relay 4	Zone 4	Summary Water flow
Relay 5	Zone 5	Smoke Detector
Relay 6	Zone 6	Spare
Relay 7	Zone 7	Spare
Relay 8	Zone 8	Spare

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 relays in FACP grouped in a cabinet as indicated for all remote reporting signals required. 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.

Radio output power is to be 2 Watts with 2.5 db gain antenna mounted on the radio case unless otherwise indicated.

2.3 SMOKE DETECTORS

Provide alarm initiating smoke detectors designed for use with 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 detectors with terminals suitable for Class A wiring powered from the panel alarm initiation or communication bus circuit; separate power sources are not acceptable.

2.4 MANUAL ALARM STATIONS

Provide non-coded, manual alarm stations designed for use with manual fire alarm systems in accordance with UL 38.

Ensure wiring terminals are suitable for Class A wiring and capable of accepting No. 18 through No. 14 AWG diameter solid copper conductors.

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.

2.5 ALARM BELLS

Provide red fire-alarm bells, 10 inch diameter, vibrating, under-dome, alarm notification appliances in accordance with UL 464, with bell which produces at least 87 dB at 10 feet, sound in a temporal pattern, conforming to NFPA 72.

Ensure alarm bells are solenoid-operated plunger sounding devices, with a rustproof operating mechanism, protected from dust and insects, and located behind the gong shell. Stop operation of bells on a signal silence.

Provide alarm bells which operate from polarized 24 V(DC) FACP, Class A

parallel wired supervised notification appliance circuits. Make wiring connection on terminal blocks suitable for No. 16 through No. 12 AWG diameter solid copper conductors. Ensure audible notification appliance circuits have sufficient capacity to operate all devices connected, plus 25 percent minimum spare capacity per circuit.

Provide strobe portion of combination audible/visual indicating appliances in accordance with the applicable provisions of the paragraph entitled, "Strobe Units," of this section.

Ensure surface-mounted alarm bells installed in unfinished areas with conduit exposed are secured to surface-mounted cast-iron, or aluminum back boxes, with threaded conduit connections. If installed outdoors, provide weatherproof alarm bells with a neoprene gasket that are protected against corrosion. Paint all exposed metal surfaces with a prime coat and one or more finish coats of red enamel to provide a smooth, hard, durable finish.

2.6 STROBE UNITS

Provide strobe units designed for use with 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, 60, 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. Strobes will be synchronized.

Provide units which operate from polarized 24 V(DC), Class A, parallel 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. Stop operations of strobes on a signal silence.

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.

2.7 WATER FLOW ALARM DEVICES

Provide alarm-initiating water flow devices designed for use with 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). 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.

2.8 VALVE TAMPER SWITCHES

Provide supervisory initiating valve tamper switches designed for use with 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). 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.

2.9 REMOTE AUXILIARY CONTROL RELAYS

Provide remote control relays with continuous duty coils rated 24 V(DC). Where relays are used on Class A parallel wired 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.

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 feet of the controlled device in accordance with NFPA 101.

2.10 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.

2.11 WIRING

Provide copper conductor wiring in accordance with NFPA 70 and NFPA 72. Connect all devices to Class A, parallel-wired 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). 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.

Where modifications are made to existing systems, match the new or added conductors to the size and color-coding of the existing system. 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.

Air sampling detection units are permitted to use No. 18 AWG for connection to modules with maximum conductor length not to exceed 25 ft.

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, bells) 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.

Provide solenoid valve control circuit conductor size of not less than No. 14 AWG diameter, with insulation type THHN/THWN for No. 14 AWG diameter and larger.

2.12 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.

2.12.1 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.

2.12.2 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 CRMS, 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 CRMS, 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 CRMS, 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

Prior to performing any installation or modification work to existing Fire Alarm system(s), secure a Transfer of Responsibility Form completed by the COTR and signed by the Contractor and Institutional Services Contractor (ISC) Fire Protective Systems designee. The completed form will be turned over to the Contracting Officer by the COTR. Permanently affix a copy of the completed "Transfer of Responsibility" Form to the affected FACP throughout the construction period.

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.

Install conductors in accordance with the paragraph entitled, "Wiring," from the FACP to a new 25 point terminal strip labeled "FATB" in the indicated telephone terminal cabinet.

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 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.

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.

3.2.3 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.

3.2.4 Alarm Bells

Mount bells at the approximate locations indicated. Ensure mounting height is 90-inch above the finished floor measured from the top of the bell, but no less than 6-inch below the ceiling.

Where bells are installed outdoors, arrange conduit systems to tap into the bottom of the junction box and to drain away from the bells or strobes.

3.2.5 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 tap into the bottom of the junction box and to drain away from strobe enclosure. Ensure visual and audible appliances are capable of operating independently via separate and independent circuits for both the audible and strobe portions.

3.2.6 Auxiliary Control Relays

Install and supervise remote control relays in accessible locations within 3 feet of the device to be controlled.

3.2.7 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" conduit system requirements. 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.

Install direct current initiating device circuits (heat detectors, manual pull station) as Class A, parallel-wired 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 A, parallel-wired 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 (bells, strobes) circuits as Class A, parallel-wired 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 A, parallel-wired 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.

3.2.7.1 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.

3.2.7.2 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.

3.2.8 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 initiating device, signaling line, notification appliance and control 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 floor 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.

3.3 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.

Activate each manual pull station to demonstrate proper operation.

Each time an initiating or supervisory circuit is activated, verify that the notification appliances circuits, auxiliary control circuits, and alarm reporting to the CRMS 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, flow switch, tamper switch, 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.

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 such as fire protection, HVAC, security and safety, 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 70 and manufacturer's requirements. Remove and ground one lead at each 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.

3.4 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, junction boxes, and cover plates red, Color No. 11105 in accordance with FED-STD-595. In lieu of painting all conduit junction boxes and cover plates, unions and fittings, provide red-colored conduit that has a factory applied red coating.

-- End of Section --

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EARTHWORK

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 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	(1991; R 2006) Standard Method of Test for Sampling of Aggregates (same as ASTM D 75)
AASHTO T 87	(1986; R 2004) Standard Method of Test for Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2008; Errata 2009) Structural Welding Code - Steel

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA C2	(2003) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA P5	(2005) Standard for Waterborne Preservatives

ASTM INTERNATIONAL (ASTM)

ASTM A 139/A 139M	(2004) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A 252	(1998; R 2007) Standard Specification for Welded and Seamless Steel Pipe Piles
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	(2006e1) Soils for Engineering Purposes (Unified Soil Classification System)
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)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes
EPA SW-846.3-3	(1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

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

29 CFR 1926	Safety and Health Regulations for Construction

1.2 DEFINITIONS

1.2.1 Satisfactory Materials

Satisfactory materials shall mean ASTM D 2487, SP, SP-SM, SM, A-2-3, A-2-4, and A-3.

1.2.2 Unsatisfactory Materials

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.

1.2.3 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure, Method B or D.

1.2.4 Unstable Material

Unstable materials are too wet to properly support the utility pipe, conduit, or appurtenant structure.

1.3 DEWATERING WORK PLAN

Submit procedures for accomplishing dewatering work in accordance with drawings.

1.4 QUALITY CONTROL TESTING DURING CONSTRUCTION

Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil-testing service approved by the Contracting Officer shall be provided by the Contractor. 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 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
Satisfactory soil materials	Sieve analysis of fine and coarse aggregates	ASTM C 136	One daily for each soil material from each source; additional test whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis is of fine and coarse aggregates	ASTM C 136	
	Amount of material passing No. 200 sieve	ASTM C 117	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	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 material except under backfill for structures; one for each backfill and fill material from each source
Soil material-in-place after compaction	Density of soil-in-place	ASTM D 1556 Sand Cone Method	At least three daily for each subgrade soil material except under backfill for structures, and for each layer and backfill and fill material; for each 400 linear feet of trench or fraction thereof, whichever is greater; and additional test whenever there is any change in moisture conditions

1.5 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.

1.6 EXISTING CONDITIONS

Records of Underground Utilities Location of Inspections, Location of Testing and Location of Utility Approvals shall be submitted to the Contracting Officer prior to start of work.

1.7 DRAWINGS

As-Built Drawings shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

1.8 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

Shoring; G

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.

SD-02 Shop Drawings

As-Built Drawings shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

SD-06 Test Reports

Borrow Site Testing

Within 24 hours of conclusion of physical tests, 6 copies of test results, including calibration curves and results of calibration tests. Results of testing at the borrow site.

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.

Certificates of Compliance for Compost shall be submitted indicating grade and compliance to state and local regulations.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill shall contain a maximum of 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and a maximum of 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall pass the TCLP test. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020. Perform TCLP in accordance with EPA SW-846.3-3 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Do not bring material onsite until tests have been approved by the Contracting Officer.

2.2 BACKFILL AND FILL MATERIALS

Backfill and fill material shall consist of sandy clay, sand, gravel, soft 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
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	
	Liquid limit of soils	ASTM D 4318	
	Plastic limit and plasticity index of soils	ASTM D 4318	
	Moisture-density relations of soil	AASHTO T 180, Method B or D	

2.3 COHESIONLESS MATERIALS

Cohesionless soil materials include gravels, gravel-sand mixtures, sands, and gravelly-sands. Moisture-density relations of compacted cohesionless soils, when plotted on graphs, will show straight lines or reverse-shaped moisture density curves.

2.4 COHESIVE MATERIALS

Cohesive soil materials include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture-density relations of compacted cohesive soils, when plotted on graphs, will show normal moisture-density curves.

2.5 SUBBASE MATERIAL

Subbase material shall be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, or sand.

2.6 COMPOST

Compost shall be yard trimmings or yard waste compost processed and graded according to state and local regulations.

2.7 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.

2.8 STRUCTURAL MATERIALS

Ensure that materials used for shoring and bracing, such as sheet piling, uprights, stringers, and crossbraces, are in good serviceable condition. Ensure that any timber used is sound and free from large or loose knots.

Use pressure-treated timber where wood sheeting or piling is specified or indicated to be cut and left in place.

Ensure that shoring and sheeting for excavations are designed by a Florida-registered Professional Engineer and are in accordance with 29 CFR 1926 OSHA Document 2226 "Safe Working Practices - Excavating and Trenching."

2.9 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

2.9.1 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.

2.9.2 Tracer Wire for Non-Metallic Piping

Provide a single conductor #6 gauge thick wire with Type TW insulation.

2.10 GROUT

Provide durable grout composed of cement, water, an air-entraining admixture, and sand mixed in proportions of one part portland cement to two parts of sand, sufficient water to produce a workable mixture, and an amount of admixture which will entrain sufficient air, as determined by the Contracting Officer. Mix grout in a concrete mixer.

2.11 PIPE CASING

2.11.1 Casing Pipe

ASTM A 139/A 139M, Grade B, or ASTM A 252, Grade 2, smooth wall pipe. Match casing size to the outside diameter and wall thickness as indicated on the drawings. Protective coating is to be fusion-bonded epoxy.

2.11.2 Wood Supports

Pressure-treated, locally available, rough, structural grade. Provide wood with nonleaching water-borne pressure preservative (ACA or CCA) and treatment conforming to AWPA P5 and AWPA C2, respectively. Secure wood supports to carrier pipe with stainless steel or zinc-coated steel bands.

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.

Protect excavation and trenching by shoring, bracing, sheet piling, underpinning, or other methods as required to prevent cave-ins or loose dirt from falling into excavations and trenches.

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

Heavy growths of 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 Clearing

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1-1/2 inches or more in diameter and shall be trimmed of all branches the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1-1/2 inches in diameter shall be painted with an approved tree-wound paint. Apply herbicide in accordance with the manufacturer's label to the top surface of stumps designated not to be removed.

3.3.3 Tree Removal

Where indicated or directed, trees and stumps that are designated as trees shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. Trees shall be disposed of as specified in paragraph DISPOSAL OF MATERIALS.

3.3.4 Pruning

Trim trees designated to be left standing within the cleared areas of dead branches 1 1/2 inches or more in diameter; and trim branches to heights and in a manner as indicated. Neatly cut limbs and branches to be trimmed close to the bole of the tree or main branches. Paint cuts more than 1 1/4 inches in diameter with an approved tree wound paint.

3.3.5 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 and sodded. 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 10 feet below the original surface level of the ground in areas indicated as areas for buildings, dry retention ponds and in a 10 foot wide perimeter around Buildings.

3.3.6 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.

Any structural backfill or fill required for site development should be placed in loose lifts not exceeding 12 inches in thickness and compacted by the use of a vibratory drum roller. If hand-held or track-mounted compaction equipment is used, the lift thickness should be reduced to 6 and 8 inches, respectively. 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.

3.3.7 Stability of Sides

Sides of excavations over 5 feet in depth shall be sloped not steeper than 34 degrees from the horizontal (slope 1/1.5) 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.

3.3.8 Shoring and Bracing

Where sheeting and bracing are required to support the side walls of the excavation, retain a Professional Engineer, registered in Florida, to design sheeting and bracing. Ensure that the design establishes requirements for sheeting and bracing and complies with all applicable codes, authorities having jurisdiction, and federal, state, and local regulations.

The sole responsibility for the design, methods of installation, and adequacy of sheeting and bracing shall be and shall remain that of the Contractor and the Contractor's Professional Engineer. Provide all necessary sheeting and bracing or other procedures as required to ensure safe working conditions and to protect the excavations.

Provide sheeting and bracing consisting of braced steel sheet piling, trench box, braced wood lagging, and soldier beams, or other approved methods.

Immediately fill and compact voids formed outside the sheeting. Where soil cannot be properly compacted to fill the void, use Class B concrete as backfill at no additional cost to the Government.

Install sheeting outside the required clearances and dimensions. Ensure that sheeting is plumb, securely braced, and tied in position. Ensure that sheeting is adequate to withstand all pressure to which is may be subjected. Correct any movement or bulging at no expense to the Government to provide the necessary clearances or dimensions.

Maintain sheeting and bracing in excavations and trenches for the entire time excavations are open.

Do not brace sheeting against pipe being laid. Brace sheeting so that no concentrated load of horizontal thrust is transmitted to the pipe.

Do not withdrawn sheeting if driven below the spring line of any pipe. Cut off tops as indicated on the drawings and leave bottoms permanently in place.

3.4 GENERAL EXCAVATION

3.4.1 Ditches, Gutters, and Channels

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.

3.4.2 Utility Structures

Excavation for valve vaults 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. Dimensions and elevations of footings and foundation excavations are only approximate and may be changed if necessary to ensure adequate foundation support. 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. Rock or other hard foundation materials shall be cleaned of loose debris and cut to a firm surface, either level, stepped, or serrated, as indicated. Loose disintegrated rock and thin strata shall be removed. 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.

3.4.3 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.

3.4.4 Dewatering

3.4.4.1 Dewatering System

The dewatering system shall be adequate to pre-drain the soils to be excavated 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.

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.

3.4.4.2 Observation Wells

The Contractor shall install observation wells as may be required to record accurate water levels.

The Contractor shall be responsible for maintaining wells and observing and recording the elevation of the piezometric water levels daily.

3.4.4.3 Discharge

Discharge of water from dewatering shall be in accordance with contract clause "Dewatering/Consumptive Use Permitting."

3.4.5 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.

3.4.5.1 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.

3.4.5.2 Removal of Unsatisfactory Materials

Remove unsatisfactory materials to a horizontal distance of 10 feet beyond the structural element plan and to a vertical depth of not less than 10 feet below the original surface level of the ground in areas designated as structural elements and dry retention ponds. A structural element is a building slab or a foundation.

3.4.5.3 Removal of Unsatisfactory Soil Materials

Unsatisfactory soil materials encountered that extend below the required elevations, as specified under Grubbing Operations shall be excavated to the depth directed by the Contracting Officer.

3.4.5.4 Excavation for Appurtenances

Provide excavation for valve vaults 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 or 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.

3.4.5.5 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 3 feet from the existing ground surface or the indicated finished grade (whichever is lower) unless it is necessary to avoid interference of the waterlines with other utilities. Ensure that utility separation requirements are as shown on the drawings.

3.4.5.6 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, unless it is necessary to avoid interference of the electrical cables or ducts with other utilities. Ensure that utility separation requirements are as shown on the drawings.

3.4.5.7 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.

3.4.6 Underground Utilities

The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Perform work adjacent to non-Government utilities as indicated in accordance with procedures outlined by the utility company. Excavation made with power-driven equipment is not permitted within two feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or

other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.5 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

Notify the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, excavate borrow pits and other excavation areas providing adequate drainage. Transport overburden and other spoil material to designated spoil areas or otherwise dispose of as directed. Provide neatly trimmed and drained borrow pits after the excavation is completed. Ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.6 SHORING

3.6.1 General Requirements

Where sheeting and bracing are required, ensure that the sheeting and bracing system meet the requirements in these specifications.

Submit a Shoring and Sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheeting as excavations are backfilled, in a manner to prevent caving.

3.7 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.

3.7.1 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 blend shall be not more than 0.10 foot above or below the indicated finish elevations.

3.8 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Protect all surfaces from erosion resulting from ponding or water flow.

3.9 GROUND SURFACE PREPARATION

3.9.1 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 inch, 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.

3.9.2 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.

3.10 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 by the Contracting Officer. 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.

3.11 BURIED TAPE AND DETECTION WIRE

3.11.1 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 inches below top of subgrade.

3.11.2 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, between connections with existing system. Terminate the ends of the wire inside the valve vaults and valve boxes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each

valve vault and valve box. Furnish insulated wire over it's entire length. Install wires at valve vaults and valve boxes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal.

3.12 FILLING AND BACKFILLING

3.12.1 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

3.12.2 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.

3.12.3 Placement and Compaction

Any structural backfill or fill required for site development should be placed in loose lifts not exceeding 12 inches in thickness and compacted by the use of a vibratory drum roller. If hand-held or track-mounted compaction equipment is used, the lift thickness should be reduced to 6 and 8 inches, respectively. 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.

3.12.4 Trench Backfill

3.12.4.1 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.

3.13 COMPACTION

3.13.1 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.

AREA CLASSIFICATION	PERCENT MAXIMUM DENSITY
Grassed areas	95
Walks	95
Utility trenches	95
Structures	
Each layer of back-fill material	98
Building slabs and steps	
Top 12 inches of subgrade and each layer of backfill material	98

3.13.2 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.

3.14 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.14.1 Water Lines

Excavate trenches to a depth that provides a minimum cover of 3 feet from the existing ground surface; or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.14.2 Electrical Distribution System

Provide a minimum cover of 36 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.14.3 Pipeline Casing

Provide new smooth wall steel pipeline casing under existing railroad and pavement by the boring and jacking, and horizontal directional drill method of installation. Provide each new pipeline casing, where indicated and to the lengths and dimensions shown, complete and suitable for use with the new piped utility as indicated. Refer to Section 33 05 24 DIRECTIONAL DRILLING for installing horizontal directional drilling. Install pipeline casing by dry boring and jacking method as follows:

3.14.3.1 Bore Holes

Mechanically bore holes and case through the soil with a cutting head on a continuous auger mounted inside the casing pipe. Weld lengths of pipe together in accordance with AWS D1.1/D1.1M. Do not use water or other fluids in connection with the boring operation.

3.14.3.2 Cleaning

Clean inside of the pipeline casing of dirt, weld splatters, and other foreign matter which would interfere with insertion of the piped utilities by attaching a pipe cleaning plug to the boring rig and passing it through the pipe.

3.14.3.3 End Seals

After installation of piped utilities in pipeline casing, provide watertight end seals at each end of pipeline casing between pipeline casing and piping utilities. Provide watertight end seals as indicated.

3.14.4 Grouting

Distribute grout to place of final deposit and work into place at end of pipe with spades or trowels.

3.15 EMBANKMENTS

3.15.1 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 8 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.

3.16 SUBGRADE PREPARATION

3.16.1 Proof Rolling

Finish proof rolling on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade.

3.16.2 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 inch 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 1.0 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.

3.16.3 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 to at least 98 percent of laboratory maximum density.

3.16.3.1 Subgrade for Pavements

As indicated on the drawings.

3.17 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.

3.17.1 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 not disturb the finished subgrade by traffic or other operation. Protect and maintain 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.

3.17.2 Capillary Water Barrier

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.17.3 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.

3.18 TESTING

Perform testing by a Corps validated commercial testing laboratory or the Contractor's validated testing facility. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer. Determine field in-place density in accordance with ASTM D 1557. When test results indicate, as determined by the Contracting Officer, 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.

3.18.1 Fill and Backfill Material Gradation

One test per 75 cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM C 136.

3.18.2 In-Place Densities

a. One test per 2,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 2,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

3.18.3 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 2,000 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 2,000 square feet, of fill or backfill areas compacted by hand-operated machines.

3.18.4 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

3.18.5 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.

3.18.6 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

3.19 MAINTENANCE

3.19.1 Protection of Graded Areas

Newly graded areas shall be protected from traffic and erosion and shall be maintained free of trash and debris.

3.19.2 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.

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SODDING

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.

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

Section 162 (2010) Prepared Soil Layer

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 applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

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-07 Certificates

Sod farm certification for sods. Indicate type of sod in accordance with TPI GSS.

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 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 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, 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.

2.1.2 Purity

Sod species shall be genetically pure, free of weeds, pests, and disease.

2.2 TOPSOIL

Supply and install topsoil in accordance with FDOT Standard Section 162.

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.4 FERTILIZER

Provide commercial fertilizer of neutral character, with some elements derived from organic sources, containing not less than 8 percent phosphoric acid, 8 percent potassium, and percentage of nitrogen required to provide less than 1 pound of actual nitrogen per 1,000 square feet of area. Provide nitrogen in form that will be available to the seeded and sodded area during initial period of growth. The chemical designation shall be 5-10-10.

Ensure that the fertilizer is delivered to the site in labeled bags or containers.

2.5 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 (including soil conditioners), 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 Soil Preparation

Provide 4 inches of off-site topsoil 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.

3.1.2.1 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Organic Granular Fertilizer 10 to 15 pounds per 1000 square feet.

Synthetic Granular Fertilizer 10 to 15 pounds per 1000 square feet.

3.2 SODDING

3.2.1 Finished Grade and Topsoil

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 31 00 00 EARTHWORK.

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove from the surface debris and stones over a minimum 5/8 inch in any dimension.

3.2.2 Placing

Place sod a maximum of 36 hours after initial harvesting, in accordance with TPI GSS as modified herein.

3.2.3 Sodding Slopes and Ditches

For slopes 2:1 and greater, lay sod with long edge perpendicular to the contour. For V-ditches and flat bottomed ditches, lay sod with long edge perpendicular to flow of water. Anchor each piece of sod with wood pegs or wire staples maximum 2 feet on center. On slope areas, start sodding at bottom of the slope.

3.2.4 Finishing

After completing sodding, blend edges of sodded area smoothly into surrounding area. Air pockets shall be eliminated and a true and even surface shall be provided. Frayed edges shall be trimmed and holes and missing corners shall be patched with sod.

3.2.5 Rolling

Immediately after sodding, 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.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.4 GRASS ESTABLISHMENT

3.4.1 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 is authorized.

3.4.2 Watering

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 water 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.

3.4.3 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.

When the average height of grass reaches 8 inches, areas shall be mowed with approved mowing equipment to a grass height of 4 inches.

3.4.4 Weeding

Weeds or other undesirable vegetation that threaten to smother the grass shall be uprooted and removed from the area.

3.4.5 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 of 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.

3.5 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.

3.6 ACCEPTANCE REQUIREMENTS

3.6.1 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.

3.6.2 Repairs

If, before completion and final acceptance of the facility, portions of the surface become gullied or otherwise damaged, the grass areas having 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.

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SECTION 33 05 23.16

BORING AND JACKING

PART 1 GENERAL

1.1 DEFINITIONS

Carrier Pipe: Water pipe.

Casing Pipe: Sleeve through which carrier pipe will be placed.

Boring and Jacking: Method of installing casing pipe by cutting, hand mining, or boring an opening in soils material, simultaneously forcing casing pipe through it with hydraulic jacks.

Casing Spacer: Fabricated item for positioning a carrier pipe inside a casing pipe.

Access pits: Jacking and receiving shafts constructed at both ends of the pipe length to be installed by trenchless installation operations.

1.2 SCOPE OF WORK

The Contractor shall provide all labor, materials, equipment, supplies, and incidentals required to install casing pipe and carrier pipe by boring and jacking at the locations shown on the contract drawings and as specified in this Section. The method of installation selected by the Contractor shall be capable of penetrating through soil, partially weathered bedrock, weathered bedrock, competent bedrock, and boulders.

Work shall be done in strict accordance with all State and local laws and regulations and requirements.

The Contractor shall make such subsurface investigations as he deems necessary for each casing installation. The Contractor shall be solely responsible for determining the nature of the subsurface materials at each casing installation and for selecting the untrenched casing installation method. Under no circumstances shall the Government pay additional costs related to unanticipated subsurface conditions.

The Contractor is required to follow all OSHA regulations regarding confined space for casing installation. The Contractor is required to obtain all permits required associated with OSHA regulations and requirements for confined space entry.

1.3 RELATED WORK

01 57 20.00 10 ENVIRONMENTAL PROTECTION
03 30 00 CAST-IN-PLACE CONCRETE
31 00 00 EARTHWORK
33 11 00 WATER DISTRIBUTION
33 71 02.00 20 UNDERGROUND ELECTRICAL

1.4 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)

ANSI/ASSE A10.16	(1995; R2001) Safety Requirements for Tunnels, Shafts, and Caissons

ASTM INTERNATIONAL (ASTM)

ASTM A 666	(2003) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A 1011/A 1011M	(2009b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM C 144	(2004) Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 404	(2007) Standard Specification for Aggregates for Masonry Grout

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

FDOT Spec 121	(2010) Flowable Fill

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

29 CFR 1926	Safety and Health Regulations for Construction

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

Proposed methods of trenchless installation

SD-02 Shop Drawings

Submit shop drawings (G) in accordance with the paragraph entitled "SHOP DRAWINGS."

SD-05 Design Data

Design mixes and design calculations for concrete, grout, and flowable fill.

The Contractor's Engineer shall submit copies of design calculations for the information to the Contracting Officer.

SD-07 Certificates

Qualifications of the trenchless installation contractor and engineer in accordance with the article entitled "QUALIFICATION."

1.6 SHOP DRAWINGS

Shop drawings shall include the following:

Shop drawings for casing pipe showing sizes and hold down assemblies or casing spacers for carrier pipe.

Shop drawings of bulkheads when shown on the drawings.

Working drawings and written procedures describing in detail proposed bore-and-jack method and entire operation to be used, including but not limited to:

Working and receiving shafts.
Dewatering.
Method of removing soils and installation of casing and carrier pipe.
Size, capacity, and arrangement of equipment.
Backstop.
Shaft base material.
Type of cutter head.
Method of monitoring and controlling line and grade.
Detection of surface movement.
Procedure for installing pipe supports, anchors, or placement of grout between carrier pipe and casing pipe.
Bulkhead details and proposed positive method of anchoring carrier pipe to prevent flotation.
Catalog data for casing spacers when used for temporary support during construction.
Procedure for monitoring line and grade.

If modifications to methods are required during construction, submit working drawings delineating modifications, including reasons for them.

1.7 DELIVERY, STORAGE, AND HANDLING

Unload and handle materials with equipment of adequate capacity.

Store materials on site in a reasonably level well-drained area free from brush.

Store individual pieces and bundles with safe walking space between to allow full view for inspection.

1.8 PROJECT CONDITIONS

Bore to avoid interfering with, interrupting, or endangering the surface and activity thereon.

Minimize subsidence of surface, structures, and utilities above and in the vicinity of bore.

Support ground continuously to prevent loss of ground and keep perimeters stable.

Be responsible for settlement resulting from operations.

Repair and restore damaged property to its condition before being disturbed at no cost to the Government.

Comply with applicable ordinances, codes, statutes, rules, and regulations of State of Florida, affected Railroad Company, and applicable regulations of Federal Government, 29 CFR 1926, and applicable criteria of ANSI/ASSE A10.16.

1.9 QUALIFICATIONS

Qualifications of the trenchless installation Contractor:

Name, business, address, and telephone number of the Contractor.

Experience in successfully constructing pipelines by the method proposed to be used to install the trenchless installation pipe for this project.

List of similar projects for the last 2 years including the name of contact person and telephone number.

Certification of workman training.

Name(s) of all supervisory personnel to be directly involved with the project.

The Contractor shall sign and date the information provided and certify that to the extent of his knowledge, the information is true and accurate, and that the supervisory personnel for the trenchless installation operations will be directly involved with this project. Substitutions of personnel and/or methods will not be allowed without the written authorization of the Contracting Officer.

The Contractor shall engage the services of a Professional Engineer registered in Florida to design each trenched and untrenched casing system, including shafts, sheeting, bracing, grouting, dewatering, soil stabilization, and jacking system which the Contractor proposes for installation. Submittals shall be prepared by a Licensed Professional Engineer registered in Florida and having a minimum of 5 years of professional experience in the design and construction of similar jacking systems.

1.10 ADDITIONAL CRITERIA FOR WORK UNDER RAILROADS

Do not schedule work within and adjacent to railroad property until the Contracting Officer and the Government approve submittals, including proper insurance. Approval does not relieve the Contractor of responsibility for adequacy and safety of procedures.

Place safety, precautionary, and protective devices and services required

by the Government before work proceeds.

PART 2 PRODUCTS

2.1 CASING PIPE

General: Use casing pipe following the drawings.

Steel Pipe:

Smooth-walled steel pipe with minimum yield strength of 36,000 psi (ASTM A 1011/A 1011M Grade 36).

Minimum wall thickness: 3/8 inch or following drawings and/or Bid Schedule.

Inside diameter: as shown on the drawings as a minimum.

Joints: Fully welded around circumference of pipe with complete penetration weld.

Weld of sufficient strength to withstand forces at pipe joints without any distortion of pipes.

Minimum welds: Follow the drawings.

Coating: Fusion-bonded epoxy.

2.2 CARRIER PIPE

Carrier Pipe: Specified in 33 11 00 WATER DISTRIBUTION.

2.3 CASING SPACERS

Fusion bond assembled carbon-steel bands, risers, and studs with PVC or Epoxy 14 to 20 mils thick.

Treat and coat stainless-steel metal surfaces and welds to reduce the chemical reactivity of the surfaces.

Bands and Risers:

Minimum two pieces, stainless-steel plate: ASTM A 666 Type 304, or hot rolled, pickled carbon steel with a minimum yield strength of 30,000 psi and coat as specified in this Section.

Band: Minimum thickness: 14 gauge for carrier pipes up to 12 inches diameter and 12 gauge for more than 12 inches.

Runners:

High-density molecular polyethylene or polymer-reinforced fiberglass with DURO Hardness A of 80 and minimum dielectric strength of 500 volts per mil with sufficient compressive and shear strengths.

Attach to risers with bolts or welded studs.

Fill bolt holes with silicone caulk.

Spacer Band: Line with minimum 0.090-inch-thick ribbed PVC liner of DURO Hardness A of 80 and minimum dielectric strength of 450 volts per mil.

Approved Manufacturers:

Pipeline Seal and Insulator Inc.

Cascade Waterworks Manufacturing Company.

Or equal (Minimum 5 years of fabricating casing spacers in the United States).

2.4 CASING END SEALS

Approved Manufacturers:

Advance Products & Systems, Model AC.

Pipeline Seal & Insulator, Inc., Model S or C.

Maloney Technical Products, MULTIFLEX End Seal.

Or equal.

2.5 GROUT

Cement: ASTM C 150, Type I or Type II.

Water: See Section 03 30 00 CAST-IN-PLACE CONCRETE.

Sand: ASTM C 404, Size No. 1.

Voids Between Casing and Existing Ground: Minimum compressive strength of 100 psi, attained within 24 hours, and sufficiently fluid to inject through lining and fill voids, with prompt setting to control grout flow.

For Carrier Pipe Bedding and Filling Annular Space between Tunnel Liner and Carrier Pipe: 3 parts ASTM C 144 sand, to 1 part ASTM C 150 cement.

2.6 CONCRETE

Concrete for cradle or filling void between casing and carrier pipe: See Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.7 FLOWABLE FILL

For Filling Void between Casing and Carrier Pipe: Excavatable flowable fill in accordance with FDOT Spec 121.

2.8 BULKHEADS

As required.

PART 3 EXECUTION

3.1 GENERAL

Limited site soil investigation was performed and may be obtained for

casing pipe design are available.

Interpret this material and investigate work site soil conditions before bidding.

Encountering rock or water will not entitle the Contractor to additional compensation.

Notify the Contracting Officer immediately if obstructions stopping forward motion of operation are encountered during installation.

When it is impossible to advance bore hole or pipe, discontinue operation, abandon completed portion in place, and fill with grout or plug unless otherwise directed by the Contracting Officer.

Dewatering: See Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

3.2 PREPARATION

Refer to Section 01 57 20.00 10 and Drawing Number EN2 for requirements when working in sites with potential contamination and environmental issues.

Excavate Shafts: Follow the drawings and this specification.

Perform preliminary work, including constructing backstop, placing guide timbers, and placing boring apparatus.

3.2.1 Reporting

Report settlement or movement immediately to the Contracting Officer and take immediate remedial action.

3.3 SHAFT CONSTRUCTION

Construction of jacking and receiving shafts shall be constructed in accordance with the submitted design, equipment, and procedure so that the casing pipe can be installed to the alignment shown and the carrier pipe can be installed without damage.

The jacking shaft shall be of adequate length to provide room for the jacking frame, the jacking head, the reaction blocks, the jacks, and the jacking pipe. The shaft shall be sufficiently wide to allow ample working space on each side of the jacking frame and pipe and for materials brought into the shaft and excavation removed. The depth of the shaft shall be such that the invert of the pipe, when placed on the guide frame, will be at the elevation desired for the casing.

The shaft shall be kept free of water at all times by deep wells, well points, or sump pumping where conditions permit. Dewatering through the casing pipe during construction shall not be permitted. Observed water levels before construction shall be below the invert elevation of the jacking shafts. Additional groundwater controls may be ordered on short notice and shall be implemented as directed.

Jacking and receiving shafts shall be designed by the Contractor's engineer in accordance with the requirements of OSHA excavation safety standards (29 CFR 1926.650 Subpart P) and all local and state requirements. The shaft jacking faces shall be designed to transfer all jacking forces safely into the earth evenly. Shafts shall be designed to resist all pressures

developed by the soil outside the shaft. Shafts shall be constructed with steel sheeting and bracing. Shaft walls shall terminate not less than 3 feet 6 inches above existing grade.

Steel rails or beams securely supported shall be used in the shaft for placement and alignment of the jacking equipment and of each piece of casing pipe during installation. Jacking shall not begin until the Contractor's surveyor has verified in writing to the Contracting Officer that the first casing segment is at the correct location and elevation and is oriented at the correct horizontal and vertical direction. After the first segment has been jacked forward, the Contractor's surveyor shall again verify in writing to the Contracting Officer that alignment is correct. If alignment is not correct at this point or any successive point, the jacked casing operation shall be stopped and shall not resume until the Contractor has modified the jacking operation as required to maintain proper alignment at no additional cost to the Government.

All components of the shafts shall be completely removed after the casing is installed, including breaking up, removing, and disposing of concrete, if used, and removing or cutting off sheeting. The bottom of the shaft shall be brought to standard trench depth for pipe installation or additional casing installation with structural fill. Pipe bedding and backfill shall be as shown.

3.4 BORING OPERATION AND CASING PIPE INSTALLATION

3.4.1 General

The casing pipe at each location shown on the drawings shall be jacked in one continuous 24-hour-per-day operation. In no event shall jacking or lubricant injection be discontinued for a sufficient period to cause the partially jacked sleeve to "freeze" in place. Proper alignment and elevation of the casing shall be consistently maintained throughout the jacking operation.

Use removable auger and cutting head arrangement.

Control line and grade.

3.4.2 Boring and Jacking

Jack casing pipe with auger rotating within pipe to remove spoil.

Hand mining may be used for large bore casing pipe, provided the method is submitted in detail and is acceptable to the Contracting Officer.

Maintain the face of the cutting head to preclude free flow of soft or poor soils material.

Overcut of Cutting Head:

Not to exceed outside diameter of casing pipe by more than 1/2 inch.

For hand mining no overcut will be permitted.

Use positive means for continuous monitoring and controlling grade of casing pipe during boring operation.

Weld steel pipe casing as required in this Section.

When coating is required, repair coating damage on each side of weld and recoat complete weld area.

Minimize the occurrence of voids outside the casing pipe and excavate at the excavation face in a manner to minimize voids. All voids between the jacked casing and the earth or rock shall be filled with pumped lubricant during jacking.

Suitable transport and hoisting equipment shall be provided to remove the excavated material from the casing and shafts.

The Contractor shall dispose of the excavated material off site.

The carrier pipe shall not be installed until leakage into the casing pipe, after removal of all dewatering pumping systems, does not exceed 2.0 gal/hour maximum.

Disposal of Wastes and Groundwater

The Contractor shall dispose of all waste soils, slurries, and other wastes in accordance with all applicable Federal, State, and County regulations. No waste will be left on-site following completion of the work.

The Contractor shall dispose of all groundwater generated by dewatering operations and any surface water entering access shafts in accordance with the approved soil and erosion control plan.

3.6 FIELD QUALITY CONTROL

Maintain line and grade following drawings to within 2-inch tolerance.

3.5 INSTALLATION OF CARRIER PIPE

Install carrier pipe following Sections 31 00 00 EARTHWORK, Section 33 11 00 WATER DISTRIBUTION, standard details, and drawings.

Use thermoplastic or other dielectric material (except wood) between carrier pipe and tunnel liner plate or steel sleeve to prevent metal-to-metal contact and damage to pipe and coating during placement.

Hold-Down Method in Casing Pipe.

Water mains, force mains, and pressure sewer mains: Concrete invert and hold-down assembly or casing spacers following standard details and drawings.

Unless shown otherwise on the drawings, install ductile iron and PVC water pipes following Standard Details.

Bulkheads: As required.

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SECTION 33 05 24

DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 SCOPE OF WORK

This Section includes furnishing all labor, materials, equipment, and incidentals necessary to complete each directional drill (or horizontal directional drilling, HDD) installation shown on the drawings.

Directional drilling at additional locations must receive prior approval from the Contracting Officer.

1.2 RELATED WORK

Section 01 33 00	SUBMITTAL PROCEDURES
Section 01 57 20.00 10	ENVIRONMENTAL PROTECTION
Section 31 00 00	EARTHWORK
Section 33 11 00	WATER DISTRIBUTION

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 PETROLEUM INSTITUTE (API)

API Spec 13A	(2006; Errata 2008) Specification for Drilling-Fluid Materials

ASTM INTERNATIONAL (ASTM)

ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM D 1248	(2005) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D 149	(2009) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D 3261	(2003) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM D 3350	(2008) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 4976	(2006) Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM F 714	(2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM D 790	(2007e1) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

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

Bore Plan; G

Submit an electronic copy and three hard copies of the record drawings (G) to the Contracting Officer within 5 days after completing the pull back. The record drawings shall include a plan, profile, and all information recorded during the progress of the work. The record drawings shall be tied to the project's survey control.

SD-03 Product Data

Directional Drilling Equipment
Locating Equipment
Size, capacity, and arrangement of equipment
Location and size of drilling and receiving pits
Dewatering and methods of removing spoils material
Method of installing detection wire and pipe
Type, location, and method of installing locator station
Method of fusing pipe segment and type of equipment
Type of cutting head
Method of monitoring and controlling line and grade
Method of detecting surface movement

SD-07 Certificates

Contractor's State License Number; G

Submit statement that Contractor has inspected the drill rod and determined that the drill rod is in satisfactory condition for its intended use.

Submit statement of qualifications and records of previous similar jobs; G

Maintain and submit upon completion of work complete logs of guided directional drilling operations.

SD-08 Manufacturer's Instructions

Submit a complete list of all drilling fluids, additives, and mixtures to be used along with Material Safety Data Sheets; G

Manufacturer's Catalog Data of the polyethylene pipe

1.5 GENERAL REQUIREMENTS

ASTM A 48/A 48M--(2003; R 2008) Standard Specification for Gray Iron Castings

ASTM A 307--(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

ASTM D 3261--(2003) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM D 3350--(2008) Polyethylene Plastics Pipe and Fittings Materials

ASTM D 4976--(2006) Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

ASTM F 714--(2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

1.6 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

Inspect materials delivered to the site for damage. Unload and store with minimum handling. Store materials onsite in enclosures or under protective covering. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

All materials found during inspection or during the progress of work to have cracks, flaws, surface abrasions, or other defects shall be rejected and removed from the job site.

Disposal of fluids is the responsibility of the Contractor. Disposal of fluids shall be done in a manner that is in compliance with all permits and applicable federal, state, and local regulations. The Contractor may dispose of the drilling fluids on approved land owned by the Government. The drilling slurry shall be spread over the Government-approved disposal area and plowed into the soil.

1.6.1 Handling

Handle conduit, piping, fittings, and other accessories in a manner to ensure delivery to the excavation in sound, undamaged condition. Carry, do not drag, conduit/piping to the excavation. Store conduit, piping, and fittings that are not to be installed immediately, under cover out of direct sunlight.

1.7 QUALIFICATIONS

The Contractor to perform this work is to be a State Licensed Underground Utilities Contractor.

The Contractor and his field supervisor assigned to this project must be experienced in work of this nature and must have successfully completed similar projects of similar length, pipe type, pipe size, and soil type using directional drilling in the last 3 years. The Contractor shall submit a description of such project(s) which shall include, at a minimum, a listing of the location(s), date of project(s), owner, pipe type and size installed, length of installation, type and manufacturer of equipment used, and other information relevant to the successful completion of the project.

1.8 SAFETY

Directional drilling equipment machine safety requirements shall include common grounding system to prevent electrical shock in the event of underground electrical cable strike. The grounding system shall connect all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operators booth, worker grounding mats, and any other interconnected equipment to a common ground. The drill shall be equipped with an "electrical strike" audible and visual warning system that will notify the system operators of an electrical strike.

Provide equipment to guard against electrocution and an alarm system on drilling equipment capable of detecting electrical current as it approaches electric lines

1.9 BORE PLAN

Prior to beginning work, the Contractor must submit to the Contracting Officer a to-scale shop drawing of the pilot bore plan with vertical scale 1-inch equals 2 inches and horizontal scale 1-inch equals 20 feet. The plan shall show finished grade, deflection and radii of the pilot bore, and all existing utilities with minimum vertical and horizontal clearances. The proposed clearance shall exceed the guidance system accuracy tolerance by a minimum of 100 percent.

PART 2 PRODUCTS

2.1 DRILL ROD

The Contractor shall select the appropriate drill rod to be used. The drill rod shall be inspected and approved for use by the Contractor prior to arrival at the work site.

2.2 DIRECTIONAL DRILLING EQUIPMENT REQUIREMENTS

The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pull back of the pipe, drilling fluid mixing, delivery, and recovery system of sufficient capacity to successfully complete the installation, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused (if required), a magnetic guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, and trained and competent personnel to operate the system. All equipment shall be in good, safe condition with sufficient supplies, materials, and spare parts on hand to maintain the system in good working order for the duration of this project.

2.2.1 Drilling Rig

The directional drilling machine shall consist of a hydraulically powered

system to rotate and push hollow drilling pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing, and rotating pressure required to complete the installation. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. The hydraulic system shall be free of leaks. The rig shall have a system to monitor and record maximum pullback pressure during the pullback operations. There shall be a system to detect electrical current from the drill string and an audible alarm that automatically sounds when an electrical current is detected.

2.2.2 Drill Head

The drill head shall be seeable by changing its rotation, and shall provide necessary cutting surfaces and drilling fluid jets.

2.2.3 Mud Motors (If Required)

Mud motors shall be of adequate power to turn the required drilling tools.

2.3 LOCATING EQUIPMENT

Shall have manufacturer tolerances of plus/minus 0.25 foot or better. Equipment shall be calibrated prior to the beginning of the work. Rods and pipe shall be located during the drilling process, to the tolerance in the contract documents.

2.4 PRODUCT PIPE

2.4.1 HDPE Piping for Potable Water

The product pipe to be installed shall be HDPE as specified in Section 33 11 00 WATER DISTRIBUTION.

2.4.2 HDPE Piping for Electrical

2.4.2.1 Polyethylene, Flexible Conduit

ASTM D 1248. Provide conduit that is continuous, flexible, high-density polyethylene Type III, SDR 11, IPS pipe of the size indicated on the drawings.

2.4.2.2 Transitions, HDPE to PVC

Install transitions for bonding high-density polyethylene conduit Type III, SDR 11 pipe to Schedule 40 PVC conduit using a two-part resin conduit adhesive specifically designed for the purpose and consisting of the following minimum properties:

Hardness (Shore D Durometer) 70-80
Flexibility (ASTM D 790) >2 percent
Dielectric Strength (ASTM D 149) 450 Volts/Mil (Nonconductive)
Air-tight (no leakage) 120 psi
Typical Adhesive Shear Strength: Substrate (HDPE to PVC 275 lbs/in2)
Typical Impact Resistance: HDPE 24.8 in-lbs, PVC 37.2 in-lbs

Bevel the inner diameter of the HDPE to create a smooth passage for cable pulling. Terminate the HDPE conduit in the belled end of the PVC conduit.

Apply adhesive in accordance with the approved manufacturer's installation instructions.

2.5 DRILLING FLUIDS

Refer to Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION and Drawing Numbers EN2 and EN3 for requirements when working in sites with potential contamination and environmental issues. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains, and other measures. Fuel may not be stored in bulk containers within 200 feet of any water body or wetland area.

A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid. The mixing system shall continually agitate the drilling fluid during operations.

A high quality bentonite drilling fluid shall be used to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Composition of the fluid must comply with API Spec 13A.

The bentonite drilling fluid shall be mixed with potable water (of proper pH) to ensure no contamination is introduced into the soil during the drilling, reaming, or pipe installation process. The Contractor is responsible for any required pH adjustments. Provide bentonite product that contains the proper additives according to the manufacturer for use in directional drilling in the soil conditions that are expected to be encountered on the project.

The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system. A berm at least 12 inches high shall be maintained around drill rigs, the drilling fluid mixing system, entry and exit pits, and the drilling fluid cycling system to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities. The Contractor shall be responsible for properly disposing of any waste product generated as part of this operation.

The drilling fluid recycling system shall separate sand, dirt, and other solids from the drilling fluid to render the drilling fluid reusable. Spoils separated from the drilling fluid will be stockpiled for later use or disposal.

2.6 WIRE TRACING

For nonmetallic piping, provide tracing wire in accordance with Section 33 11 00 WATER DISTRIBUTION. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

2.7 GUIDANCE SYSTEMS

A Magnetic Guidance System (MGS) probe or proven gyroscopic probe and interface shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance shall be capable of tracking at all depths up to 50 feet and in

any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate and calibrated to the manufacturer's specifications of the vertical depth of the borehole at the sensing position at depths of up to 50 feet and accurate to 2 feet horizontally.

Components: The Contractor shall supply all components and materials to install, operate, and maintain the guidance system.

The guidance system shall be of proven type, and shall be set up and operated by personnel trained and experienced with the system. The operator shall be aware of any geo-magnetic anomalies and shall consider such influences in the operation of the guidance system.

PART 3 EXECUTION

3.1 DRILL SET-UP AREA

Contractor may not disturb existing fence, structure, walkways, drive isles, and business operations during directional drilling operations.

3.2 DRILL ENTRANCE AND EXIT PITS

Contractor shall be responsible for design and construction of the drill entrance and exit pits.

Drill entrance and exit pits are required and shall be maintained at a minimum size to allow only the minimum amount of drilling fluid storage prior to transfer to mud recycling or a processing system or removal from the site.

Drilling mud shall not be allowed to flow freely on the site or around the entrance or exit pits. Mud spilled shall be removed as soon as possible and the ground restored to original condition. Pits shall be shored to OSHA standards.

When drilling near wetlands or water courses, the Contractor shall provide secondary containment to prevent drilling fluids from entering the wetlands area or water course by using sandbags or other acceptable means as approved by the Contracting Officer.

3.3 DRILL ENTRANCE AND EXIT ANGLE

Entrance and exit angles can be whatever the Contractor desires such that the elevation profile maintains adequate cover to reduce the risk of drilling fluid breakouts and that ground exit occurs as specified herein.

Contractor shall be responsible for ensuring that entrance and exit angles ensure pullback forces do not exceed 5 percent strain on the polyethylene pipe.

3.4 DRILLING FLUIDS

Maintain drilling fluid in the bore hole to increase the stability of the surrounding soil and reduce drag on the pulled pipe.

Dispose of the drilling fluids in compliance with all relative environmental regulations, right-of-way and work space agreements, and

permit requirements.

Drilling fluid returns can be collected in the entrance pit, exit pit, or spoils recovery pit. Immediately clean up any drilling fluid spills or overflows from these pits.

Provide drilling fluid relief holes as required to prevent heaving of earth, pavement, or roads. Properly seal the relief holes in a timely manner to prevent any damage or injury.

Minimize drilling fluid at locations other than entry and exit points. Immediately clean up any drilling fluids that inadvertently surface.

3.5 PILOT HOLE

The type and size of the pilot string cutting head and the diameter of the drill pipe shall be at the Contractor's discretion.

The pilot hole shall be drilled along the path shown on the plan and profile drawings. Pilot hole tolerances are as follows:

1. Horizontal tolerance: 1-1/2 feet from the centerline of the product pipe.

2. Entry Point Location: The pilot hole entry point shall be within plus or minus 3 feet of the location shown on the drawings or as directed by the Contracting Officer in the field.

3. Exit Point Location: The exit point location shall be within plus or minus 3 feet of the location shown on the drawings or as directed by the Contracting Officer in the field.

The installed pipeline cover requirements as shown on the drawings or as specified shall not be violated.

At completion of pilot hole drilling, furnish Contracting Officer with tabulations of horizontal and vertical alignment.

3.6 REAMING

Reaming operations shall be conducted at the Contractor's discretion. The type of back reamer to be utilized shall be determined by the type of subsurface soil conditions that are encountered during the pilot hole drilling operation. The reamer type shall be at the Contractor's discretion.

3.7 PULLBACK

The entire pipeline to be installed via directional drill shall be fully assembled prior to commencement of pullback operations.

The pipeline shall be supported during pullback operations in a manner to enable it to move freely and prevent damage. The pipeline shall be installed in one continuous pull.

Torsional stress shall be minimized by using a swivel to connect the pull section to the reaming assembly.

The maximum allowable tensile force imposed on the pull section shall not

exceed 90 percent of the pipe manufacturer's safe pull (or tensile) strength. If the pull section is made up of multiple pipe sizes or materials, the lowest safe pull strength value shall govern and the maximum allowable tensile force shall not exceed 90 percent of this value.

External pressure shall be minimized during installation of the pullback section in the reamed hole. Damaged pipe resulting from external pressure shall be replaced at no cost to the Government. Buoyancy modification shall be at the discretion of the Contractor.

Pull detection wire along with HDPE pipe. Extend wire into closest valve box at each end of HDPE pipe.

3.8 GUIDANCE SYSTEMS

Use a magnetic survey tool located behind the pilot string cutting head.

3.9 CLEANING CONDUIT PIPE

Thoroughly clean out each conduit run as it is completed by drawing a stiff bristle brush, of the nominal conduit size, through until conduit is clear of particles of earth, sand, gravel, and water. Swab the conduits with a poly-pig of the nominal conduit size and test the conduit with a non-flexible testing mandrel no less than 7 inches in length with a diameter suitable for the conduit being cleaned. After cleaning immediately install conduit caps. Provide mule tape in each conduit with minimum 8900 newton pulling strength. Mandrel shall be approved by the Contracting Officer before use. A tag line is required on each end of the mandrel during the testing process. Provide a tag line of sufficient strength to withdraw the cleaning device.

3.10 DOCUMENTATION

The Contractor shall maintain drilling logs that accurately provide drill bit location (both horizontally and vertically) at least every 15 feet along the drill path. In addition, logs shall be kept that record, as a minimum, the following every 15 minutes throughout each drill pass, back ream pass, or pipe installation pass:

1. Drilling fluid pressure.
2. Drilling fluid flow rate.
3. Drill thrust pressure.
4. Drill pullback pressure.
5. Drill head torque.

The Contracting Officer or Contracting Officer's Representative shall have access to instrumentation, readings, and logs at all times during operation.

3.11 UTILITY LOCATES

Contractor shall locate all utilities prior to the start of excavation or drilling. The Contractor shall be responsible for damage to utilities and shall repair damaged utilities at no cost to the Government.

3.12 TESTING

See Section 33 11 00 WATER DISTRIBUTION for testing requirements.

3.13 CLEANUP

Immediately upon completion of work of this section all rubbish and debris shall be removed from the job site. All construction equipment and implements of service shall be removed and the entire area involved shall be left in a neat condition acceptable to the Contracting Officer.

"Blow holes" or "breakouts" of drilling fluid to the surface shall be cleaned up immediately and the surface area returned to its original condition. All drilling fluids, spoils, and separated materials shall be disposed of in compliance with federal, state, and local environmental regulations.

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SECTION 33 11 00

WATER DISTRIBUTION

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 Pipe
ANSI A21.53	(2006) Ductile Iron Compact Fittings for Water Service
ANSI B1.20.1	(1983; R2001) Pipe Threads, General Purpose (Inch)
ANSI B16.1	(2005) Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
ANSI B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ANSI B31.1	(2007) Power Piping
ANSI B36.10	(2004; R2010) Welded and Seamless Wrought Steel Pipe

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(2009) Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2008) 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	(2002) Thickness Design of Ductile-Iron Pipe
AWWA C151/A21.51	(2009) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C207	(2007) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
AWWA C500	(2002; R 2003) Metal-Seated Gate Valves for Water Supply Service
AWWA C502	(2005) Dry-Barrel Fire Hydrants
AWWA C504	(2006) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2001) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
AWWA C509	(2001) Resilient-Seated Gate Valves for Water Supply Service
AWWA C510	(1997) Double Check Valve Backflow Prevention Assembly
AWWA C511	(1997) Reduced-Pressure Principle Backflow Prevention Assembly
AWWA C512	(2007) Air-Release, Air/Vacuum, & Combination Air Valves for Waterworks Service
AWWA C515	(2009) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C550	(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 C800	(2005) Underground Service Line Valves and Fittings
AWWA C900	(2007; Errata 2008) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution
AWWA C901	(2002) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13mm) Through 3 In. (76 mm), for Water Service
AWWA C906	(2007) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 63 In., (1,575 mm) for Water Distribution and Transmission

ASME INTERNATIONAL (ASME)

ASME B16.1	(2005) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B18.2.1	(1996; Addenda A 1999; Errata 2003; R 2005) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 2005) Standard for Square and Hex Nuts
ASME B18.21.1	(1999; R 2005) Lock Washers (Inch Series)
ASME B18.22.1	(1965; R 2008) Plain Washers
ASME B18.5.2.1M	(2006) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2005) Metric Round Head Square Neck Bolts
ASME B18.6.1	(1981; R 2008) Wood Screws (Inch Series)
ASME B18.6.3	(2003; R 2008) Machine Screws and Machine Screw Nuts
ASME SA-36	(1998) Steel Designations
ASME SA-675	(1998) Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A 105M	(2009) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 126	(2004) Standard Specification for Gray Iron Castings for Valves, Flanges, and

Pipe Fittings

ASTM A 148/A 148M	(2008) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 242/A 242M	(2004; R 2009) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A 269	(2008) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A 27/A 27M	(2008) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A 283/A 283M	(2003; R 2007) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 322	(2007) Standard Specification Steel Bars, Alloy, Standard Grades
ASTM A 325	(2009) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A 47/A 47M	(1999; R 2009) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray 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 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
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 575	(1996; R 2007) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b; R 2006) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A 582/A 582M	(2005) Standard Specification for Free-Machining Stainless Steel Bars
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 90/A 90M	(2009) Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM B 427	(2009) Standard Specification for Gear Bronze Alloy Castings
ASTM B 584	(2000) 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	(2002) 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 1238	(2004c) Melt Flow Rates of Thermoplastics by Extrusion Plastometer
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 2000	(2008) Standard Classification System for Rubber Products in Automotive Applications
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 3261	(2003) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3350	(2008) Polyethylene Plastics Pipe and Fittings Materials
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 2206	(2002; R2010) Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock
ASTM F 436	(2009) 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	(2008) Standard Specification for Stainless Steel Nuts
ASTM F 714	(2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 879	(2008) Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2003) EJMA Standards

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR Manual	(1988e9) Manual of Cross-Connection Control

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (FDEP)

FAC 62-555.340	(2003) Disinfection and Bacteriological Evaluation of Public Water System

Components

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2009) International Plumbing Code

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 8500.1	KSC Environmental Requirements

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2009) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-60	(2004) Connecting Flange Joint Between Tapping Sleeves and Tapping Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	(2010) Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NSF INTERNATIONAL (NSF)

NSF 14	(2003) Plastics Piping System Components and Related Materials
NSF 61	(2009) Drinking Water System Components - Health Effects

PLASTICS PIPE INSTITUTE (PPI)

PPI TR-4	(2010) PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe
PPI TR-33	(2006) Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe

1.2 DESIGN REQUIREMENTS

1.2.1 Water Distribution Mains

Provide water main accessories, gate valves and check valves as specified and where indicated.

Provide water distribution mains indicated as 6 through 18 inch diameter pipe sizes of ductile-iron pipe. Provide water distribution mains indicated as 2- through 4-inch diameter pipe sizes of polyvinyl chloride (PVC) plastic pipe. Provide water distribution mains indicated as 3- through 12-inch diameter pipe sizes of high density polyethylene (HDPE)

pipe. Also provide water main accessories, gate valves, pressure control valves, check valves, ball valves, and water meters as specified and where indicated.

1.2.2 Water Service Lines

Provide water service lines indicated as 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

The following drawing types shall be submitted in accordance with paragraph entitled, "Shop Drawings," of this section.

Water Line Connection Plan; G
As-Built Drawings; G

SD-03 Product Data

Manufacturer's instructions and catalog data shall be submitted for the following items:

Pipe Connections; G
Ductile Iron Pipe; G
Rubber Gaskets; G
Ductile Iron Fittings; G
Valves; G
HDPE Pipe and Fittings; G
Water Meters; G
Appurtenances; G
Water Service Lines; G
Polyvinyl Chloride (PVC) Pressure Pipe; G
PVC Fittings; G
Unions; G
Valve Boxes; G
Valve Vaults; G
Hydrants; G
Corporation; G
Signage
Backflow Preventer Assemblies; G
Service Saddles; G
Line Stop Sleeves; G

SD-05 Design Data

Axial Deflection Calculations

SD-06 Test Reports; G

Test reports for the following items shall be submitted in accordance with the paragraphs entitled, "Testing" of this section.

Pressure Test; G
Leakage Test; G
Disinfection; G
HDPE Pipe and Fittings; G
Backflow prevention assemblies; G

SD-07 Certificates

Lining
HDPE Pipe and Fittings; G

SD-08 Manufacturer's Instructions

Manufacturer's instructions including special provisions required to install equipment, components, and systems packages shall be submitted for the following. Special notices shall detail impedances, hazards and safety precautions.

Backflow Preventer Assemblies

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, hydrants, and meters free of dirt and debris.

1.5.2 Handling

Pipe and accessories shall be handled to ensure delivery to the trench in an undamaged condition. Particular care shall be taken 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. No other pipe or material shall be placed inside of a pipe or fitting after the coating has been applied. Pipe shall be carried into position. Pinch bars and tongs for aligning or turning the pipe shall be used only on the bare ends of the pipe. Interiors of pipe and accessories shall be cleaned before the pipe or accessories lowered into the trench and shall be kept clean during laying operations by an approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional cost to the Government. Rubber Gaskets that are not to be installed immediately shall be stored in a cool dark place out of the direct rays of the sun.

PART 2 PRODUCTS

Newly installed or constructed Public Water System (PWS) components that come into contact with drinking water or drinking water treatment chemicals shall conform to NSF 61 or Section 6 of NSF 14.

Any pipe and pipe fitting used in the construction, alteration, or repair of any PWS shall be lead free (contain not more than 8% lead). 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 shall be lead free (in compliance with Section 9 of NSF 61 as adopted in Rule 62-555.335 F.A.C.).

All water main pipes, including fittings, shall be color coded or marked using blue as a predominant color to differentiate drinking water from reclaimed or other water. Underground metal pipe shall have blue stripes applied to the pipe wall. Pipe striped during manufacturing of the pipe shall have continuous stripes that run parallel to the axis of the pipe, that are located at no greater than 90-degree intervals around the pipe, and that will remain intact during and after installation of the pipe. If tape or paint is used to stripe pipe during installation of the pipe, the tape or paint shall be applied 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, tape or paint shall be applied 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

All materials in contact with potable water shall be NSF 61 approved and shall be suitable for use with chloraminated water.

2.1.1.1 Ductile-Iron Piping

Ductile iron pipe shall be manufactured in accordance with AWWA C150 and AWWA C151/A21.51 with push-on joints.

All non-flanged pipe shall be minimum Pressure Class 250.

Unless otherwise noted on the drawings, all ductile iron pipe exposed above grade shall be flanged ductile iron pipe in accordance with AWWA C115/A21.15, minimum thickness Class 53 with Class 125 flanges. Flanges shall be ductile iron.

All ductile iron pipe and ductile iron fittings shall be cement lined in accordance with AWWA C104/A21.4.

All buried pipe and fittings shall be 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. All flanged and above grade or exposed pipe and fittings shall be painted in accordance with Section 09 90 00.00 98 PAINTING AND COATING.

Unless noted otherwise on the drawings, exposed fittings shall be flanged, ductile iron in accordance with AWWA C110/A21.10, rated for 250-psi operating pressure. Where new flanged pipe is to be joined with existing and other new flanges, adaptor flange pipe sections shall be provided if necessary.

All bolts, nuts, and studs shall be 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.

Flange gaskets shall conform to the requirements of AWWA C111/A21.11, shall be 1/8-inch thick full-face-type and shall conform to the dimensions of Appendix A of AWWA C115/A21.15. Gaskets shall be suitable for the service conditions and shall be provided by the pipe manufacturer.

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 4-Inch PVC Pressure Pipe

Unless otherwise noted, ensure that PVC pressure pipe for nominal diameters 4 inches conforms to the requirements of AWWA C900 DR 18 with gasketed integral bell ends. Ensure that pipe is designed for maximum working pressure of not less than 150 psi. Ensure that the pipe is made to ductile iron pipe ODs instead of IPS. Ensure that the PVC pipe is NSF approved for potable water use.

The following pipe joints and fittings restraint methods can be used to prevent pipe joints and fittings from separating under pressure. No additional financial compensation will be provided to the Contractor for providing the following methods of restraint:

a. Restrain mechanical joint fittings used with PVC pipe (3-inch-through 36-inch-diameter DR 18 pipe) with the EBAA Iron MEGALUG® Series 2000 PV Restrainer or an equal approved by the Contracting Officer. Ensure that the Series 2000 PV restrainers provide a minimum of 150-psi restraint with a 2 to 1 safety factor. Ensure that the restraining device and Tee head bolts are manufactured of high-strength ductile iron meeting ASTM A 536, Grade 65-42-10. Ensure that clamping bolts and nuts are manufactured of corrosion-resistant, high-strength, low-alloy CORTEN steel meeting the requirements of ASTM A 242/A 242M.

b. Coat all parts of the joint restraint system with coal tar epoxy as in Section 09 90 00.00 98 PAINTING AND COATING, Mega-Bond coating system by EBAA Iron, Inc. or Contracting Officer approved equal.

2.1.1.3.2 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.

2.1.1.4 PVC Fittings

2.1.1.4.1 4-Inch PVC Pressure Pipe Joints

Ensure that pipe joints are made with integral bell and spigot pipe ends. Ensure that the bell consists of an integral thickened wall section designed to be at least as strong as the pipe wall. Supply the bell with a factory glued rubber ring gasket which conforms to the manufacturer's standard dimensions and tolerances. Ensure that the gasket meets the requirements of ASTM F 477. Ensure that the PVC joints are "Ring-Tite" as manufactured by J-M Manufacturing Company, Inc. or an equal approved by the Contracting Officer. Ensure that nontoxic gasket lubricant is as specified by the pipe manufacturer.

2.1.1.4.2 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.

2.1.1.4.3 4-Inch PVC Pressure Pipe Fittings

Ensure that fittings for use with 4-inch PVC pipe are ductile-iron fittings conforming to the requirements of mechanical joint fittings as specified in Part 2.1.1.1 of this Section.

Ensure that exterior coating for fittings is as specified in Part 2.1.1.1 of this Section.

Lining:

a. Ensure that lining for fittings is as specified in Part 2.1.1.1 of this Section.

b. Repair any damaged lined areas in accordance with the manufacturer's recommendations so that the repaired area is equal to the undamaged lined areas.

2.1.1.4.4 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.

2.1.1.4.5 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.

2.1.1.5 HDPE Pipe and Fittings

Provide a statement in writing from the HDPE pipe manufacturer that the manufacturer is listed with the Plastic Pipe Institute as a qualified

extruder for the polyethylene resin to be used in the manufacture of the pipe for this project. Ensure that the performance requirements of the pipe comply with the most current version of AWWA C901 or AWWA C906. Ensure that the manufacturer is listed with NSF 61 certification and include the third party certification in the print line of the product.

All persons making heat fusion joints shall receive training in the manufacturer's recommended procedures. The Contractor shall maintain records of trained personnel and certify that training was received not more than 12 months before construction began. Additionally, the Contractor shall have worked on one or more projects involving combined installation of at least 10,000 feet of HDPE butt-fusion-welded pipe and shall provide the Contracting Officer with a written list of HDPE pipeline installation experience, including project location, date, Owner, and personnel assigned and installing on this project.

The pipe manufacturer shall certify in writing that the Contractor is knowledgeable and has been trained to join, lay, and pull the pipe or a representative of the pipe manufacturer shall be onsite to oversee all pipe joining. The Contractor shall pay all costs for the manufacturer's representative.

2.1.1.5.1 Quality Assurance

The pipe and fitting manufacturer(s) shall have an established quality-control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rated, and contamination.

2.1.1.5.2 Pipe and Fittings

General

All HDPE shall be Performance Pipe PE 3408 HDPE, PolyPipe PW PE 3408 HDPE, or approved equal and conform to ASTM D 3350 44576C cell classification.

All HDPE pipe 4 inches in diameter or greater shall have a ductile iron pipe outside diameter in accordance with ASTM F 714, and HDPE pipe 3 inches in diameter and smaller shall be IPS in accordance with ASTM F 714, unless otherwise specified or shown in the drawings.

HDPE Pipe

HDPE pipe 4 inches in diameter and larger shall conform to ASTM D 3350 445576 cell classification rated as PE 3408 by the Plastics Pipe Institute. Minimum pressure rating shall be as specified in this Section. Minimum pressure rating shall be 100 psi SDR 17 (standard dimension ratio) for pipe sizes greater than 4 inches in diameter. For pipe sizes 4 inches and smaller in diameter, the minimum pressure rating shall be 200 psi SDR 9.

The polyethylene compound shall be suitably protected against degradation by ultraviolet light.

The maximum allowable hoop stress shall be 1,000 psi at 73.4° F.

The pipe manufacturer shall be listed with the Plastic Pipe Institute as meeting the requirements of the resin manufacturer to manufacture

pipe from the resin used in accordance with PPI TR-4.

Fittings

HDPE pipe fitting shall conform to ASTM F 2206. The pipe manufacturer shall mold or fabricate the polyethylene fittings. Butt fusion outlets shall be made to the same outside diameter, wall thickness, and tolerances as the mating pipe. All fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe.

Molded Fittings: Molded fittings shall be manufactured in accordance with ASTM D 3261 and shall be so marked. Each production lot of molded fittings shall be subjected to the test required under ASTM D 3261. The manufacturer shall submit samples from each molded fitting production lot to x-ray inspection for voids and shall certify that voids were not found.

Fabricated Fittings: Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings. Fabricated fittings shall be rated for internal pressure service equivalent to the full-service pressure rating of the mating pipe. Pressure de-rated fittings are not acceptable. Directional fittings 16 inches IPS and larger, such as elbows, tees, crosses, etc., shall have a plain end inlet for butt fusion and flanged directional outlets. Ensure that fittings fabricated from thicker wall pipe have an ID taper bore to match the wall of the pipe to which it will be fused.

HDPE Pipe Jointing Method

HDPE pipe shall be jointed by butt fusion in accordance with PPI TR-33 and the pipe manufacturer's directions and only for pipe within one SDR ratio of each other.

For SDR ratios that are two or more apart (i.e., SDR 21 to an SDR 11), the joint shall be made using restrained joints. Same-diameter pipe may be joined by using HDPE flange adapters and backup rings bolted to each other. The thicker wall pipe may also have an ID taper bore to match the wall of the thinner wall pipe to which it will be fused.

All HDPE pipe joined by butt fusion shall be made from the same class and type of raw material made by the same raw material supplier.

Butt fusion means the butt joining of the pipe by heat fusion aligned faces of the pipe ends (butts) in a suitable apparatus and joining under controlled pressure and alignment.

The external bead resulting from the butt-fusion process shall be visible and examined for complete butt-fusion 360 degrees around the pipe exterior.

Short spools of pipe between valves and fittings shall be ductile iron pipe, with all joints restrained for sizes 4 inches and larger. For 2-inch pipe, the spool shall be Schedule 40 Type 304 stainless steel piping or Schedule 80 PVC piping with IP threads stainless steel or PVC fittings and all joints restrained.

Where approved by the Contracting Officer, the HDPE pipe and fittings may be fused with Electrofusion Couplings, as manufactured by Central

Plastics Company, or approved equal. Technical information must be provided to demonstrate that the fused coupling will not compromise the structural integrity of the HDPE pipe.

2.1.1.6 Ductile Iron Pipe for HDD

2.1.1.6.1 General

Ductile iron pipe used for directional drilling shall meet all requirements of ANSI/AWWA C151/A21.51. Unless otherwise specified pipe shall be lined with cement mortar in accordance with ANSI/AWWA C104/A21.4, with all operations completed in a single facility by one manufacturer. Pipe shall be AMERICAN Flex-Ring® or approved equal.

2.1.1.6.2 Pipe Joints

Joints used for directional drilling shall be boltless, flexible restrained, with smooth contoured bells and shall have the minimum properties as shown in Table 1. Joints with bulky glands or flanges that may prevent the smooth flow of the drilling fluid/soil slurry over the joint are not acceptable. Pipe shall be AMERICAN Flex-Ring® or approved equal.

a. Pressure and Thrust (Pulling): Joint seals and Flex-Ring® joint pipe used for HDD, when properly assembled and installed, shall be capable of dependably handling the specified internal pressure and pulling loads in straight alignment or at maximum rated joint deflection. Maximum internal pressure and allowable pulling loads for all sizes are provided in Table 1.

b. Proof-of-Design Tests: The manufacturer shall make available to the Contracting Officer proof-of-design tests for each size and type of flexible restrained joint pipe used. These tests shall establish the basis for the maximum allowable pulling loads shown in Table 1. Proof-of-design tests for the pulling heads shall also be made available to the Contracting Officer.

2.1.1.6.3 External Loads and Buckling

In cases where the borepath alignment is at an extreme depth or if the Contractor anticipates high pumping pressures particularly for larger sizes of pipes, the Contractor shall consult the pipe manufacturer to ensure that the buckling strength of the pipe has been properly evaluated.

2.1.1.6.4 Lining and Coating

Ductile iron pipe for water service shall be lined with cement mortar in accordance with ANSI/AWWA C104/A21.4.

Ductile iron pipe for wastewater service and for application as culvert pipes shall be lined with cement mortar in accordance with ANSI/AWWA C104/A21.4 unless otherwise specified.

The exterior of all ductile iron pipe and fittings shall be coated with an asphalt-based coating as required by ANSI/AWWA C151/A21.51.

2.1.1.6.5 Pipe Weight - Net Unit Buoyancy

Pipe buoyant force or buoyant weight shall be calculated based on the

density of drilling fluid(s) to be used. Any counter-weight placed inside the pipe shall be free from any dirt, grease, oil, or other contaminants that may prevent proper disinfection for waterlines.

TABLE 1 - FLEX-RING® DIMENSIONS AND OTHER PARAMETERS

Nominal Pipe Size (inch)	Maximum Working Pressure [1] (psi)	Pipe Barrel O.D. (inch)	Pipe Bell Outside Diameter (inch)	Unit Weight Lined PC 350 Pipe (lb/ft)	Bulk Density of Empty Pipe (lb/ft3)	Net Unit Buoyancy [2], Empty Pipe in Water (lb/ft)	Allowable Pulling Loads (lbs)	Allowable Deflection (Deg.)
4	350	4.80	7.06	13	100	-5	10,000	5
6	350	6.90	9.19	18	69	-2	20,000	5
8	350	9.05	11.33	25	55	3	30,000	5
10	350	11.10	13.56	31	46	11	45,000	5
12	350	13.20	15.74	40	42	19	60,000	5
14	350	15.30	19.31	53	41	27	75,000	4
16	350	17.40	21.43	65	40	38	95,000	3.75
18	350	19.50	23.70	78	37	52	120,000	3.75
20	350	21.60	25.82	90	35	69	150,000	3.5
24	350	25.80	29.88	122	34	104	210,000	3
30	250	32.00	36.34	173	31	175	220,000	2.5
36	250	38.30	42.86	233	29	266	310,000	2
42	250	44.50	49.92	315	29	359	390,000	2
48	250	50.80	56.36	395	28	484	500,000	2

[1] Working pressure is the maximum pressure rating of the joint and is based on its capability to resist thrust due to internal pressure. If higher working pressure is required, check with AMERICAN. Pressure rating of the joint is limited by the pressure rating of the parent pipe.

[2] Based on weight of empty (full of air) Pressure Class 350 Flex-Ring pipe with standard cement lining immersed in water. Positive numbers indicate such pipe will float.

2.1.1.6.6 Entry and Exit Angles

The entry angle of the drill string shall range from 8 degrees to 20 degrees. Exit angles for the drill string shall consider the allowable deflection (reference Table 1) and the method of installation proposed for the new Flex-Ring®, flexible restrained joint ductile iron pipe. Submit a detailed connection plan showing the connection between the HDD installed piping and the next section of pipeline.

2.1.1.6.7 Minimum Radius of Curvature

Maintain the borepath alignment and radii that are indicated on the drawings. Any alternate designs must be submitted to the Contracting Officer for approval before beginning drilling operations and shall be based on a range from 50 feet to 100 feet per inch of nominal diameter, using 20-foot joint lengths.

2.1.1.6.8 Borepath Inside Diameter

The finished inside diameter of the borepath shall be nominally 1.5 times the outside diameter of the Flex-Ring® bell (see Table 1) for pipe sizes 4 inches through 24 inches. The inside diameter of the borepath for pipe sizes 30 inches through 48 inches shall be equal to the outside diameter of the Flex-Ring® bell (see Table 1) plus 12 inches. To ensure proper borepath size and integrity, the borepath shall be swabbed before final pipe pullback.

2.1.1.6.9 External Protection

a. Polyethylene (PE) Encasement: Apply PE encasement according to the following procedure. Using only tube-type PE sleeves, the PE tube shall be centered onto the barrel of the pipe and firmly secured in accordance with the requirements of AWWA C105/A21.5, Method A and other requirements as described below. Ensure that all excess material along the barrel of the pipe is creased and the excess folded over itself longitudinally so that the PE wrap is tight up against the pipe barrel. Secure the wrap tightly to the pipe by applying circumferential wraps of tape applied over the folded PE encasement, and applied at intervals of approximately 2 feet to within 18 to 24 inches of either end of the pipe. Tape applied in a helical pattern should only be used as a supplementary wrap.

b. The excess PE encasement shall be pulled back over itself to expose approximately 18 to 24 inches of both ends of the pipe. First overlap the PE encasement so that this first layer can be securely anchored to the pipe barrel, without interference from the PE encasement on that pipe section, using tape. The excess material should be trimmed, or the length and/or positioning of the PE tube may need adjustment to accomplish this.

c. After engaging the spigot into the bell and verifying engagement of the restraining Flex-Ring® or Flex-Ring® segments, the following sequence is recommended for securing and completing the PE encasement at the pipe joints. This sequence should be followed so that the final overlap is made opposite the direction of the pull, preventing any catching of the edge and minimizing any collection of drilling fluids etc. inside the wrap. For each layer of PE encasement always complete the joint by first

overlapping the end of the tube from the spigot end over the bell and secure the end of the tube onto the pipe barrel with several contiguous circumferential wraps of tape. It is important to ensure that the PE encasement is secured to the pipe barrel with enough circumferential wraps to anchor the PE encasement so that any possibility of slippage is reduced. The PE encasement from the pipe closest to the HDD drilling machine (bell end of pipe) shall then be overlapped over its bell and secured to the barrel on the spigot end of the pipe being installed with circumferential wraps of tape.

d. Apply one final, tight circumferential wrap a few inches from the bell face on the last PE wrap overlap over the most recently assembled spigot end. This final wrap should consist of strong strapping tape or other firm fastening means (that will not damage the wrap) and that will further minimize any slippage or bunching of the wrap-in installation. Any other proposed methods of installing and fastening PE encasement must be approved by the Contracting Officer.

2.1.1.7 Galvanized Steel Pipe

Pipe: Steel piping shall conform to the requirements of ASTM A 53/A 53M, Type S, Grade B, and ANSI B36.10, Schedule 40 as indicated on the drawings.

Fittings: Forged steel conforming to ASTM A 105/A 105M and ANSI B16.11, Class 2000.

Joints: Threaded conforming to ANSI B1.20.1.

Galvanizing: Conform to ASTM A 90/A 90M.

2.1.2 Valves, Hydrants, and Other Water Main Accessories

2.1.2.1 Gate Valves

2.1.2.1.1 Type 620 - Cast-Iron Resilient Wedge Gate Valves, 2 Inches through 3 Inches, Threaded End (AWWA C509)

Provide valves 2 inches through 3 inches that are of cast-iron or ductile-iron body construction and conform to AWWA C509 for resilient seated gate valves. Provide the valve design that incorporates non-rising stems and triple "O" ring seal staff box. Provide valves that open counterclockwise. Ensure that the valve wedge is symmetrical and fully encapsulated with molded rubber with no exposed iron. Design valves for bubbletight shutoff to flow in either direction. Before shipment the valve manufacturer shall test each valve to 200-psi pressure differential in both directions and provide a certificate to the Contracting Officer stating each valve provided bubbletight shutoff during testing. Ensure that the valve interior and exterior is epoxy fusion coated.

Ensure the ends are threaded ends complying with ANSI B1.20.1.

Gate valves shall be manufactured by Mueller, American Flow Control or Kennedy.

2.1.2.1.2 Type 685 - Ductile-Iron Resilient Wedge Gate Valves, 3 Inches through 20 Inches, for Exposed and Buried Service (AWWA C515)

Provide valves that are cast-iron or ductile-iron body valves and comply with 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 Butterfly Valve

2.1.2.2.1 General Description

Butterfly valves shall meet or exceed AWWA C504, Class 150B, unless otherwise specified in this Section. Each valve shall operate in fully opened and in intermediate positions as the valve opens and closes without noticeable flutter or vibration of the disk and shall be free of backlash and loose connections in the operating mechanism, linkage, and shaft connections. Valves shall be identified properly by size, type, serial number, and manufacturer in stainless-steel plates attached permanently on the valve body or bonnet.

The valve body shall be ductile-iron according to ASTM A 536 Grade 65-45-12 or cast-iron according to ASTM A 48/A 48M. The valve disc shall be ductile-iron in accordance with ASTM A 536 (65-45-12) or cast-iron in accordance with ASTM A 48/A 48M. The disc seating edge shall be solid 316 stainless-steel. The disc shall be securely attached to the valve shaft using 304 stainless-steel taper pins. The valve disc shall be designed without using external reinforcing ribs. The valve disc shall provide an uninterrupted 360-degree seating edge. The valve seat shall be of EPDM or Viton materials. The valve seat shall be designed to provide a tight shutoff in both directions at the specified design differential pressure, with a pressure of 0 psig on the face of the disc opposite the pressurized side. The valve seat shall be molded in and bonded to the valve body for 3- to 24-inch valves. For valves 30 inches and larger, the seat shall be field replaceable without disassembly of the disc and shaft and shall be retained within a dovetail groove in the valve body and locked in place by an epoxy compound edge. The valve shaft shall be of Type 304 stainless-steel. The valve shaft may be a one-piece unit extending completely through the disc or of the stub shaft type consisting of two separate shafts inserted into the valve disc hubs. Stub shafts shall extend into the disc hubs for a distance of at least 1.5 shaft diameters. The valve shaft shall have a diameter equal to or greater than that shown for Class 150B in Table 3 of AWWA C504. Connection between the shaft and disc shall be dowel or taper pins, which are mechanically secured. Alignment marks on the valve shaft and on the valve body shall be provided to indicate the fully closed and fully open positions. Valve shaft

bearings shall be Teflon-lined with a nonmetallic fiberglass composite backing and shall be permanently lubricated. The bearings shall be sleeve-type bearings contained in the hubs of the valve body. Design bearings in accordance with AWWA C504, Section 4.5.6. Thrust bearings shall be provided "as required" to hold the valve disc in the center of the valve seat. The valve shaft seal shall be self-compensating V-type packing with a minimum of four sealing rings. One-piece molded shaft seals and O-ring shaft seals are not acceptable. The shaft seal shall be designed to allow seals to be replaced without the valve shaft being removed. Packing shall be made of resilient, nonmetallic material and shall not contain asbestos. Metallic components (e.g., dowels, pins, etc.) shall be 300 series stainless-steel, ductile-iron, or other materials approved by the Contracting Officer. Brass, bronze, and copper alloy materials are not acceptable. Nonmetallic components shall be EPDM, Viton, Teflon, or other materials approved by the Contracting Officer.

Valves shall be as manufactured by DeZurik, Pratt, M&H, Val-Matic, or an approved equal.

2.1.2.2.2 Flanged, Rubber-Seated Butterfly Valves, 4 Inches through 72 Inches, for Exposed Service

The valve bodies shall have flanged ends. Flanged-end valves shall be of the short-body design with 125-pound flanged ends faced and drilled in accordance with ANSI B16.1 for cast-iron flanges.

2.1.2.2.3 Mechanical-Jointed, Rubber-Seated Butterfly Valves, 4 Inches through 72 Inches, for Buried Service

The valve bodies shall have mechanical-jointed ends. The mechanical-joint end valves shall meet the requirements of AWWA C111/A21.11.

2.1.2.3 Swing-Flex Check Valves

The valve body and cover shall be constructed of ASTM A 536 Grade 65-45-12 ductile-iron. The disc shall be precision-molded Buna-N, ASTM D 2000 Class BG. A screw-type backflow actuator shall be provided to allow opening the valve during no-flow conditions. Buna-N seals shall be used to seal the stainless-steel stem in a bronze bushing. The backflow device shall be of the rising-stem type to indicate position. Provide full size top access port allowing removal of the disc without removal of the valve from the line. A stainless-steel T-handle shall be provided for ease of operation. The valve shall be designed for a minimum working pressure of 150 psi. The manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow shall be directly cast on the body. Swing check valves shall exceed the minimum requirements of AWWA C508 with a heavy-duty body of ductile-iron with integral flanges, faced and drilled in accordance with ASME B16.1 Class 125. Bolts, nuts, washers, etc., shall be 316 stainless-steel. The valve body shall be the full-waterway type. The disk arm shall be ductile-iron or steel, suspended from and keyed to a stainless-steel shaft that is completely above the waterway and supported at each end by heavy bronze bushings. The shaft shall rotate freely without the need for external lubrication. Where it passes through the body, the shaft shall be sealed by means of a stuffing box and adjustable packing. Simple O-ring shaft seals are not acceptable. The valve interior shall be painted with epoxy coating by the valve manufacturer in accordance with AWWA C550. The check valve shall be Val-Matic Swing-Flex® check valve, or approved equal.

2.1.2.4 Slanting Disc Check Valve

Slanting disc check valves 6 inches through 72 inches shall have materials of construction as described below:

Component	Material	Specification
Body	Cast or ductile-iron	ASTM A 126, Class B or ASTM A 536, Grade 65-45-12
Seat ring and disc ring	Bronze	See the following specification
Pivot pins	Stainless-steel	ASTM A 582/A 582M, Type 303 or 304
Bushings	Stainless-steel	ASTM A 269, Type 304 or 316
Oil reservoirs	Stainless-steel	AISI Type 316

Bronze or brass components in contact with water shall comply with the following requirements:

Constituent	Content
Zinc	7 percent maximum
Aluminum	2 percent maximum
Lead	8 percent maximum
Copper plus Nickel plus Silicon	83 percent minimum

Ends shall be flanged, ANSI B16.1, Class 150. The body shall be of two-piece construction, bolted at the center to hold the seat at an angle of 55 degrees. The area throughout the valve body shall equal the full pipe area. Provide bottom-mounted hydraulic dashpot to control valve closing. The dashpot shall have a control valve to adjust the speed of the closing cycles. Time spreads shall be 1 second to 30 seconds for closing. Provide oil-filled dashpots to operate the closing arrangement over the last 10 percent of the closing range. The valve shall be APCO Series 800, Golden-Anderson, Val-Matic Series 9600, or approved equal.

2.1.2.5 Pressure Control Valves

The system pressure control valve will be installed between two zones and remain closed under normal conditions. The valve will sense the system pressure on the downstream side/ outlet of the valve. If the pressure on the downstream side of the valve drops to 55 psi or lower the valve will open and provide fire flow interconnecting the two systems. When the high demand/fire condition ceases and normal pressure is returned the valve will reset and close at 70 psi.

The main valve will be diaphragm actuated and consist of three major components. The body, with seat installed, the diaphragm assembly and the cover with cover bearing. The main valve will be ductile iron and have stainless-steel trim. The diaphragm assembly shall be fully guided

throughout its entire stroke. The main valve will have a fusion bonded epoxy coating on all ferrous metal surfaces. It will be a packless valve with no O-rings or packing glands anywhere within the main valve. The main valve will be a full ported, with a 12-inch seat area.

The pilot control system will have two separate pilots. One for opening and one for closing. The pressure reducing control (CRA) will be installed on the downstream of the cover and control the open point at 55 psi. It will be a normally open control that stays closed as long as the pressure is above the spring set point. The pressure relief control (CRL) will be on the feed to the cover and open to close the 12" main valve at 70 psi. It will be normally closed and open as the downstream system pressure rises to 70 psi. The pilot system will also contain the X105LCW dual limit switch assembly to provide a dry contact signal of open or close.

The manufacturer shall also provide a direct factory employee for start up, training and adjustment.

The valve shall be a 12-inch 208G-11BYKC D.B. X105LCW as manufactured by Cla-Val Company or approved equal.

2.1.2.6 Pressure Relief Valves

There are two 8-inch pressure relief valves installed in parallel inside the W-5 Pump Station building.

Design valves to act as a pressure relief valve to protect the pumps and piping system in the case of a pressure spike. The valve will have a normally closed high pressure pilot designed to open if the pressure exceeds the normal pressure while pumping. The 8-inch main valve will stay open as long as the pressure is at or above the set point on the pilot.

The main valve will be ductile-iron and have stainless-steel trim internals. The main valve will have a one-piece stainless-steel seat and have an NSF approved fusion bonded epoxy coating. The cover will have a locating lip or locating pins. The main body will have 150 ANSI flanged ends rated to 250 psi working pressure. The CRL relief pilot will have a 20-200 psi spring range. The manufacturer will factory-install an X141 gauge on the inlet for monitoring and set up. Provide an X101 visual valve position indicator to monitor valve position at any time.

The manufacturer shall provide a direct factory employee for start up and training.

The valve shall be a model 8-inch 50A-01BYKC D.S. X141, X101 as manufactured by Cla-Val Co. Newport Beach, Ca. or approved equal.

2.1.2.7 Tank Fill Valve

The tank fill control valve is composed of a main control valve and a pilot control system. The pilot system includes a solenoid pilot valve, a differential pilot valve with a downstream orifice plate, and a pressure sustaining pilot valve. Install the tank fill control valve on the tank inlet lines and open when the tank level drops to replenish the tank. The valve will open or close if the tank water level is below a preset setting or above a preset setting through a solenoid pilot valve. When the valve opens it will limit the flow into the tank to a preset maximum. A differential pilot control shall sense pressure across a downstream orifice plate and will modulate the 6-inch main valve to limit the flow. A

pressure sustaining pilot shall maintain a minimum back pressure while filling. The valve shall also have a solenoid override feature. When the pump station is running, the solenoid pilot valve will be energized to lock the valve closed.

The main valve will have a 6-inch 100-01 full ported main valve. It will be diaphragm actuated and consist of three major components: the body, with seat installed, the diaphragm assembly and the cover with cover bearing. The main valve will be ductile iron and have 316SS anticavitation trim. The diaphragm assembly shall be fully guided throughout its entire stroke. The main valve will have a fusion bonded epoxy coating on all ferrous metal surfaces. It will be a packless valve with no O-rings or packing glands anywhere within the main valve. The main valve will have a one piece stainless steel seat. No snap seat rings will be accepted.

The pilot control system will have three separate pilots. The solenoid pilot valve is for opening and shutting off at tank high water level and the solenoid override feature. The differential pilot valve is for throttling/limiting the flow. The pressure sustaining pilot valve will be a CRL sustaining pilot. This solenoid feature will be energized when the pump is running and the valve will be locked closed to prevent recirculation. The pilot system will also have opening and closing speed controls. The valve system will have an X52E orifice plate installed downstream. The pilot control system will contain a limit switch to monitor valve open or closed position.

The manufacturer shall also provide a direct factory employee for start up, training and adjustment.

The valve shall be a 6-inch 210DG-28BCSYKCKOKX D.S. X105LCW as manufactured by Cla-Val Co. Newport Beach, Ca or approved equal.

2.1.2.8 Backflow Preventer Assemblies

Provide backflow preventers that are the double-check type conforming to AWWA C510 for fire services and the reduced pressure type conforming to AWWA C511 for potable water services. Provide valves that are FEBCO 850 for double-check and FEBCO 825YD for reduced pressure or approved equal. Ensure that the assembly includes 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. Ensure that the assemblies are rated for a working pressure of 175 psi and that the maximum pressure loss is 6 psi at a flow rate equal to the sprinkler water demand for fire lines or the average day demand for domestic lines, at the location of the assembly. Provide a test port for a pressure gauge both upstream and downstream of the double-check backflow prevention assembly valves.

Use double-check type backflow devices or assemblies for low degree of hazard non-pollutants or contaminants. Ensure that this device conforms to AWWA C510, ASSE 1015, and FCCCHR Manual-9 Standard. Install this unit a minimum of 32 inches above the ground or flood level.

Ensure that the interior of the backflow preventers is epoxy-coated in accordance with AWWA C550. Provide backflow preventers equipped with a thermally activated valve set for freeze protection installed on the downstream side of the backflow preventer. Provide thermally activated valve manufactured by Crispin, Freezetron, or approved equal. Provide backflow preventers equipped with galvanized steel chain and security

lock. Ensure that fire service backflow preventer and associated aboveground piping is red in color. Ensure that domestic service backflow and associated aboveground piping is blue in color.

Ensure that plumbing fixtures, equipment, and pipe connection do not cross connect or interconnect between a potable water supply and any source of non-potable water. Install backflow preventers where indicated and in according 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, install backflow preventers at all locations where the potable water outlet is below the flood level of the equipment or where the potable water outlet is located below the level of the non-potable substance. Locate backflow preventers so that no part of the device will be submerged. Ensure that backflow preventers are 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. Do not provide bypass piping around backflow preventers. Provide access for maintenance and testing. Ensure that each device is a standard commercial unit.

Design and install backflow prevention devices to meet the NFPA's Code requirement for testing backflow prevention devices. Ensure that design includes a method to forward flow (full flow) test downstream of the backflow prevention device and meets all design criteria as stated herein and as shown on the drawings. Ensure that test outlet connection is UL listed, FM approved for fire service. Ensure that each outlet is capable of supplying water flow with a minimum of 250 gpm. Ensure that the outlet connection meets all testing and material specifications as stated herein and as shown on the drawings.

Provide test outlet connections with cast-brass body or Contracting Officer-approved equal material, NPT inlets with 2-1/2-inch NST male outlets equipped with the listed manufacturers cap and chain. Ensure that the test outlet connection includes a brass plate with engraved letter for identification as specified and shown on the drawings.

2.1.2.9 Combination Air Valve, Single Body

All valves shall meet or exceed all applicable provisions of the latest revision of AWWA C512, Standard for Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service. All valves for drinking water services shall comply with ANSI/NSF 61. Design pressure is 150 psig.

All valves shall consist of a float or a float assembly. Valves shall be identified properly in plates attached permanently on the valve body. The body and cover shall be cast iron ASTM A 126, Class B; or ASTM A 48/A 48M, Class 35. Valves 3 inches and smaller shall have threaded ends. Valves 4 inches and larger shall have flanged ends. Threaded ends shall comply with ANSI B1.20.1. Flanges shall comply with ANSI B16.11, Class 125. All flanges shall be flat faced.

The float shall be Type 304 or 316 Stainless Steel. For valves with inlet sizes less than 4 inches, the float shall be capable of withstanding a collapse pressure of 1,000 psig. Trim shall be Type 304 or 316 Stainless Steel. The valve seat shall be of EPDM or other rubber materials that are applicable to water. The valve seat shall be easily removed and replaced in the field.

Drain/test ports on all valves with inlet size 1 inch or larger shall have

two 1/2-inch NPT minimum plugged ports, one near the bottom of the valve body and the other near the top of the valve. The plug shall be of stainless-steel, ASTM B 584, Alloy C83600.

Combination Air Valves for Water Services, Single Body

Combination air valve for water service shall be 1-inch through 4-inch inlet size. It shall consist of an air and vacuum valve with an air-release valve in a single-body double-orifice arrangement. The valve body and cover shall be constructed of ASTM A 126 Class B cast iron. The body inlet shall be baffled with a float cushion. The floats shall be 300 series stainless steel. The seats shall provide drop tight shut-off. Valves shall be APCO 140C Series, Val-Matic Model 201C - 204C, or approved equal.

2.1.2.10 Air-Release Valves for Water Services, Compound Lever

Air-release valves for water services shall be inlet size 1 inch and 2 inches, of a compound lever with linkage mechanism to release air, Class 300. Orifice size shall be 1/8 or 3/32 inch. Valves shall be APCO 200A, Val-Matic Model 38, or approved equal.

2.1.2.11 Ball Valves

Stainless steel ball valves, 2 inches and smaller, shall be rated at a minimum pressure of 1,500 psi WOG at a temperature of 100 degrees F. Valve body shall be 300 Series stainless steel, NSF 61 approved. Ball shall be Type 316 stainless steel. Seat and seals shall be reinforced Teflon. Valves shall have lever handle, plastic coated. Valves shall have screwed ends (ANSI B1.20.1) and nonblowout stems. Valves shall be McCanna M402, Worcester Series 48, Stockham SD 2120-CS, Apollo 73-100 Series, or approved equal.

2.1.2.12 Valve Actuators

The valve actuator shall be an integral part of a valve. The valve actuator shall be provided, installed, and adjusted by the valve manufacturer. Actuator mounting arrangements shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the drawings or directed by the Contracting Officer.

All valves shall open counterclockwise as viewed from the top. Unless otherwise required by the Government, the direction of rotation of the wheel or wrench nut to open each valve shall be to the left (counterclockwise). Each valve body or actuator shall have the word "Open" cast on it and an arrow indicating the direction to open.

Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. All exposed nuts, bolts, and washers shall be AISI Type 304 stainless-steel. Unless noted otherwise, equip valves with the following manual actuators:

a. Exposed valves 6 inches and smaller: removable lever or handwheel actuators.

b. Exposed valves 8 inches and larger: geared actuators with handwheels.

c. Buried or submerged valves 6 inches and smaller: 2-inch-square operating nuts (with valve bonnets, valve boxes, and extension stems as

required) and T-handle wrench.

d. Buried or submerged valves 8 inches or larger: Geared actuators with 2-inch-square operating nuts (with valve bonnets, valve boxes, and extension stems as required) and wrench.

Provide levers or handwheels to actuate the valves where the valves are within 6 feet and 7 inches from finished grade or the operating floor. Construct handwheels of ductile-iron. Coat levers and handwheels in accordance with Section 09 90 00.00 98 PAINTING AND COATING. Handwheel diameters for traveling nut actuators shall not exceed 8 inches for valves 12 inches and smaller and shall not exceed 12 inches for valves 20 inches and smaller.

Provide chainwheel and guide actuators for all exposed valves installed with their centerlines more than 6 feet and 9 inches above finished grade. Chainwheels shall be cast-iron with stainless-steel stem, clip, and pins. The actuating chain shall be AISI Type 304 SS. Provide stainless-steel chain baskets with these units. Coat chainwheels in accordance with Section 09 90 00.00 98 PAINTING AND COATING.

Chainwheels and guides shall be Clow Figure F-5680, DeZurik Series W or LWG, Stockham, or approved equal.

Gear actuators for vales 8 inches through 20 inches shall be of the worm-and-gear or of the traveling-nut type. Gear actuators for valves 24 inches and larger shall be of the worm-and-gear type. Gear actuators for motorized valves shall be of the worm-and-gear type, regardless of size.

a. Gear actuators should be designed assuming that the differential pressure across the valves is equal to the test pressure of the connecting piping and assuming a line fluid temperature range of 33 degrees F to 125 degrees F, unless otherwise required in the detailed valve specifications.

b. Enclose and oil lubricate gear actuators with seals provided on shafts to prevent entry of dirt and water into the actuator. Gear actuators for valves aboveground or in vaults and structures shall have handwheels. The actuators for valves in exposed service shall contain a dial indicating the position of the valve disc or plug.

c. Traveling nut and worm-and-gear actuators shall be of the totally enclosed design and proportioned to permit operation of the valve under full differential pressure rating of the valve with a maximum pull of 80 pounds on the handwheel or crank. Provide stop-limiting devices in the actuators in the open and closed positions. Actuators shall be of the self-locking type to prevent the disc or plug from creeping. Design actuator components between the input and the stop-limiting devices to withstand without damage a pull of 200 pounds for handwheel or chainwheel actuators and an input torque of 300 foot-pounds for operating nuts when operating against the stops.

d. The self-locking worm gear shall be a one-piece design of gear bronze material (ASTM B 427 or ASTM B 584, Alloy C86200) that is accurately machine cut. Actuators for eccentric and lubricated plug valves may use ductile-iron gears provided the gearing is totally enclosed with spring-loaded rubber lip seals on the shafts. The worm shall be hardened alloy steel (ASTM A 322, Grade G41500 or G41400, or ASTM A 148/A 148M, Grade 105-85) with thread ground and polished.

Support worm-gear shafts at each end by ball or tapered roller bearings. Valves in aboveground locations or in vaults and structures shall have handwheels. The actuators for valves in exposed service shall contain a dial indicating the position of the valve disc or plug.

e. Traveling nut and worm-and-gear actuators shall be of the totally enclosed design and proportioned to permit operation of the valve under full differential pressure rating of the valve with a maximum pull of 80 pounds on the handwheel or crank. Provide stop-limiting devices in the actuators in the open and closed positions. Actuators shall be of the self-locking type to prevent the disc or plug from creeping. Design actuator components between the input and the stop-limiting devices to withstand without damage a pull of 200 pounds for handwheel or chainwheel actuators and an input torque of 300 foot-pounds for operating nuts when operating against the stops.

f. The self-locking worm gear shall be a one-piece design of gear bronze material (ASTM B 427 or ASTM B 584, Alloy C86200) that is accurately machine cut. Actuators for eccentric and lubricated plug valves may use ductile-iron gears provided the gearing is totally enclosed with spring-loaded rubber lip seals on the shafts. The worm shall be hardened alloy steel (ASTM A 322, Grade G41500 or G41400, or ASTM A 148/A 148M, Grade 105-85) with thread ground and polished. Support worm-gear shafts at each end by ball or tapered roller bearings. The reduction gearing shall run in a proper lubricant. The handwheel diameter shall be no more than twice the radius of the gear sector in contact with the worm. Worm-gear actuators shall be Limitorque Model HBC, EIM Series W, or approved equal.

For buried or submerged service, provide watertight shaft seals and watertight valve and actuator cover gaskets. Provide totally enclosed actuators designed for buried or submerged service.

All buried valves shall have non-rising stems. Furnish all buried valves 3 feet below grade or deeper as measured at the valve centerline with an operator stem extension to extend the operating nut within 6 inches from the top of the valve box cover.

2.1.2.13 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.

2.1.2.14 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 screw or 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.

2.1.2.15 Valve Vaults

For valve vault manufacturing, please refer to drawings and Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

2.1.2.16 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.

2.1.2.17 Water Meters

Water meters through 1-inch diameter shall comply with AWWA C700 and NSF 61 standards. The meter housing, bottom plates, and trim shall be bronze. The measuring chamber, disc, strainer, generator housing, register lid, and shroud shall be thermoplastic. The magnet shall be ceramic. The disc and magnet spindles shall be stainless steel. External bolts shall be non-corrosive metal.

Water meters shall be rated for continuous operation and have a maximum operating pressure of 150 psi. The measuring element shall be a positive displacement nutating disc. An oscillating piston-type meter is not acceptable. The sealed register shall consist of a straight reading, odometer-type totalizing display with a 10,000,000-gallon capacity (minimum) for meters smaller than the 1.5-inch unit and a 100,000,000-gallon capacity (minimum) for the 1.5-inch meter and larger, 360° test circle with center sweep hand, and flow finder to detect leaks. All meters shall have rigid, non-ferrous strainers that are easily removable and have an effective straining area of double that of the main-case inlet.

The meters shall have the following minimum characteristics:

Meter Size	Minimum Test Flow	Normal Test Flow Limits	Pressure Loss @AWWA Max.	Laying Length
1-inch	3/4 gpm	3 - 50 gpm	7.0 psi	10 3/4-inch

Water meters shall be Badger Recordall Model, Neptune or approved equal. Headloss through the meter shall not exceed the published headloss through the named meters at any point on the headloss curve.

The water meters larger than 1 inch shall have flanges for inlet and outlet connections; other water meters shall have threaded male inlet and outlet. All meters shall be easily removed from the installed piping.

2.1.2.18 Warning Tape and Tracing Wire for Buried Piping

Warning tape and tracing wire for buried pipe is specified under Section 31 00 00 EARTHWORK.

2.1.2.19 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.

2.1.2.20 Mechanical Joint Tapping Sleeve

Mechanical joint tapping sleeve shall be iron body with 3/4-inch NPT test plug and shall be of the proper style to fit most types of pipe including cast iron, ductile iron, A-C, and steel pipe as required. Standard mechanical joint ends shall comply with AWWA C111/A21.11. Minimum pressure rating shall be 250 psi. All sleeves shall have outlet flange with dimensions and drilling that comply with ASME B16.1, Class 250. The Contractor shall field measure the outside diameter of the pipe to be tapped prior to submitting the tapping sleeve submittal. Sleeves shall be mechanically attached to the water main. Lead caulking shall not be allowed.

2.1.2.21 Tapping Valves

Provide double disc valves with mechanical and flanged ends in accordance with requirements of AWWA C500. Comply with requirements of ASME B16.1 for inlet flange and with AWWA C111/A21.11 for mechanical joint outlet. The minimum pressure rating shall be 250 psi. Valve body shall be iron, bronze fitted. Valve shall have double disc parallel seat with four-point wedging mechanism. Valve shall be non-rising stem and with O-ring sealed stuffing box. Provide valves with a 2-inch square wrench nut. Provide valve with a 2-inch square nut, operator, and valve box. Epoxy coat the interior of the valves in accordance with AWWA C550. The exterior shall be epoxy coated by the manufacturer. Before shipment from the factory, hydrostatically pressure test the valve to the requirements for both AWWA and ULC. Submit the test results to the Contracting Officer for approval.

2.1.2.22 Sleeve-Type Mechanical Couplings

Couplings shall be designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall provide for confinement and compression of the gaskets. For ductile iron pipe, the middle ring shall be of cast-iron or steel; and the follower rings shall be of malleable or ductile iron. Malleable and ductile iron shall, conform to ASTM A 47/A 47M and ASTM A 536, respectively. Gaskets shall be designed for resistance to set after installation and shall meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts shall be track-head type, ASTM A 307, Grade A, with nuts, ASTM A 563, Grade A; or round-head square-neck type bolts, ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts, ASME B18.2.2. Bolts shall be a minimum of 5/8 inch in diameter.

2.1.2.23 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.

2.1.2.24 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 GR60, free of surface defect.

Flanges: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675 GR60, free of surface defect. Bolt circles and bolt holes shall match those of ANSI 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.

2.1.2.25 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 ANSI A21.11 and ANSI 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.

2.1.2.26 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 ANSI/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.

2.1.2.27 Pump Expansion Joint Couplings (Metallic Bellows Flexible Connectors)

High service pump and jockey pump suction and discharge flexible connectors shall be corrugated metal bellows-type expansion joints reinforced with equalizing/control rings.

Expansion joints shall conform to the EJMA Stds in all respects. Bellows elements shall be formed by the hydro forming process. Expansion joints shall be supplied with equalizing/control rings of the bolted type. Bellows convolutions shall be 2 inches in pitch and height, minimum. Provide all bellows designs with bellows calculations and submitted for record purposes which conform to the EJMA Stds, including cycle life. Hydro-test bellows to 1-1/2 times the design pressure, minimum. The bellows shall not exhibit any signs of squirm. Devices such as flow liners, covers, hinge or gimbal hardware, etc., shall not be used to prevent (or mitigate) the effects of squirm during hydro testing.

The expansion joints shall have a design pressure rating of at least 200 psig and shall be furnished with van-stone-type flanged ends with 125-pound drilling.

Each expansion joint shall be furnished with an inner flow liner than shall be suitable for the conveyance of potable water at velocities of up to 20 fps in either direction through the expansion joint.

Materials of construction shall be as follows:

Bellows:	304 stainless-steel
Liner:	304 stainless-steel
Equalizing/control rings:	304 stainless-steel
Collars/bands:	304 stainless-steel
Flange plates:	Carbon steel

Welded stainless-steel components shall be made of low-carbon-type

stainless-steel.

Each expansion joint shall enable a limited gap to be obtained in the flanged joint connections to facilitate pump installation/removal. Design each expansion joint to provide the following concurrent movements as a minimum:

Compression:	3/4 inch
Lateral offset:	1/8 inch
Angular rotation:	Flange faces parallel within 1/8 inch

Factory precompress expansion joints as necessary to facilitate installation. Installed lay length shall be as specified herein.

Equip each expansion joint with a tie rod/restraint system designed to limit the axial deflection of the entire flexible connector assembly to no more than 0.005 inch with the piping system subjected to 200 psig pressure. Submit axial deflection calculations for record purposes. Position cotter pins to prevent excessive tie rod nut travel and extension of the flexible connectors beyond their allowable axial movement range. Equalizing/control rings shall prevent excessive compression of the flexible connectors beyond their allowable axial movement range. Double-nutting of the tie rods using jam nuts and heavy hexagonal nuts on/against each side of each plate flange shall lock the position of the connector and prevent tie rod nuts from loosening during system operation, yet allow loosening/resetting in the event of future pump removal/reinstallation. The tie rod/restraint system shall be reviewed by the high-service pump manufacturer and shall comply with the pump manufacturer's recommendations for the proposed pump/piping configuration.

Store, handle, align, and install expansion joint in conformance with the manufacturer's recommendations.

1. Provide a copy of the manufacturer's installation recommendations to the Contracting Officer at the time of expansion joint installation.

2. Align the piping and each expansion joint during installation so that no axial, lateral, or torsional deflection is imposed. Expansion joints shall not be used to correct piping misalignment. All piping shall be laid true so that the expansion joint end fittings mate perfectly with connecting pipe and/or equipment. The Contractor shall demonstrate this alignment to the Contracting Officer during assembly.

3. Provide all temporary spacers/bracing as necessary to provide proper alignment and installation and to maintain the preset compression traverse. Upon completion of the installation, position/tighten tie rod inner and outer nuts bearing against the faces of each plate flange along with their associated jam nuts according to the manufacturer's instructions, providing a tied/locked assembly that prevents movement.

4. Install each expansion joint compressed axially 1/4-inch of the available 3/4-inch; this position is the lay length indicated on the drawings. The provided expansion joints shall be fully compatible with the installation conditions and geometry shown on the drawings. The expansion joints shall be manufactured by Senior Flexonics, Inc., Expansion Joint Division of New Braunfels, Texas.

2.1.2.28 Hanger and Support Systems

2.1.2.28.1 General

Not all pipe supports or hangers required are shown on the drawings. Provide pipe supports for every piping system installed. Support piping by pipe support where it connects to pumps or other mechanical equipment.

Ensure that pipe support and hanger components shall withstand the dead loads imposed by the weight of the pipes, fittings, and valves (all filled with water) plus valve actuators and any insulation and shall have a minimum safety factor of 5 based on the material's ultimate strength.

All of the equipment specified in this Section is intended to support the various types of pipe and piping systems. The details shown on the drawings are intended to indicate the generally desired methods of support under normal conditions. Develop final details and any details associated with special conditions not already covered to meet the system conditions specified in the respective Division 22 Pipe Sections.

Support all pipe and tubing as required to prevent significant stresses in the pipe or tubing material, valves, fittings, and other pipe appurtenances and to support and secure the pipe in the intended position and alignment. Design all supports to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. Any structural steel members required to brace any piping from excessive dislocation shall conform to the applicable requirements of Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS and shall be furnished and installed under this Section.

Space hangers and supports in accordance with ANSI B31.1 except that the maximum unsupported span shall not exceed 10 feet unless otherwise specified in this Section.

Where flexible couplings are required at equipment, tanks, etc., the end opposite to the piece of equipment, tank, etc. shall be rigidly supported.

Support all pipe and appurtenances connected to the equipment so as to prevent any strain from being imposed on the equipment or piping system.

Furnish all rods, clamps, hangers, inserts, anchor bolts, brackets, and components for interior pipe supports with galvanized finish, hot-dipped, or electro-galvanized coated, except where field welding is required. Plastic coat interior clamps on plastic pipe. Provide copper-plated supports for copper pipe or shall have a 1/16-inch plastic coating. All rods, clamps, hangers, inserts, anchor bolts, brackets, and components for exterior pipe and pipe within outdoor structures shall be of Type 316 stainless-steel.

Supports shall be sufficiently close together so that the sag of the pipe is within limits that will permit drainage and avoid excessive bending stresses from concentrated loads between supports.

Protect all uninsulated nonmetallic piping such as PVC, CPVC, etc., from local stress concentrations at each support point. Provide protection by galvanized steel protection shields or other method as approved by the Contracting Officer. Where pipes are bottom supported 180 degrees, furnish arc shields. Where 360-degree support is required, such as U bolts,

provide protection shields for the entire pipe circumference. Protection shields shall have an 18-gauge minimum thickness, not be less than 12 inches in length, and be securely fastened to pipe with stainless-steel or galvanized metal straps not less than 1/2-inch wide.

Furnish all insulated pipe with a rigid foam insulating saddle at each pipe support location as specified under respective pipe insulation. Provide galvanized protection shields as specified in this Section at each location.

Where pipe hangers and supports come in contact with copper piping, provide protection from galvanic corrosion by wrapping pipe with 1/16-inch-thick neoprene sheet material and galvanized protection shield or copper-plated or PVC-coated hangers and supports.

Provide pipe supports as follows:

1. Support cast-iron and ductile-iron piping at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.

2. Support steel and stainless-steel piping 2-1/2 inches or larger diameter at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.

3. Support spacing for steel and stainless-steel piping 2 inches and smaller diameter and copper tubing shall not exceed 5 feet.

4. Supports for multiple PVC plastic piping shall be continuous wherever possible. Support individually supported PVC pipes as recommended by the manufacturer except that support-spacing shall not exceed 3 feet. Where possible, support multiple, suspended, horizontal plastic PVC pipe runs by ladder-type cable trays such as the Electray Ladder by Husky-Burndy; Cable Tray by Enduro Composite Systems; the Globetray by the Metal Products Division of United States Gypsum or approved equal. Ladder shall be of FRP construction. Run spacing shall be 12 inches. Tray width shall be approximately 6 inches for single runs and 12 inches for double runs. Furnish ladder-type cable trays complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc., required for a complete support system. Secure individual plastic pipes to the rungs of the cable tray by strap clamps, or fasteners similar to Globe, Model M-CAC; Husky-Burndy, Model SCR; or approved equal. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe. Individual clamps, hangers, and supports in contact with plastic PVC pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

5. Support all vertical pipes at each floor or at intervals of not more than 12 feet by approved pipe collars, clamps, brackets, or wall rests and at all points necessary to ensure rigid construction.

6. Pipe supports shall not induce point loadings, but shall distribute pipe loads evenly along the pipe circumference.

7. Provide supports at changes in direction and elsewhere as shown on the drawings or as specified in this Section. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless specifically directed or authorized by the Contracting Officer.

8. Provide pipe supports to minimize lateral forces through valves, both sides of split-type couplings, and sleeve-type couplings and to minimize all pipe forces on pump housings. Pump housings shall not be used to support connecting pipes.

9. Account for effects of thermal expansion and contraction of the pipe in the pipe support selection and installation.

Fabricate or construct any required pipe support for which the supports specified in this Section are not applicable from standard structural steel shapes and concrete and anchor hardware similar to items previously specified in this Section and shall be subject to the approval of the Contracting Officer.

2.1.2.28.2 Hanger and Support Systems

Pipe hangers and supports shall be as manufactured by Anvil, Unistrut, Cooper B-Line, Aikinstrut, Superstrut, or approved equal.

Pipe hangers and supports shall comply with MSS SP-58 for the standard types references on the drawings. Construct special hangers and supports if detailed in the drawings. Type numbers for standard hangers and supports shall be in accordance with MSS SP-58 as listed below:

Type Number	Description	Manufacturer and Model (or Equal)
1	Adjustable steel clevis	Anvil Fig. 590 or 260, B-Line B3100 or B3102
3	Steel double-bolt pipe clamp	Anvil Fig. 295A or 295H, B-Line B3144 or B3144A
4	Steel pipe clamp(pipes smaller than 3 inches)	Anvil Fig. 212, B-Line B3140
4	Steel pipe clamp (pipes 3 inches and larger)	Anvil Fig. 216, B-Line 3142
5	Pipe hanger	B-Line B6690
6	Adjustable swivel pipe ring	Anvil Superstrut 714, Anvil Fig. 104
7	Adjustable steel band hanger	B-Line B3172
8	Extension pipe or riser clamp	Anvil Fig. 261, B-Line B5573
9	Adjustable band hanger	Anvil Fig. 97
10	Adjustable swivel ring band hanger	Anvil Fig. 70, B-Line B3170 NF
11	Split pipe ring with adjustable turnbuckle	Anvil Fig. 108, B-Line B3173

Type Number	Description	Manufacturer and Model (or Equal)
13	Steel turnbuckle	Anvil Fig. 230, B-Line B3202
14	Steel clevis	Anvil Fig. 299, B-Line B3201
15	Swivel turnbuckle	Anvil Fig. 114, B-Line B3224
16	Malleable iron socket	Anvil Fig. 110R, B-Line B3222
17	Steel weldless eye nut	B-Line B3200
18	Steel or malleable iron concrete insert	Anvil Fig. 281, Superstrut 452
19	Top beam C-clamp	Anvil Fig. 92, B-Line B3033
20	Side I-beam or channel clamp	Anvil Fig. 14 or 217
21	Center I-beam clamp	Anvil Figure 134
22	Welded attachment type	Anvil Fig. 66 B-Line B3083
23	C-clamp	Anvil Fig. 86, B-Line B3036L
24	U-bolt	Anvil Fig. 137, B-Line B3188
26	Clip	Anvil Fig. 262, B-Line B3180
28	Steel I-beam clamp with eye nut	Anvil Fig. 228
29	Steel wide flange	Anvil Fig. 228 clamp with eye nut
30	Malleable iron beam clamp with extension piece	Superstrut CM-754, B-Line B3054
31	Light welded steel bracket	Anvil Fig. 194, B-Line B3063
32	Medium welded steel bracket	Anvil Fig. 195, B-Line B3066
33	Heavy welded steel bracket	Anvil Fig. 199, B-Line B3067
34	Side beam bracket	Anvil Fig. 202, B-Line B3062
36	Pipe saddle support	Anvil Fig. 258, B-Line B3095
37	Pipe stanchion saddle	Anvil Fig. 259, B-Line B3090

Type Number	Description	Manufacturer and Model (or Equal)
38	Adjustable pipe saddle support	Anvil Fig. 264, B-Line B3093/B3089
39	Steel pipe covering	Anvil Fig. 160, 161, 162, 163, 164, or 165; Superstrut A 789; B-Line B3160/B3165
40	Insulation protection shield	Anvil Fig. 167, B-Line B3151
41	Single pipe roll	Anvil Fig. 171, B-Line B3114
43	Adjustable roller hanger with swivel	Anvil Fig. 181, B-Line B3110
44	Pipe roll, complete	Anvil Fig. 271, B-Line B3117SL

Pipe hangers and supports shall be hot-dipped galvanized according to ASTM A 153/A 153M carbon steel (ASTM A 36/A 36M, ASTM A 575, or ASTM A 576). Bases, rollers, and anchors shall be steel as described above or may be cast iron (ASTM A 48/A 48M). Pipe clamps shall be steel as described above or may be malleable iron (ASTM A 47/A 47M).

2.1.2.29 Bonded Joints

Where indicated, a metallic bond shall be provided at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous metallic piping to effect continuous conductivity. The bond wire shall be Size 1/0 copper conductor suitable for direct burial shaped to stand clear of the joint. The bond shall be of the thermal weld type.

2.1.2.30 Tracer Wire for Nonmetallic Piping

Tracer wire for nonmetallic piping is specified under Section 31 00 00 EARTHWORK.

2.1.2.31 Polyethylene Bagging

Polyethylene bagging for buried ductile iron pipe, fittings, and valves shall be 8 mils thickness minimum polyethylene, manufactured in accordance with ASTM D 1238, Type I, Class C, Grade E1.

2.1.2.32 Line Stop Sleeves

Line stop sleeves shall be the high strength type having a wide body, made of a minimum of ASTM A 283/A 283M Grade C, 285 Grade C Steel, ASTM A 36/A 36M or equal, which conforms to and reinforces the pipe. The sleeves shall have as a minimum 7/8-inch-wide recessed Buna-N gasket around the outlet, 3/4-inch corrosion resistant alloy bolts (in accordance with AWWA C111/A21.11, ANSI A21.11), a 3/4-inch forged steel test outlet and hydrostatic test pressure capability of 200 psi in 12-inch and smaller outlet sizes. Flanged outlet shall be ANSI 150-pound AWWA C207 Class D and shall be indexed in accordance with MSS SP-60. Furnish JCM 440 line stop sleeve with corrosion resistant shop coat paint primer with epoxy coating. Furnish sleeves with a 3/4-inch stainless steel type 304 plug in the test

outlet and optional stainless steel 18-8 type 304 bolts.

2.2 WATER SERVICE LINE MATERIALS

2.2.1 Water Service Line Appurtenances

2.2.1.1 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.

2.2.1.2 Corporation

Corporation (through 2-1/2 inches in diameter) shall be manufactured from cast bronze with machined fitting surfaces and in accordance with AWWA C800. Corporation shall withstand a minimum working pressure of 200 psi. The inlet and outlet connections shall be coordinated to connect to the adjoining equipment, tubing, piping, couplings, unions, adapters, reducers, etc. by the Contractor. The inlet and outlet size shall be the same. The corporation outlet shall have the required all-bronze adapters, unions, reducers, bushings, or couplings to properly secure to the adjacent items and appurtenances. Corporation shall be Model FB series as manufactured by Ford Meter Box Company, Inc., or approved equal. Each corporation shall be furnished with a solid bronze square-head plug for plugging the corporation outlet. Ford stainless-steel insert stiffeners shall be used as required for connection to tubing, PVC pipe, HDPE pipe, or as required.

2.2.1.3 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.

2.2.1.4 Curb Boxes

Provide a curb box for each curb or service stop. Curb boxes shall be of cast iron of a size suitable for the stop on which it is to be used. Provide a round head. Cast the word "WATER" on the lid. Each box shall have a heavy coat of bituminous paint.

2.3 SIGNAGE

2.3.1 Nonpotable Water

Provide a rigid sign indicating that the water is nonpotable at the following locations through the project:

a. Entrances to restroom which are now served by nonpotable water
b. Each hose bibb now served by nonpotable water
c. At the vehicular entrance to each Launch Pad
d. At the pedestrian entrance to each Launch Pad

e. The vehicular entrance to the Crawler Maintenance Yard.

The size and lettering of the signs at the entrances to restrooms which are now served by nonpotable water and each hose bibb now served by non-potable water shall conform to OSHA requirements. Signs shall be Seton Nameplate Company 20-gauge baked enamel, minimum size 7 inches by 3 inches; Brady B-120 Fiber-Shield fiberglass, minimum size 7 inches by 3 inches, 1/8-inch thick; or approved equal.

The size and lettering of the signs at the vehicular entrance to each Launch Pad shall conform to the size and material requirements of the 2004 Manual on Uniform Traffic Control Devices Sign Type W7-4.

The size and lettering of the signs at the pedestrian entrance to each launch Pad shall conform to the size and material requirements of the 2004 Manual on Uniform Traffic Control Devices Sign Type R9-4.

The language and location of signs are to be determined by the Contracting Officer.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

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

New or relocated, underground water mains shall be laid to provide a horizontal distance of at least 3 feet between the outside of the water main and the outside of any existing or proposed storm sewer and at least 6-1/2 feet (preferably 10 feet) between the outside of the water main and the outside of any existing or proposed gravity- or pressure-type sanitary sewer. The minimum horizontal separation distance between water mains and gravity-type sanitary sewers may be reduced to 3 feet where the bottom of the water main is laid at least 18 inches above the top of the sewer.

New or relocated, underground water mains crossing any existing or proposed gravity-type sanitary sewer or storm sewer shall be laid so the outside of the water main is at least 18 inches above or at least 18 inches below the outside of the other pipeline.

New or relocated, underground water mains crossing any existing or proposed pressure-type sanitary sewer shall be laid so the outside of the water main is at least 18 inches above or below the outside of the other pipeline. It is preferable to lay the water main above the other pipeline.

At utility crossings, one full length of water main pipe shall be centered so the water main joints will be as far as possible from the other pipeline. Alternatively, at such crossings, the pipes shall be arranged so that all water main joints are at least 3 feet from all joints in storm sewers and at least 6.5 feet from all joints in gravity- or pressure-type sanitary sewers.

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

Where nonmetallic pipe is used, install a tracer wire above the pipe to facilitate pipe location.

3.1.1.9 Locating Devices

For all subsurface elbows, tees, and valves, 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. The locating devices shall be Omni Marker Model 161 Water Marker or approved equal.

3.1.1.10 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.

3.1.1.11 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with link-seal.

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 HDPE Pipe and Fittings

3.1.1.13.1 General

All polyethylene pipe shall be cut, fabricated, joined, and installed in strict conformance with the pipe manufacturer's recommendations. Joining, laying, and pulling of polyethylene pipe shall be accomplished by personnel experienced in working with HDPE pipe.

3.1.1.13.2 Laying Pipe

Joints

All HDPE to HDPE pipe joints shall be joined by heat fusion that produces homogeneous, sealed, leak-tight joints.

Restrained mechanical joint adaptors shall be provided at tie-ins with valves, ductile iron fittings, and other pipe materials.

Butt Fusion Testing

The Contractor shall test the first fusion of each day.

In testing, the fusion shall be allowed to cool completely and then fusion test straps shall be cut out. The test shall be a minimum of 12 inches or 30 times the wall thickness in length with the fusion in the center and a minimum of 1 inch or 1.5 times the wall thickness in

width. Bend the test strap until the ends of the strap touch. The Contractor shall not begin until a fusion test has passed the bent strap test.

Pipe Deflection

When it is necessary to deflect pipe from a straight line in either the vertical or horizontal plane or where long radius curves are permitted, the amount of deflection shall not exceed 75% of that recommended by the manufacturer.

Pipe Cutting

Cutting HDPE butt fusion connections to HDPE pipe, valves, fittings, or closure pieces shall be done in a neat, workmanlike manner without damaging the pipe. Ends shall be cut square and perpendicular to the pipe axis.

3.1.1.14 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.

3.1.2 Installation of Water Service Piping

3.1.2.1 Service Line Connections to Water Mains

Connect service lines 2 inch size 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.

3.1.3 Special Requirements for Installation of Water Meters

3.1.3.1 Location of Meters

Meters shall be installed at the locations as shown on the drawings.

3.2 INSTALLATION OF SIGNS

3.2.1 Non-Potable Water

The Contractor shall attach miscellaneous signs according to the sign manufacturer's recommendations and in accordance with OSHA requirements.

3.3 TESTING -- NON-HDPE PIPE AND FITTINGS

3.3.1 Pressure Test

Pressure test shall be made no sooner than 72 hours after installation of thrust blocks.

After the pipe is laid, the joints completed, and the trench backfilled, the newly laid piping or any valved section of piping shall be subjected

for 1 hour to a hydrostatic-pressure test of 150 psi. For jack and bore installations only, perform pressure testing before backfilling the boring pits. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the open-trench test. Joints showing visible leakage shall be replaced or remade as necessary. Leaking rubber gasketed joints shall be remade using new gaskets when necessary. Pipe, mechanical joints, fittings, or valves discovered to be cracked or defective as a consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are approved.

3.3.2 Leakage Test

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:

$$L = \frac{SD(P)^{1/2}}{C}$$

in which:

L = allowable leakage (gallons)
S = length of pipe tested (feet)
D = diameter of the pipe (inches)
P = specified test pressure (psig)
C = 133,200

Allowable leakage in gallons per hour per 1,000 feet of pipeline shall be as follows:

PIPE DIAMETER (INCHES)	ALLOWABLE LEAKAGE (GALLONS PER HOUR)
4	0.37
6	0.55
8	0.74
10	0.92
12	1.10
14	1.29
16	1.47

Allowable leakage in gallons per hour not exceed 5 percent of total system

pressure.

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.

3.3.3 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.

3.3.4 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.

3.3.5 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.

3.4 TESTING -- HDPE PIPE AND FITTINGS

Hydrostatic Tests-General

All field tests shall be made in the presence of the Government or Contracting Officer. Except as otherwise directed, all pipelines shall be tested. All piping to operate under liquid pressure shall be tested in sections of approved length, typically from valve to valve and in no case longer than 1,000 feet.

Hydrostatic testing shall consist of a 150 psi combined pressure test and leakage test. The field test pressure shall be measured at the lowest point of the section being tested. The pressure shall be applied by a pump connected to the pipe in a manner satisfactory to the Contracting Officer. The pump, pipe connection, and all necessary apparatus shall be furnished by the Contractor and shall be subject to the satisfaction of the Contracting Officer.

The maximum duration for any test, including initial pressurization, initial expansion, and time at test pressure, must not exceed 8 hours. If the test is not completed due to leakage, equipment failure, etc., depressurize the test section and allow it to "relax" for at least 8 hours before bringing the test section up to test pressure again.

Monitored Make-Up Water Test: The test procedure consists of initial expansion and test phases.

During the initial expansion phase, the test section is filled with water. Once the line is filled, make-up water is added at hourly intervals as required to maintain the test pressure for 3 hours.

At the end of the initial expansion period, the addition of make-up water will cease. During the test phase the pipe will not have any water added to it for the following 2 hours. The 2 hours will be the actual leakage test. At the end of the 2-hour period, measured make-up water will be added to the pipe to return it to the original test pressure.

If the amount of make-up water added is greater than calculated using the numbers listed below, the section being tested will be considered to have a leak. The leak shall be found and fixed at the Contractor's expense and that section of the line retested before continuing with subsequent leakage tests. Testing and repairs shall be repeated at the Contractor's expense until the amount of make-up water is less than the amount calculated using the numbers listed below.

ALLOWABLE FOR EXPANSION UNDER TEST PRESSURE*
POLYETHYLENE PIPE

Nominal Pipe Size (inches)	Allowances for Expansion		
	1-Hour Test	2-Hour Test	3-Hour Test
2	0.08	0.12	0.15
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.5
10	0.75	1.3	2.1
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
24	4.5	8.98	13.3
30	6.2	12.6	19.1
36	9.0	18.0	27.0

ALLOWABLE FOR EXPANSION UNDER TEST PRESSURE* POLYETHYLENE PIPE			
42	12.0	24.0	36.0
48	15.0	27.0	43.0

These allowances only apply to the test phase and not to the initial expansion phase.

3.5 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.

3.6 WATER MAIN TAPS/SADDLES

The existing distribution system shall be protected from backflow contamination during filling for pressure testing, flushing, disinfection, and final connections in accordance with AWWA C651. A 2 inch jumped connection bypassing the tie-in valve with an approved double-check valve or approved backflow prevention device shall be used for filling the new water main. The tie-in valve shall be closed and secured by a locking mechanism until flushing of the new water main occurs.

Prior to installing a service saddle, the KSC Pollution Control and Sanitation Officer (PCSO), or designated representative, must be contacted to monitor the installation. The exterior surface of the main to be tapped shall be thoroughly cleaned. Once the sleeve is securely attached to the main, the sleeve shall be filled with a hypochlorite solution and hydrostatically tested at 200 psi for a minimum of 15 minutes with no loss of pressure or sign of leakage. During the tapping process, the interior surface of the sleeve and the surface being tapped shall be in direct contact with the hypochlorite. After the tapping procedure is complete,

flush the line to remove metal bits and debris.

All connections to existing work shall be in accordance with AWWA C651 for protection of existing main from contamination by the new line during filling, flushing and testing.

3.7 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 EG&G 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).

3.8 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.

3.9 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 --

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SECTION 33 16 13.16

PRESTRESSED-CONCRETE GROUND STORAGE TANK

PART 1 GENERAL

1.1 SCOPE OF WORK

This Section includes work necessary for the construction of one 0.5-million-gallon ground-storage tank of reinforced and prestressed concrete composite perimeter wall as shown on the drawings and as specified. Ensure that the complete tank is watertight and free of cracks. Show waterstops or sealants on the drawings. The water storage tank construction includes furnishing, installing, and constructing the water tank and accessory items shown on the drawings.

The prestressed concrete tank manufacturer is responsible for structural design, coordination of all dimensions, special procedures, and placement of any necessary embedment items.

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.

ACI INTERNATIONAL (ACI)

ACI 318	(2008; Errata 2008; Errata 2009; Errata 2009; Errata 2009; Errata 2009; Errata 2009) Building Code Requirements for Structural Concrete and Commentary
ACI 344R-W	(1988) Design and Construction of Circular Wire and Strand Wrapped Prestressed Concrete Structures
ACI 506	(2005) Guide to Shotcrete
ACI 350	(2006; Errata 2007) Code Requirements of Environmental Engineering Concrete Structures and Commentary

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A10.14	(1991) Construction and Demolition Operations - Requirements for Safety Belts, Harnesses, Lanyards, and Lifelines for Construction and Demolition Use
ANSI Z359.1	(1997) Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C652	(2002) Disinfection of Water-Storage Facilities
AWWA D110	(2004; Errata 2005) Wire- and Strand Wound, Circular, Prestressed Concrete Water Tanks

ASTM INTERNATIONAL (ASTM)

ASTM A 185/A 185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 366	(1972) Standard Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality
ASTM A 821	(2005) Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
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)

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

29 CFR 1910.66	Powered Platforms for Building Maintenance
29 CFR 1926.502	Fall Protection Systems Criteria and Practices

NSF INTERNATIONAL (NSF)

NSF/ANSI 61	(2009) Drinking Water System Components - Health Effects

1.3 GENERAL DESCRIPTION

Provide a water storage tank of prestressed composite construction.

Ensure that the tank floor is concrete or shotcrete construction containing no less than 0.625 percent reinforcing steel in each orthogonal direction.

Ensure that the wire-prestressed composite wall consists of a shotcrete core wall encasing a steel shell diaphragm continuous the full wall height. Perform all prestressing with high-tensile wire, permanently bonded to the tank wall.

Ensure that the storage tank roof is a circumferentially prestressed free-span dome of concrete or shotcrete construction containing no less than 0.25 percent reinforcing steel in each orthogonal direction.

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

Design Analysis and Drawings
Construction Joints

SD-05 Design Data

Design Loads: Load/Shear/Deflection Data to support shear and Deflection Calculations for base of wall shall be submitted if a sliding waterstop is used in the floor/wall joint.

Concrete mix designs.

Shotcrete mix designs.

Overflow system design calculations

Roof Ventilator design calculations

SD-06 Test Reports

Tank Settlement testing results

SD-07 Certificates

Qualifications and Experience of the tank manufacturer to demonstrate compliance with paragraph entitled "Qualifications and Experience" of this Section.

Letter of Certification

1.5 QUALITY ASSURANCE

Ensure that the entire tank including all portions of the floor, wall, roof, bracing/supports, etc. is designed and constructed by the tank manufacturer using its own trained personnel and equipment.

1.5.1 Qualifications and Experience

Ensure that the tank manufacturer has the following qualifications and experience:

1. Is a firm specializing in the design and construction of wire-wound circular prestressed composite tanks.

2. Has at least 10 years experience in the design and construction of wire-wound circular prestressed composite tanks.

3. Gives satisfactory evidence that it has the skill, reliability, and financial stability to build and guarantee the tank in accordance with the quality required by these specifications.

4. Is presently responsible for a minimum of five prestressed composite circular tanks of comparable size and now giving satisfactory service.

5. Has on its staff a full-time structural engineer registered in Florida who has no less than 10 years experience in the design and field construction of circular prestressed composite tanks and who is in responsible engineering charge of the work to be done. Ensure that all drawings and design calculations carry the seal of such a registered structural professional engineer.

1.5.2 Acceptable Tank Manufacturers

Subject to compliance with requirements, tank manufacturers offering products which may be incorporated in the work are limited to the following:

The Crom Corporation; Gainesville, Florida, or approved equal.

1.6 DESIGN ANALYSIS AND DRAWINGS

After award of the contract, the tank manufacturer shall submit complete design analyses, working drawings, and details of the structure which is sealed by a Florida licensed structural professional engineer. Ensure that the drawings include details, influent and effluent pipes/sumps, and plan and elevation details of the tank proposed for erection. In addition, upon request, provide the complete calculations upon which the drawings are based.

1.7 DESIGN CRITERIA

Calculate the thickness of the core wall to accept the initial compressive forces applied by prestressing, hydrostatic stresses induced by contents, and other applicable loads such as soil backfill and wind.

Do not use backfill loads in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.

Ensure that the design is in conformance with ACI 344R-W and currently accepted engineering principles and practices for the design of such facilities.

Base the tank design on elastic analysis methods and take into account effects of all loads and prestressing forces and conditions of edge restraint. To ensure the safety of the structure, meet the applicable strength requirements of ACI 350 and ACI 318, except as supplemented or modified by ACI 344R-W, ANSI/AWWA D110, or this specification. Ensure that the tank design is consistent with the geotechnical information presented in the following report:

Final Report of Geotechnical Exploration and Evaluation, Water and Wastewater System--Kennedy Space Center, July 20, 2010, prepared by Nodarse & Associates, Inc.

Consider the following design loads:

Wall design loads: Internal water pressure, backfill loading, effect of construction, appurtenances, operating loads such as dewatering compartments adjacent to fully loaded sections of the tank, effects of prestressing, and effects of temperature and moisture gradients in the vertical direction.

Roof design loads: Dead loads, live loads, appurtenances, operational loads, and temperature stresses.

Floor design loads: Live loads, dead loads, water loads, and uplift due to groundwater.

Ensure that all ground storage tank materials, including sealants, are suitable for potable water contact according to FDA regulations and the requirements of regulatory agencies having jurisdiction.

Allowable stresses, concrete and shotcrete: Compressive stresses in concrete and shotcrete shall not exceed the values given below. Vertical tensile stresses shall be taken fully by reinforcing steel and/or the diaphragm.

PART 2 PRODUCTS

2.1 MATERIALS

Concrete		
Compressive Strength	f_c	3,500 psi at 28 days
Shotcrete		
Compressive Strength	f_g	4,000 psi or greater at 28 days
Allowable Compressive Strength	f_g	1,250 plus 75t with 0.45 fg maximum*
Allowable Compressive Stress due to Initial Prestressing Force	f_{gi}	0.5 fg_i or less, with a maximum of 2,250 psi (where fg_i is defined as compressive strength at time initial prestressing force is applied)
Prestressing Wire		
Wire Size	Diameter	0.162-inch (8 gauge), 0.192-inch (6 gauge), or larger, but no larger than 0.250-inch
Working Stress, Wall	f_g	115,000 psi
Working Stress, Dome	f_g	120,000 psi

Concrete		
Allowable Tensile Stress Before Losses	f_{gi}	145,600 psi or no greater than 0.70 f'_s
Ultimate Tensile Strength	f'_s	231,000 psi or greater for 8 gauge 222,000 psi or greater for 6 gauge
Reinforcing Steel		
Allowable Tensile Stress	f_s	18,000 psi
Yield Strength	f_y	60,000 psi

* Thickness of core wall.

2.2 FABRICATIONS

2.2.1 Floor

Provide concrete membrane floors (4-inch-thick minimum) with a minimum thickness of 8 inches of concrete over all pipe encasements and around sumps. The minimum percentage (0.625 percent) of reinforcing steel applies to these thickened sections and extends a minimum of 2 feet into the adjacent 4-inch-thick membrane floor.

Minimum tank floor thicknesses are shown on the drawings and specified herein. The tank manufacturer shall be responsible for designing and providing a sufficiently thick reinforced floor slab, including the foundation slab beneath the walls for the vertical loading.

Ensure that floors are vibratory screeded to effect consolidation of concrete and proper encasement of floor-reinforcing steel.

Continuously water-cure floors until tank construction is complete.

2.2.2 Watertightness

Where joints are provided, use waterstops and thicken the section around the waterstop to a minimum of 8 inches. No reinforcements shall pass across the joints. Construct watertight piping through walls or slabs and concrete encase piping under slab.

2.2.3 Subgrade

Ensure that compaction achieves a density of at least 98 percent of the maximum laboratory density determined by ASTM D 1557. Field tests for measurement of in-place density shall be in accordance with ASTM D 1556.

2.2.4 Core Wall

Construct the core wall of shotcrete encasing a steel diaphragm continuous for the full wall height without horizontal splices.

Calculate the thickness of the core wall to accept the initial compressive forces applied by prestressing, backfill, and other applicable loads. The wall may taper uniformly on the outside face from top to bottom as required by design computations. In no case shall the core wall be less than 3-1/2 inches thick. Ensure that horizontal sections of the wall form true circles without flats, excessive bumps, or hollows.

To compensate for bending moments and for shrinkage, differential drying, and temperature stresses, incorporate the following reinforcing steel in the core wall:

Ensure the top 2 feet of core wall have not less than 1 percent circumferential reinforcing.

Ensure the bottom 3 feet of core wall have not less than 1 percent circumferential reinforcing.

Inside face:

Minimum of 26 gauge continuous steel shell diaphragm the full wall height without horizontal splices.

Additional vertical and horizontal reinforcing steel bars as required by design computations. (See drawings).

Outside face:

Vertical reinforcing steel: minimum of #4 bars at 12 inches center to center.

Additional vertical and horizontal reinforcing steel bars as required by design computations. (See drawings).

2.2.5 Steel Shell Diaphragm

Use a 26 gauge steel tank shell, complying with ASTM A 366 for commercial quality cold rolled steel, within and throughout the core wall, providing a positive waterstop. Encase and protect the steel shell diaphragm with shotcrete no less than 1 inch thick at all places. Form and erect the steel shell so that a mechanical key between shotcrete and diaphragm will be created. Ensure that the sheets of steel diaphragm are continuous from top to bottom of wall; horizontal joints or splices will not be permitted.

Seal watertight all vertical joints in the diaphragm by epoxy injection.

Carry out epoxy injection from bottom of wall to top of wall using a pressure pumping procedure after the steel shell has been fully encased inside and outside with shotcrete. Ensure that the epoxy sealant is suitable for bonding to concrete, shotcrete, and steel. Ensure that the sealant conforms to the requirements of ASTM C 881/C 881M, Type III, Grade 1 and is a 100 percent solid, moisture insensitive, low-modulus epoxy system. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77 degrees F.

In all tanks designed to use a waterstop at the floor/wall joint, epoxy-bond the steel shell diaphragm to this waterstop.

Ensure that the steel shell design and its epoxy injection procedure have been used and proven satisfactory in the tanks required in the tank manufacturer's experience record. Make no nail or other holes in the steel shell for erection or other purposes except for inserting pipe sleeves, reinforcing steel, bolts, or other special appurtenances. Seal such penetrations with an approved epoxy sealant.

2.2.6 Shotcrete

Apply all shotcrete by or under the direct supervision of experienced nozzlemen certified in accordance with guidelines by ACI 506. Certification will be by a recognized authority such as Engineering Laboratory Forum, Florida Institute of Consulting Engineers (ELF)/ Florida Concrete and Products Association (FC&PA), ACI, or approved equal.

Ensure that shotcrete mixes, measured by weight, are:

First coat on steel shell diaphragm and prestressing wire:	1 part cementitious material to 3 parts sand
All other shotcrete:	1 part cementitious material to 4 parts sand

Broom each shotcrete layer before final set to effect satisfactory bonding of the following layer. Do not apply shotcrete to reinforcing steel or diaphragm that is encrusted with overspray. Ensure that no less than 1/8-inch-thick shotcrete separates reinforcing steel and prestressing wire.

The Contractor shall be responsible for approved laboratory testing of concrete and shotcrete, submitting design mixes, taking field samples, and providing a laboratory report of compaction testing of subbase material installed. Ensure that all testing is as required by these Specifications and that the test results are furnished to the Contracting Officer for approval. Retake testing not approved after the Contractor's correction of deficiencies; the Contractor shall pay for these retests.

2.2.7 Dome Roof

Construct the storage tank dome roof of reinforced concrete, circumferentially prestressed. Ensure the dome shell reinforcement consists of reinforcing steel bars and welded wire fabric meeting ASTM A 185/A 185M, not galvanized. Ensure that bolsters for wire fabric and reinforcing bars are plastic tipped. Ensure that wire ties are galvanized.

Design the dome shell as a free span, spherical thin shell, with a one tenth rise. Prestress the dome ring girder with sufficient wire to withstand the dome dead load and design live loads. Ensure that the ring girder has a cross section suitable to accept the applied prestressing forces. Coat all surfaces in the wall/dome ring girder joint with an approved bonding epoxy.

Permit the high water level in the tank to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder. Install overflow outlets on the dome roof in such numbers to provide an overflow open area two times the area of the largest tank pipe.

The typical dome thickness and steel reinforcement shall meet the requirements of AWWA D110, Section 3.6.3., *Thickness and Reinforcement*. In all cases, ensure that the thickness of the dome is no less than 3 inches and the dome concrete thickness and reinforcement is no less than that shown on the drawings.

Design the dome edge and upper wall to resist the moments, thrusts, and shears that occur in this region due to dome and wall prestressing and loading conditions. Use the following design parameters:

Dome edge thickness:

(1) Determine the buckle diameter, as defined by:

d_b = 2.5 x the square root of r_d x t_d, rounded up the next foot

Where: d_b = buckle diameter in feet
r_d = dome radius in feet
t_d = typical dome thickness in feet

(2) Ensure that dome edge thickening begins at a radial location on the dome, defined as s_2 , which is at least one buckle diameter away from the tank wall.

(3) Provide a springline haunch, which extends radially from the inside face of the tank wall to radial location s_1 , which is defined as:

s_1 = 0.6 x the square root of 1.5 x r_d x t_d, rounded up the next foot

Ensure that this springline haunch begins at the inside face of the tank wall with a springline thickness as required by Item (6) below and ends at radial location s_1 with the following thickness:

t_{d1} = 1.33 x t_d

Where: t_{d1} = minimum thickness at s_1 in feet
t_d = typical dome thickness in feet at one buckle diameter from tank wall

(4) Beginning at s_1 and continuing to s_2, ensure that the dome shell is a straight line taper.

(5) Items (2), (3), and (4) above are not required for domes where the calculated typical dome thickness is less than 75 percent of the actual typical dome thickness.

(6) Provide sufficient concrete thickness at the springline of the dome so that no more than 2 feet of the springline haunch is considered in calculating the effective dome edge ring cross sectional area. Ensure that compressive stress in this area does not exceed 1,000 psi when subjected to initial prestressing, offset by dead load only.

Dome edge steel reinforcement:

(1) Throughout the dome edge, ensure that the percentage of steel reinforcement, both radially and circumferentially, is no less than 0.25 percent of the gross cross sectional area of concrete.

(2) Along the dome edge, distribute steel reinforcement between the upper and lower layers unless finite element analysis calculations indicate that tensile stress does not exist in the concrete along the bottom face of the dome edge. In that case, only top bars are required radially and circumferentially. In addition, radial and circumferential reinforcing bars will not be required along the bottom face of the dome edge where the

calculated typical dome thickness is less than 75 percent of the actual typical dome thickness.

(3) Where reinforcing bars are required in the bottom layer, anchor them near the tank wall to ensure adequate development at the intersection between dome and wall.

(4) In all cases ensure that the percentage of circumferential steel reinforcement in the first 2 feet of the dome edge is no less than 1 percent of the gross cross sectional area of concrete.

(5) Where bottom dome edge steel reinforcement is required, ensure that the vertical steel reinforcement along the inside face of the tank wall is no less than 0.5 percent of the cross sectional area of wall shotcrete.

Water-cure the concrete dome roof until the dome ring girder is prestressed.

2.2.8 Horizontal Prestressing

Achieve circumferential prestressing of the tank by the application of cold-drawn, high-carbon steel wire complying with ASTM A 821 Type B, placed under high tension. Make a substantial allowance for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.

Ensure that placement of the prestressing steel wire is in a continuous and uniform helix of such pitch to provide in each lineal foot of core wall height an initial force and unit compressive stress equivalent to that shown on the drawings. Permit splicing of the wire only when completing the application of a full coil of wire or when removing a defective section of wire.

Ensure that areas to be prestressed contain not less than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge. Allow a maximum of 24 wires per layer per foot for 8 gauge and 20 wires per layer per foot for 6 gauge. Use shotcrete to completely encase each individual wire and protect it from corrosion. To facilitate this encasement, ensure that the clear space between adjacent wires is no less than one wire diameter.

Accomplish prestressing by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Generate tension in the wire by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, consider the aggregate force of all tensioned wires per foot of wall rather than the force per individual wire, and ensure that such aggregate force is no less than that required by the drawings. Do not circumferentially move the wire along the tank during or after tensioning.

2.2.9 Measurement of Wire Stress

Supply equipment at the construction site to measure tension in the wire after it is positioned on the tank wall. Ensure that this stress measuring equipment includes electronic direct reading stressometer accurate to within 2 percent, calibrated dynamometers, and a test stand to field-verify the accuracy of the stressometer. Record the initial tension in each wire.

2.2.10 Exterior Cover Coat

After circumferential prestressing wires have been placed, protect them by encasement in shotcrete. Ensure that this shotcrete encasement completely encapsulates each wire, and permanently bonds the wire to the tank wall. Ensure that the shotcrete cover has a thickness of no less than 1 inch over the wire. When multiple layers of wire are required, ensure that the shotcrete cover between layers is no less than 1/8 inch thick.

2.2.11 Wall Openings

Insofar as possible, ensure that all pipes pass into the tank through the floor slab. Encase underfloor piping in concrete.

When it is necessary for a pipe to pass through the tank wall, ensure that the invert of such pipe is no less than 18 inches above the floor slab, and the prestressing wires required at the pipe elevation are distributed above and below the opening, leaving an unbanded strip around the entire tank. Ordinarily, unbanded strips have a vertical dimension of no more than 36 inches.

Provide a design analysis for unbanded wall spaces having a vertical dimension greater than 36 inches.

Seal all pipe sleeves passing through the wall to the steel shell diaphragm by epoxy injection after the sleeve and diaphragm have been encased in shotcrete.

2.2.12 Tank Accessories

The tank manufacturer shall furnish, install, and guarantee for 5 years the following tank accessories for each tank:

Wall Manhole	AISI Type 316 stainless steel frame cover, and bolts, minimum clear opening: 17 inches high x 52 inches wide
Exterior Ladder	T-6061 clear anodized aluminum with safety cage, keyed gate, and appropriate tie-off mechanisms (safety climb system) as shown on the drawings. All brackets and fasteners shall be AISI Type 316 stainless steel. Cage and ladder shall be properly grounded and shall meet the minimum requirements of all national, state, and local standards, regulations, and code requirements, including OSHA.

Interior Ladder	Fiberglass with safety cage-an appropriate safety climb system. All fasteners shall be AISI Type 316 stainless steel. Interior safety ladder system shall meet the minimum requirements of all national, state, and local standards, regulations, and code requirements, including OSHA. Safety climb system shall have an extended grab bar at the top of the roof hatch such that the climber can stay attached to the safety climb system while entering or exiting the tank roof hatch.
Safety Climbing Belts	Provide three full-body harnesses (2 size large and 1 size extra large; Government reserves the right to amend sizes at submittal review), each designed for and compatible with the rail-type safety climbing devices provided on the interior ladder. Safety climbing harnesses shall meet or exceed all applicable industry standards, including ANSI A10.14, ANSI Z359.1, OSHA 29 CFR 1910.66, and OSHA 29 CFR 1926.502. Provide four lanyards with shock absorbing devices. Meet or exceed all applicable industry standards including ANSI Z359.1, ANSI A10.14, OSHA 29 CFR 1910.66, and OSHA 29 CFR 1926.502.
Precast Concrete Overflows	A minimum of 4 precast concrete overflows for a total design overflow rate per tank of 37 MGD.
Roof Hatch Cover	All fiberglass with AISI Type 316 stainless steel fasteners. Cover shall be one piece with integral stiffeners and shall have turned down edges to direct surface water runoff beyond the support curb. Cover shall be equipped with stainless steel hinges and padlock hasp.
Roof Ventilator	All fiberglass with AISI Type 316 stainless steel fasteners. Ventilation openings shall be equipped with replaceable 24/24 mesh fiberglass screens. The ventilator shall be designed and sized to prevent damage to the ground storage reservoir during reservoir filling or draining rate of 37 MGD.

Probe Dome Curb	Provide probe dome curbs shown on the drawings for installation of level measurement equipment during construction. Provide pipe spools with blind flange for probe dome curbs shown on the drawings.
Through-Wall Pipe Sleeves	AISI Type 316 stainless steel sleeves with 2-inch welded waterstop rings and neoprene Link-Seal units using stainless
Liquid Level Indicator	Fiberglass and/or stainless steel construction with gaskets and AISI Type 316 stainless steel float, float cable, brackets, and fasteners. Target-reading type gauge board shall extend over half of the full height of the tank and be calibrated in feet of liquid depth. The board shall have a 2:1 compressed scale and shall be approximately 17 feet tall, showing a water level depth range from 0 to 34 feet. Markings shall be black on white background with even 2-foot increments numbered and 1-foot sub-increments marked. Float cable shall enter through dome roof and shall be totally enclosed above top of reservoir sidewall.

Handrail System	Clear anodized 6061 aluminum handrail and toeboard system with 2-inch-diameter rails and posts with 1/4-inch wall thickness. The aluminum toeboard shall be a minimum of 4 inches high when installed. Post spacing shall not exceed 8 feet. Rail joints shall be finished flush and shall occur only at posts. Fittings and brackets shall be fastened by concealed pins or by welding ground smooth. A base flange shall be rigidly connected to the bottom of each post. The base flange shall be anchor-bolted to the structure with the area below the base flange completely filled with non-shrink epoxy grout to provide a plumb post and constant rail height installation. All fasteners shall be AISI Type 316 stainless steel. The completed handrail system shall be rigid and completely free of play at all joints, connections, and attachments. The completed handrail system shall be capable to withstanding a load of at least 400 pounds applied in any direction at any point on the rails and posts. Handrails shall meet the minimum requirements of all national, state, and local standards, regulations, and code requirements, including OSHA.
Barrier Rail System	Fiberglass barrier rail shall be provided around the perimeter of sump, as indicated in the drawings. All fasteners shall be AISI Type 316 stainless steel. The barrier rail systems shall meet the minimum requirements of all national, state, and local standards, regulations, and code requirements, including OSHA.
Pipe, Fittings, and Appurtenances	As shown on the drawings and in accordance with Division 22-Plumbing.
Perimeter Sidewalk	Construct a 4-foot-wide concrete perimeter sidewalk as shown on the drawings.

Ensure that all roof openings are continuously curbed to prevent surface water from entering the tank. Curbs shall extend at least 3 inches above the roof.

All components, including ladders, safety climbing devices, handrails

systems, and hatch cover, shall, as a minimum, comply with OSHA requirements.

Ensure that all fiberglass components contain an inhibitor to prevent ultraviolet degradation.

PART 3 EXECUTION

3.1 CONSTRUCTION PROCEDURES

The purpose of this section is to state additional requirements that specifically relate to circular prestressed tank construction. Ensure that all construction on the interior of, exterior of sumps, pipe and fittings, attachments, and painting is performed by or under the supervision of the tank manufacturer.

3.1.1 Concrete

3.1.1.1 Weather Limitations

Unless specifically authorized in writing, do not place concrete during cold weather when the ambient temperature is below 35 degrees F and rising, or below 40 degrees F and falling, or when the concrete is likely to be subjected to freezing temperatures before final set has occurred and the concrete strength has reached 500 psi. Provide curing by water or by covering exposed surfaces with polyethylene sheets.

3.1.1.2 Floors

Continuously cast concrete membrane floors or floor sections without cold joints. Where construction joints are approved, proper placement and embedment of the waterstop is required.

3.1.1.3 Construction Joints

Submit proposed layouts and details of all proposed joints in floors and footings.

3.1.2 Shotcrete

3.1.2.1 Weather Limitations

Unless specifically authorized in writing, do not place shotcrete in cold weather when the ambient temperature is below 35 degrees F and rising, or below 40 degrees F and falling, and when the shotcrete is likely to be subjected to freezing temperatures before gaining sufficient strength to avoid damage. Water-cure exposed surfaces once the shotcrete has taken initial set.

3.1.2.2 Coating Over Prestressing Wire

Protect wire against corrosion and mechanical damage by three or more coats of shotcrete. Protect each layer of circumferential prestressing by a shotcrete wire coat. Protect the outer layer of wire by the wire coat plus two or more additional coats of shotcrete, totaling a minimum of 1 inch in thickness over the outer layer of wire. Ensure that wire coat thickness is sufficient to provide a clear cover over the wire of at least 1/8 inch. Apply two or more additional finish coats of shotcrete totaling not less than 7/8 inch over the last layer of wire coat. Remove dust,

efflorescence, oil, and other foreign material from surfaces to be shotcreted. Apply shotcrete with the nozzle constantly moved during application in a smooth motion with the nozzle generally pointing toward the center of the tank. Ensure that the nozzle distance from the prestressing is such that shotcrete does not build up or cover the front face of the wire until the spaces between the prestressing elements are filled. Ensure that the shotcrete is wet but not dripping. Install vertical shooting wires under tension and space no more than 3 feet apart to establish uniform and correct coating thickness. Use wires of 18- or 20-gauge minimum high-tensile steel. Ensure that the shotcrete has a sponge finish. Keep all exposed shotcrete coatings moist for at least 3 days. Start moist curing as soon as possible without damaging the shotcrete. Provide curing by fog spraying or sprinkling. Curing may be interrupted for subsequent application of prestressing and shotcreting.

3.1.2.3 Control Testing

Perform quality control of shotcrete in accordance with the applicable requirements of ACI 506.

3.1.3 Forming

Ensure that formwork design provides for adequate safety and is sufficient to maintain proper tolerances.

3.1.4 Nonprestressed Steel Reinforcement

Place steel reinforcement in conformance with the drawings.

3.1.4.1 Concrete and Shotcrete Cover

Ensure that the minimum cover over steel diaphragms and nonprestressed steel reinforcement is in accordance with the design criteria of this specification and AWWA D110.

3.1.5 Prestressing

3.1.5.1 Circumferential Prestressing

The application of high-tensile steel wire, wound under tension by machines, around cylindrical concrete walls and domes. An essential feature of this stressing system is the proper application of tension to the prestressing element before it is placed on the wall. Ensure that field handling and storage of prestressing wire is such that it is fully protected from physical damage and corrosion before, during, and after placement. Use a stressing system that is able to consistently produce a stress at any point around the wall, falling within plus\minus 7 percent tolerance of the specified initial stress. Temporarily anchor each coil of prestressing wire at sufficient intervals to minimize the loss of prestress in case a wire breaks during wrapping. Join ends of the individual coils by suitable steel splicing devices able to develop the full strength of the wire. Do not apply stress to the concrete core wall or dome ring by the prestressing operation until the wall attains the strength as given in the above table of design criteria. Use a calibrated stress-measuring device that can be easily recalibrated to determine wire stress levels frequently throughout the wrapping process. Take at least one stress reading for every coil or foot of wall height immediately after application on the wall, and ensure that all such readings are on straight lengths of wire. Ensure that readings refer to the applicable height and layer of wire for

which stress is being recorded. Maintain a written record of stress readings until all stressing is completed and the cover coats are applied. Ensure that the total prestress force measured on the wall per vertical foot of height is less than the specified force plus/minus 5 percent. Prepare the force diagram for minimum spacing between the prestressing elements of 3/8 inch and ensure that the minimum clear space between wires on the wall are 1/4-inch or 1.5 wire diameters, whichever is greater. Uniformly space wires in areas next to openings or inserts in accordance with the above. Place prestressing no closer than 2 inches from the base of walls where radial movement may occur between wall base and floor of footing. The practice of bundling wires is prohibited.

3.1.6 Elastomeric Materials

3.1.6.1 Waterstops

Center waterstops the joints and secure by split forms to ensure positive positioning. Secure horizontal waterstops that are accessible during concreting in a manner that allows them to be bent up while concrete is placed and compacted underneath, after which allow the waterstop to return to position and immediately place concrete over the waterstop. Positively tie waterstops that are not accessible during concreting in such a manner that bending in either direction is prevented. Nails may be driven through the edges of waterstops to facilitate placing and tying. Splice all waterstops in a manner that ensures complete continuity as a water barrier.

3.1.6.2 Elastomeric Bearing Pads

Attach bearing pads to the concrete with a waterproof adhesive material. Nailing of pads is not permitted.

3.1.7 Finishes

Give the floor slab a soft broom finish.

Give exterior shotcrete a sponge float finish and coat.

Ensure that the concrete surface to be coated is clean, i.e. free of all dirt, grease, and foreign material. Fill and/or repair all defective surfaces as recommended by the finish manufacturer. Ensure that application is in full accordance with the manufacturer's instructions or as amended by the Contracting Officer.

3.1.8 Special Requirements

Provide a continuous waterproof steel diaphragm throughout and within the tank wall between the water and the prestressing wires.

Ensure that the minimum concrete or shotcrete cover on the inside face of the diaphragm is 1 inch.

Ensure that the minimum concrete or shotcrete cover on the outside face of the diaphragm is 1-1/2 inches.

Individually encase each prestressing wire in mortar.

Ensure that there is no reduction in ring compression or tension in the wall due to restraint at the bottom.

3.1.9 Testing

At the Contractor's expense, provide a technical representative of the tank manufacturer at the jobsite as necessary to ensure compliance of the work.

Before liquid testing, the Contracting Officer and the tank manufacturer shall inspect the finished ground storage reservoirs/tanks. The tank manufacturer shall provide a letter of certification to the Government (and copies to the Contractor and Contracting Officer) certifying, without exception, that the ground storage reservoirs, as installed, meet the requirements of the drawings, specifications, and manufacturer's recommendations. Remedy all items precluding this certification by and at the expense of the Contractor.

Obtain water required for testing and disinfection. Dispose of test water without flooding or damage of the jobsite or downstream facilities.

Do not connect plant site yard piping to the ground storage reservoir piping installed by the tank manufacturer until after successful completion of reservoir leakage testing and settlement testing.

Scheduling of each test shall be coordinated with and approved by the Government. Notify the Government and Contracting Officer at least 7 days in advance of the start of a proposed test. Ensure that all tests are witnessed by the Contracting Officer.

Provide all labor, equipment, temporary piping, chemicals, and other items as required to perform testing and disinfection.

Disinfect the ground storage reservoir at the time of leakage testing by chlorination in accordance with AWWA C652. Take special care to clean and disinfect all piping systems provided.

3.1.9.1 Leakage Testing

Fill the completed tank to the top with water. Ensure that the tank remains filled for at least 48 hours to allow for absorption. After the initial period, add makeup water as required and allow the tank to stand for a minimum of 24 hours to allow swell and slosh to abate. Measure the drop in liquid level over the next 48 hours. Evaporation losses may be deducted from the drop to determine the net drop in liquid level. Ensure that the net drop in liquid level does not exceed an average of 1/4-inch per 24-hour period. If the net drop in liquid level exceeds the maximum allowable, extend the liquid level test to a total of 5 days. If at the end of 5 days the average net drop in liquid level does not exceed the maximum allowable, consider the test satisfactory. If the net liquid loss exceeds the maximum allowable, consider the test unsuccessful, correct the source of leakage, and retest the tank. Do not permit damp spots on the exterior wall surface. Damp spots are defined as spots where moisture can be picked up on a dry hand. Locate and permanently seal the source of water movement through the wall in an acceptable manner. No leakage that includes visible flow through the wall-floor joint shall be permitted. Dampness on the top of the footing shall not be construed as leakage.

3.1.9.2 Tank Settlement Testing

Settlement testing is defined to be the monitoring and recording of initial and final vertical settlement of the completed and filled prestressed concrete tank. The *filled tank* is defined as the tank filled with water to

match the top of the total tank sidewall height. Initial and final vertical settlement monitoring and recording is defined as the accurate determination of a minimum of five vertical fixed locations (e.g., top of tank wall, top of tank foundation, etc.) chosen by the Contracting Officer throughout the tank structure. Conduct the settlement test over the duration indicated in the following paragraph or until the settlement rate decreases appreciably as reflected from the settlement time curve. A settlement rate of 0.01 inches or less per 10 days shall be considered satisfactory. A *test-day* is defined as a 24-hour period with the tank completely filled. A *completely filled tank* is defined as the maintenance of the tank water surface 6 inches or less to the top of the exterior tank wall. Water shall not be added to the tank during the leak testing period, unless approved by the Contracting Officer.

Submit settlement measurements, as specified hereinbelow, to the Contracting Officer within 48 hours of the time the measurement was taken. Provide the services of a professional land surveyor, registered in Florida, to perform an initial and subsequent settlement measurements for all of the vertical fixed point locations. Begin the settlement test by taking initial measurements at the vertical fixed point locations before filling the tank for leak testing. Begin the subsequent settlement measurements upon filling the prestressed concrete tank for the leak testing specified herein. Take and record settlement measurements as follows:

(1) First settlement measurements-0-hours, base readings, before tank filling.

(2) Second settlement measurements-72 to 120 hours (3 to 5 days) subsequent to complete filling.

(3) Third settlement measurements-240 to 336 hours (10 to 14 days) subsequent to complete filling.

(4) Fourth settlement measurements-600 to 720 hours (25 to 30-days) subsequent to complete filling.

(5) Fifth settlement measurements-1,200 to 1,440 hours (50 to 60 days) subsequent to complete filling.

3.1.10 Tank Backfill

Place backfill material in uniform layers and compact as specified by the Contracting Officer for the material and site conditions. Avoid asymmetrical backfill placement except where allowed by the design. Backfill tank after filling and testing.

3.2 PAINTING

3.2.1 Exterior Concrete Surfaces of the Prestressed Composite Tank

Apply the following paint system to the exterior, exposed concrete tank wall and dome cover surfaces.

General: Water-based cementitious and acrylic polymer emulsion admixture/acrylic emulsion, three-coat system.

Surface Preparation: Prepare exterior-exposed concrete surfaces in accordance with the paint system manufacturer's recommendations.

Primer Coat(s): One coat at the tank manufacturer's recommended application rate.

Intermediate Coat(s): One coat at 275 square feet per gallon (230 sfpg to 345 sfpg maximum).

Finish Coat(s): One coat at 275 sfpg (230 sfpg minimum to 345 sfpg maximum).

Paint system manufacturer and product(s): Harris Specialty Chemicals, Inc, Thoroseal modified with Acryl60 (primer coat); Tnemac Tneme-Cryl Series 6 (intermediate and finish coats).

Color of finished paint selected by Government.

3.2.2 Interior Concrete Surfaces of the Prestressed Composite Tank

Coat the interior of the ground storage tank as described below:

Coat all tank concrete surfaces (wall, floor, sumps, etc.) in contact (continuously, intermittently, or potentially) with drinking water with Tamoseal or other Contracting Officer accepted NSF/ANSI 61 compliant coating system.

Prepare surface and apply coating system in accordance with the manufacturer's instructions/requirements.

3.3 CLEANUP

Clean the project site of litter and foreign substances. Sweep paved areas to a broom-clean condition; remove stains, petrochemical spills and other foreign deposits. Rake grounds which are neither planted nor paved to a smooth, even-textured surface.

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UNDERGROUND ELECTRICAL DISTRIBUTION

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.

ACI INTERNATIONAL (ACI)

ACI 318M	(2008; Errata 2008; Errata 2009) Metric Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges
AASHTO M 198	(2008) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

ASTM INTERNATIONAL (ASTM)

ASTM B 1	(2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
ASTM B 8	(2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 32	(2009) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 478	(2009) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 857	(2007) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006; Errata 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48 2009) National Electrical Safety Code
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)Normal Measurements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005	(Basic; Notice 1) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Standard for Grounding and Bonding Equipment

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 Std 100.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

c. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

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 underground structures; G

SD-03 Product Data

Conduit, Ducts and Fittings; G

Precast concrete structures; G

Sealing Material

Pulling-In Irons

Manhole frames and covers; G

1.4 QUALITY ASSURANCE

1.4.1 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

1.4.2 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.

1.4.3 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. 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.

1.4.3.1 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.

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

Provide in accordance with Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL and Section 33 05 24 DIRECTIONAL DRILLING

2.1.1 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 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 GROUNDING AND BONDING

2.2.1 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.

2.2.2 Grounding Conductors

Stranded-bare copper conductors shall conform to ASTM B 8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors shall conform to ASTM B 1 for sizes No. 8 and smaller. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Aluminum is not acceptable.

2.3 CAST-IN-PLACE CONCRETE

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.

2.4 UNDERGROUND STRUCTURES

Manhole structure and cover system shall be rated for heavy traffic use, Designation ASTM C 857A-16 (HS20-44) in accordance with ASTM C 857.

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C 857 and ASTM C 478. 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 rack arms and insulators, shall be adequate to accommodate the cable.

2.4.1 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.

2.4.1.1 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 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.

2.4.1.2 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 = 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, or industrial) 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 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.

2.4.1.3 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 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 12 inches in diameter and 4 inches deep for precast structures.

2.4.1.4 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.

2.4.2 Manhole Frames and Covers

Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the word "ELECTRIC" in the top face of power manhole covers.

2.4.3 Brick for Manhole Collar

Brick shall be sewer and manhole brick conforming to ASTM C 32, Grade MS.

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 construction as specified herein and as indicated, or precast construction as specified herein. 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 C 309. 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 6 inches of level, 90 percent compacted granular fill, 3/4 inch to 1 inch size, extending 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 6 inches from the edge of the sump, and in the walls the irons shall be located within 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 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 6 inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 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 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 4 inches and shall be designed to withstand a minimum pulling-in load of 6000 pounds. Irons shall be hot-dipped galvanized after fabrication.

3.2.3 Cable Racks, Arms and Insulators

Cable racks, arms and insulators shall be sufficient to accommodate the cables. Racks in power manholes shall be spaced not more than 3 feet apart, and each manhole wall shall be provided with a minimum of two racks.Methods of anchoring cable racks shall be as follows:

a. Provide a 5/8 inch diameter by 5 inch long anchor bolt with 3 inch foot cast in structure wall with 2 inch protrusion of threaded portion of

bolt into structure. Provide 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 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 5/8 inch steel nuts in channel insert to receive 5/8 inch diameter by 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 800 pound load rating. Provide 5/8 inch diameter by 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.

3.3 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.3.1 Requirements

Depths to top of the conduit shall be in accordance with NFPA 70 unless indicated otherwise on the drawings. 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 3 inches per 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. Unless otherwise indicated, provide long sweep bends having a minimum radius of 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 3 inches and larger, draw a flexible testing mandrel approximately 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.

3.3.4 Multiple Conduits

Separate multiple conduits by a minimum distance of 2 1/2 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 10 feet of conduit assembly.

3.3.5 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 3 feet of slack at each end of unused or empty conduits.

3.4 CABLE PULLING

As specified in Section 26 05 13.00 98 MEDIUM VOLTAGE CABLE.

3.5 GROUNDING SYSTEMS

Provide grounding system as indicated, in accordance with NFPA 70 and IEEE C2, and as specified herein.

Pad-mounted transformers without protective fences	5 ohms
Ground in manholes	5 ohms
Grounding other metal enclosures of primary voltage electrical and electrically-operated equipment	5 ohms

3.5.1 Grounding Electrodes

Provide cone pointed driven ground rods driven full depth plus 6 inches, installed to provide an earth ground of the appropriate value for the particular equipment being grounded.

If the specified ground resistance is not met, an additional ground rod shall be provided in accordance with the requirements of NFPA 70 (placed not less than 6 feet from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

3.5.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.

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.

3.5.3 Grounding Conductors

Provide bare grounding conductors, except where installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. 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. 6 AWG.

3.5.4 Ground Cable Crossing Expansion Joints

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.

3.5.5 Manhole Grounding

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 12 inches above finished floor. Secure the conductor to the manhole walls at intervals not exceeding 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 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 6 AWG conductor.

3.5.6 Fence Grounding

Fences shall be grounded with a ground rod at each fixed gate post and at each corner post. Drive ground rods until the top is 12 inches below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 12 inches of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Each gate section shall be bonded to its gatepost by a 1/8 by one inch flexible braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

3.5.7 Manhole Grounding

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 12 inches above finished floor and connect to ground rod installed at the manhole. Secure the conductor to the manhole walls at intervals not exceeding 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 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 6 AWG conductor.

3.5.8 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE Std 81. 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 megohmmeter tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

3.5.9 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.

3.6 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with Section 31 00 00 EARTHWORK.

3.6.1 Reconditioning of Surfaces

3.6.1.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct or direct burial cable. 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.

3.6.1.2 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.

3.7 CAST-IN-PLACE CONCRETE

3.7.1 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.

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PROCESS CONTROL SYSTEM

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/NSF 61	(2009) Drinking Water System Components - Health Effects

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C701	(2007) Standard for Cold-Water Meters - Turbine Type for Customer Service
AWWA C704	(2008) Propeller-Type Meters for Waterworks Applications
AWWA C706	(1996; R 2005) Direct-Reading, Remote-Registration Systems for Cold-Water Meters

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 587	(1980) Guide/Surge Voltages/Lo-Volt.AC.Power.Circuits
IEEE C37.90	(2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C62.41.1	(2002; R 2008) IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE Std 142	(2007) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book (Color Book Series)
IEEE Std 802.3	(2009) Standard for Information Technology - Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks

ISA - INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 5.1	(2009) Instrumentation Symbols and Identification
ISA 5.4	(1991) Instrument Loop Diagrams
ISA 50.1	(1982; R 1992) Compatibility of Analog Signals for Electronic Industrial Process Instruments
ISA S50.1	(1982; R 1992) Compatibility of Analog Signals for Electronic Industrial Process Instruments

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; CORR 2009) Quality Management Systems- Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems General Requirements
NEMA ICS 2	(2000; Errata 2002; R 2005; Errata 2006) Standard for Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 4	(2005) Industrial Control and Systems: Terminal Blocks

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250	(1991) Calibration Services Users Guide

NSF INTERNATIONAL (NSF)

NSF 61	(2009) Drinking Water System Components - Health Effects

UNDERWRITERS LABORATORIES (UL)

UL 1059	(2001; Rev thru Dec 2006) Terminal Blocks
UL 508	(1999; Rev thru Sep 2008) Standard for Industrial Control Equipment
UL 489	(2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.2 SYSTEM DESCRIPTION

The process instrumentation and control system project scope includes four distinct sites, as follows:

W-5 Pump Station
Schwartz Road Water Quality Monitoring
SLF and Saturn V Pressure Control Station

The process instrumentation and control system shall facilitate monitoring and control of the process equipment as specified herein and in the drawings (i.e., P&IDs, Sequence of Operation, Control Schematics, and Details. Provide the necessary hardware configured and sized to meet the specified performance requirements.

1.2.1 General Requirements

The following is a brief description of the monitoring and control features required for each location:

W-5 Pump Station - Monitor/Control the water system distribution pressure locally. Provide remote monitoring capability via the KCCS. The pump station shall operate to provide potable water to the (1) water cooling towers and the (2) distribution system.

Implement the controls in a new Field Interface Controller (FIC) connect the FIC to the KCCS Utility Wide Area Network (WAN) for data transmission to/from the Government's SCADA application, and configure the Government's SCADA application for remote monitoring of the facility.

Schwartz Road Water Quality Monitoring - Monitor the residual values of free ammonia, total chlorine, and mono-chloramine and transmit for remote presentation at the Government's SCADA application via the KCCS Utility Wide Area Network (WAN). No control operation is required.

Provide and install a new Field Interface Controller (FIC), connect the FIC to the KCCS Utility WAN for data transmission to/from the Government's SCADA application, and configure the Government's SCADA application for remote monitoring of the facility.

Saturn V Pressure Control Valve (PCV) - Monitor the PCV valve position (CLOSED, NOT-CLOSED) via the W-5 Pump Station FIC. Transmit the PCV status data to the SCADA application via the KCCS WAN, along with the other W-5 Pump Station data. No control operation is required.

1.2.2 Operation

Provide monitoring and control features as described in the Sequence of Operation, the Control Narratives provided as an Attachment herein, and as further specified herein.

W-5 Pump Station - The following required as a minimum:

Field Interface Controller (FIC) complete in NEMA 3R enclosure. FIC serves to control operation of the pumps and filling of the Ground Storage Tank (GST).

Hydropneumatic tank control panel not covered under this Section.

Schwartz Road Water Quality Monitoring - Provide the following:

UV Water Quality Analyzer.
Field Interface Controller (FIC) complete in NEMA 3R enclosure.

Saturn V Pressure Control Valve - Panels or control equipment required are not covered under this Section.

1.2.3 Points

Inputs and Outputs to be monitored/controlled by the FIC are provided in tabular form as an ATTACHMENT to this Section.

1.2.4 Data Transmission Systems (DTS)

Data Transmission between the FIC and the SCADA application shall be achieved using the KCCS Utilities Wide Area Network (WAN). Media shall be fiber optic cable as specified in Section 27 13 23.00 COMMUNICATIONS OPTICAL BACKBONE CABLING.

Data transmission between the FIC and the SCADA application shall use the Government's standard, Ethernet-based, communication protocol; Modbus-TCP.

1.2.5 Process Control System Sub Contractor Responsibilities

The Process Control System Sub Contractor shall complete the detailed design to achieve the performance requirements specified herein. The work includes the following tasks:

Prepare and make the submittals required herein.

Purchase, fabricate, and install equipment and ancillaries.

Provide instructions, details, and recommendations to, and coordinate with the Contractor.

Prepare new screens for and make revisions to the Government's SCADA application data base for the work specified herein. The SCADA application software is Citect.

Configure and commission all smart instruments and devices.

Verify readiness for operation.

Adjust and calibrate instruments

Perform system start up services.

Test the system and coordinate system testing with other trades, the Government, and the Contracting Officer.

Train the Government's staff in system operation and maintenance.

1.3 DEFINITIONS

a. General: Definitions, symbols, and engineering unit abbreviations shall conform to ISA 5.1, as applicable.

b. Abbreviations:

CP:	Control Panel
FP:	Field Panel
HMI:	Human/Machine Interface
ISA:	Instrumentation Society of America
I/O:	Inputs and Outputs
KCCS:	Kennedy Complex Communication System
MCC:	Motor Control Center
OIU:	Operator Interface Unit
ORT:	Operational Readiness Test
PAT:	Performance Acceptance Test
PICS:	Process Instrumentation and Control System
RTU:	Remote Telemetry Unit
SCADA:	Supervisory Control and Data Acquisition

c. Terms:

1. Enclosure: Control panel, console, cabinet, or instrument housing.

2. Instructor Day: 8 hours of actual instruction time.

3. Software: Programs or configuration data for digital devices, stored in read-only memory, programmable read-only memory, read/write memory, disk, tape, or other electronic storage device.

Types of Software:

Standard Software: Package independent of the project on which they are used. Standard software includes system software and Process Monitoring and Control software.

Application Software: Configuration to provide functions unique to this project.

4. Rising/Falling: Terms used to define actions of discrete devices about their set points.

Rising: Contacts close when an increasing process variable rises through set point.

Falling: Contacts close when a decreasing process variable falls through set point.

d. Signal Types:

Analog Signals, Current Type: 4 to 20 mA de signals conforming to ISA S50.1. Unless otherwise indicated for specific PICS Subsystem components, use the following ISA 50.1 options.

Transmitter Type: Number 2, two-wire.
Transmitter Load Resistance Capacity: Class L.
Fully isolated transmitters and receivers.

Analog Signals, Voltage Type: 1 to 5 volts DC within panels where a common high precision-dropping resistor is used.

Discrete Signals: Two-state logic signals using 24V DC or 120V AC sources as indicated.

Pulse Frequency Signals: Direct current pulses whose repetition rate is linearly proportional to process variable. Pulses generated by contact closures or solid state switches as indicated. Power source less than 30V DC.

Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

e. Instrument Tag Numbers: A shorthand tag number notation is used in the Loop Specifications. For example: 10PI-2(A/B).

Notation	Explanation
10	Unit process/Loop designation
PI	ISA designator for Pressure Indicator
(2)	Unit designation; alphanumeric designation of same process types in a given loop; -1, -2 in this example
(A/B)	Component designation; Alphanumeric designation of same component type within a process; -A, -B in this example

In this example, 10PI-(2)(A/B) is shorthand for:

10PI-1-A, 10PI-1-B, 10PI-2-A, 10PI-2-B

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

Panel Fabrication Drawings; G
Installation Drawings; G

Field Wiring Drawings; G

In accordance with the paragraph entitled "DRAWINGS."

SD-03 Product Data

Manufacturer's descriptive and technical literature, performance charts and installation instructions. Product specific catalog cuts shall be in booklet form, indexed to the unique identifiers, and shall consist of data sheets that document compliance with the specification. Where multiple components are shown on a catalog cut, the application specific component shall be marked.

Training Manual; G

Instruction manual within 30 days of Notice to Proceed.

Performance Verification Test (PVT); G

The performance verification test procedure; it shall refer to the actions and expected results to demonstrate that the control system performs in accordance with the sequence of control. Include a list of the equipment to be used during the testing plus manufacturer's name, model number, equipment function, the date of the latest calibration and the results of the latest calibration.

SD-05 Design Data

Control Drawings; G

Provide ladder logic or other logic diagrams reflective of the hardwired logic proposed.

SCADA Application 50 Percent Development Submittal; G

Submit PLC code and color graphic screen representative of the work described herein. Provide the PLC code in the hardware programming language and containing example functions or routines representative of those proposed for this work. Provide the screens using Citect Graphics Builder. Include the navigation map(s), Genies, Super Genies, Cicode functions, and metadata proposed for this work. Provide a submittal that is reproducible, hard-copy as a minimum.

SCADA Application 90 Percent Development Submittal; G

Submit the completed PLC code and color graphic screens for the work described herein. Provide the PLC code in the hardware programming language. Provide the screens using Citect Graphics Builder. Include the navigation map(s), Genies, Super Genies, Cicode functions, and metadata proposed for this work. Provide a submittal that is reproducible, hard-copy as a minimum. Demonstrate the operation of the programmed system complete. Provide computing hardware (i.e., laptop computer). Ensure the submittal also includes one electronic copy of the operational Citect project.

SCADA Application Metadata; G

Submit the metadata for all points monitored/controlled by the Government's existing SCADA application. The Contracting Officer will provide an example presentation of metadata from previous work. Provide a presentation of the metadata that complies with this example, is clearly and logically organized, and clearly describes the monitored/controlled data. Use this data to facilitate the integration of the Citect projects unique to this work with the Government's overall SCADA application.

SD-06 Test Reports

Testing, Adjusting and Commissioning; G
Performance Verification Test (PVT); G

SD-07 Certificates

Submit names, resumes, certificates, or other documents descriptive of the technicians' and supervisor's qualifications with respect to programming and configuring of Citect SCADA. Provide documentation in accordance with the paragraph entitled "QUALIFICATIONS.":

SD-10 Operation and Maintenance Data

Instrumentation and Control System

Six complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions layout, wiring and control diagrams of the system as installed, the manufacturer's name, model number, service manual, parts list and a brief description of all equipment and their basic operating features.

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs and trouble shooting guides.

SD-11 Closeout Submittals

Submit Record Drawings for the completed work.

Deliver to the Contracting Officer two, full license and executable copies of the software used to configure/program the PLC and OIU.

Submit an annotated copy of the programming code implemented for the FIC. Provide a submittal that is both paper and in electronic format. Ensure that the electronic formal submittal is in a form suitable for access and editing with the FIC hardware programming software.

1.5 SITE ENVIRONMENTAL CONDITIONS

a. Location; Kennedy Space Center

1. Latitude	28.62
2. Longitude	80.72
3. Altitude (above MSL)	16 ft

b. Outside Design Conditions

1. Winter Design Temperature: 35 degrees F

2. Summer Design Temperature: T_{db} = 90 degrees F, T_{wb} = 78 degrees F

c. Inside Design Conditions, Air Conditioned

1. Winter Design Temperature: 62 degrees F
2. Summer Design Conditions: T_{db} = 90 degrees F, T_{wb} = 78 degrees F

d. Inside Design Conditions, Non-Air Conditioned

1. Winter Design Temperature: 45 degrees F
2. Summer Design Conditions: T_{db} = 90 degrees F, T_{wb} = 78 degrees F

1.6 SEQUENCING

No specific requirements.

1.7 DRAWINGS

Panel Fabrication Drawings: Detailed drawings illustrating sufficient information for a panel shop to purchase the component parts and fabricate/wire the panel.

Installation Drawings: Detailed drawings illustrating how instruments, panels, and other components are to be installed in the field, complete.

Field Wiring Drawings: Detailed drawings illustrating the termination of analog and discrete signals for instruments and panels in the field. As a minimum, the field wiring drawings shall include 'Analog Loop Diagrams', in compliance with ISA 5.4.

1.8 QUALIFICATIONS

List of projects programming/configuring Citect SCADA, completed within the last 3 years.

Certificates of Completion:

Citect HMI/SCADA configuration training
Cicode Programming

Programming Supervisor contact information (name, address, mobile phone).

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

First Named Manufacturer: PICS design is based on first named manufacturers of equipment and materials.

1. If an item is proposed from other than first named manufacturer,

obtain approved from Contracting Officer for such changes in accordance with paragraph entitled "Submittals".

2. If proposed item requires change in system design, (i.e., different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories), the PICS contractor shall be responsible for any additional cost. The PICS contractor shall first obtain approval from the Contracting officer before furnishing equipment and work.

Use product of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.

Implement all same or similar functions in same or similar manner. For example, control logic, sequence control, and display layouts.

2.2 GENERAL REQUIREMENTS

The diagrams, as shown in the drawings, are diagrammatic and supplement PICS performance requirements.

PICS functions are as shown on the drawings and as described herein. Furnish equipment items as required. Furnish all materials, equipment, and software necessary to affect required system and loop performance.

Equipment located outdoors, not provided with climate controlled enclosure, shall be capable of operating in the ambient temperature range indicated in paragraph SITE ENVIRONMENTAL CONDITIONS - Outdoor Conditions, unless otherwise specified.

Equipment located inside a structure or building facility without air conditioned environment shall be capable of operating in the ambient temperature range indicated in paragraph ENVIRONMENTAL CONDITIONS - Indoor, Non-Air Conditioned, unless otherwise specified.

Equipment located inside a structure or building facility with air conditioned environment shall be capable of operating in the ambient temperature range indicated in paragraph ENVIRONMENTAL CONDITIONS - Indoor, Air Conditioned, unless otherwise specified.

Electrical equipment will conform to Division 26 ELECTRICAL. Equipment and wiring must be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

2.3 NAMEPLATES

Provide the manufacturer's name and address and the model and serial number on each major component of equipment in a conspicuous place.

Nameplates shall be laminated plastic and shall identify the device, such as pump "P-1" or valve "VLV-402". Nameplates shall be 1/8 inch thick, white with black center core, 1 by 3 inches in size as a minimum, 1/4 inch high engraved block lettering.

Attach nameplates for devices smaller than 1 by 3 inches using a nonferrous metal chain. All other nameplates shall be physically attached (screwed) to the device.

Coordinate labels with the schedules and the process and instrumentation drawings.

2.4 SCHEDULES

Listed below are schedules included as an ATTACHMENT to this Section. The Contractor shall consider these sections as integral to this Section.

2.4.1 General Control Narratives

A description of common functions (motor start/stop, valves open/close, etc.) to be implemented for this work, including the operator interface required at the FIC or KCCS SCADA Application.

2.4.2 Instrument List

Major components for each loop are listed in the Instrument List referenced in Article ATTACHMENT. Furnish all equipment that is necessary to achieve required loop performance.

2.4.3 FIC Input/Output List

The Input/Output for each FIC are listed in the FIC Input/Output List referenced in Article ATTACHMENT. Furnish all equipment and labor necessary to achieve the required FIC Input/Output.

2.4.4 Component Specifications

Generalized specifications for each type of component are located in Article ATTACHMENT.

2.5 CONTROL PANELS

2.5.1 Panel Assembly

Control panels shall be factory assembled and shipped to the jobsite as a single unit. Panels shall be fabricated as indicated and devices shall be mounted as shown or required. Each panel shall be fabricated as a bottom-entry connection point for control system electrical power, control system wiring, communications system wiring to KCCS.

2.5.2 Components

2.5.2.1 Enclosures

The enclosure for each control panel shall conform to the requirements of NEMA 250 for the types specified. Finish the enclosure outside with white baked epoxy. Damaged surfaces shall be repaired and refinished using original type finish.

Enclosures shall be Type 3R.

Provide enclosure with a single, continuously hinged exterior door with print pocket, 3-point latching mechanism and key lock.

Cutouts shall be cut, punched, or drilled and finished to have smooth rounded edges.

2.5.2.2 Pilot Devices

Indicator lights, NEMA 4 rated, complying with NEMA ICS 1, NEMA ICS 2 and UL 508. Lights shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. Indicator lights shall be LED type and shall operate at 120 vAc or 24 vDc. Long life bulbs shall be used. Indicator light shall be provided with a legend plate labeled as shown on the drawings. Lens color shall be as indicated on the drawings. Lights shall be push to test (lamp) type.

Selector switches, NEMA 4 rated, complying with NEMA ICS 1, NEMA ICS 2 and UL 508. Selector switches shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. The number of positions shall be as indicated on the drawings. Switches shall be non-illuminated. Switches shall be rated for 600 volts, 10 amperes continuous. Selector switches shall be provided with a legend plate labeled as shown on the drawings. Where indicated or required, dual auxiliary contacts shall be provided for the automatic position to provide position sensing at the central station or workstation. Auxiliary contacts shall be rated for 120 vAc, 1A as a minimum.

Push buttons, NEMA 4 rated, complying with NEMA ICS 1, NEMA ICS 2 and UL 508. Push buttons shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. The number and type of contacts shall be as indicated on the drawings or required by the Sequence of Operation. Push buttons shall be rated for 600 volts, 10 amperes continuous. Push buttons shall be provided with a legend plate labeled as shown on the drawings.

2.5.2.3 Relays

Relays shall comply with IEEE C37.90 and derated for altitude above 1,500 m. Relays shall be double-pole, double-throw (DPDT). Relay coil shall be 120 vAc and shall be provided with matching mounting socket. Power consumption shall not be greater than 3 watts.

2.5.2.4 Terminal Blocks

Terminal blocks shall comply with NEMA ICS 4 and UL 1059. Terminal blocks for conductors exiting control panels shall be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks shall be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip shall form part of the terminal block and each terminal shall be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.5.2.5 Alarm Horns

Alarm horns shall be provided where indicated on the drawings. Horns shall be vibrating type and shall comply with UL 508. Horns shall provide 100 dB at 10 feet. Exterior mounted horns shall be weather proof by design or shall be mounted in a weather proof enclosure that does not reduce the effectiveness of the horn.

2.5.2.6 Hour Meter

Hour meter shall provide a totalized readout of the number of hours of operation for the equipment monitored. Meter shall provide readout with a minimum of seven (7) digits including 1 decimal place. The display shall

be non-resettable. The meter shall be driven by a 120 vAc synchronous motor.

2.5.3 Electrical Requirements

Each panel shall be powered by a dedicated separate 120 VAC circuit, or 120 VAC from a leg of the 3-phase power supply via a control power transform appropriately sized for the anticipated loads, and provided in the panel enclosure. Protect the control power feed with a fuse sized appropriately for the anticipated loads. Provide a suitable disconnect switch internal to the panel for the control power. Electrical work shall be as specified in Division 26 ELECTRICAL and as shown on the drawings.

Certifications or Ratings: All I&C and electrical components, terminals, wires, and enclosures shall be UL recognized or UL listed.

Circuit Breakers: In compliance with NEMA AB 1 and UL 489 35,000 RMS symmetrical rating, minimum at 480 volts, unless otherwise specified. Tripping indication; Operator handle position.

Non-Motor Branch Circuit Breakers: Molded case thermal magnetic.

Motor Branch Circuit Breakers: Molded case with manufacturer's recommended trip setting for maximum motor protection.

50 horsepower or less: Magnetic

Larger than 50 horsepower: Thermal magnetic with adjustable magnetic trips.

Padlock provisions: OPEN position.

Wire within Enclosures:

AC Circuits:

Type: 300-volt, Type MTW stranded copper.
Size: For current to be carried but not less than No. 18-AWG.

Analog Signal Circuits:

Type: 300-volt stranded copper, twisted shielded pairs.
Size: No. 18-AWG minimum.

Other DC Circuits:

Type: 300-volt, Type MTW stranded copper.
Size: No. 18-AWG minimum.

Special Signal Circuits: Use manufacturer's standard cables.

Wire Identification: Numbered and tagged at each termination.

Wire Tags: Snap-on or slip-on PVC wire markers with legible machine printed markings and numbers. Adhesive or taped-on tags are not acceptable.

Wire entering or leaving enclosures, terminate and identify as follows:

Analog and discrete signal, terminate at numbered terminal blocks.

Special signals terminated using manufacturer's standard connectors.

Identify wiring in accordance with Division 26 ELECTRICAL.

Terminal Blocks for Enclosures:

General:

Provide sufficient terminal blocks necessary to accommodate present, indicate future, and spares, as specified below. Land no more than one (1) wire per terminal block. Wire spare and unused panel mounted elements to their panels' terminal blocks.

Provide twenty (20) percent of all connected terminals but not less than 5 per terminal blocks as spares.

Common Terminal Blocks Configuration:

Connection Type: Screw compression clamp.

Compression clamp: Complies with DIN-VDE 0611. Hardened steel clamp with transversal groves that penetrate wire strands providing a vibration-proof connection. Clamp shall guide strands of wire into terminal.

Screws: Hardened steel, captive and self-locking.

Current Bar: Copper or treated brass.

Insulation: Thermoplastic rated for minus 55 to 110 degrees C. Insulation shall be shaped at inputs to facilitate wire entry.

Mounting: Stranded DIN rail, suitable to allow Terminal block extraction from an assembly without displacing adjacent blocks.

End Stops: Minimum of one at each end of rail.

Wire Preparation: Stripping only permitted.

Jumpers: Allow jumper installation without loss of space on terminal or rail.

Marking System:

Terminal number shown on both sides of terminal block. Allow use of preprinted and field marked tags. Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.

Mark the top of fuse protected terminal blocks with fuse voltage and amperage.

Test Plugs: Soldered connections for 18-AWG wire.

Pin Diameter: 0.079 inch.

Terminal Block, General-Purpose:

Rated Voltage:	600V AC
Rated Current:	30 amp
Wire Size:	22- to 10-AWG
Rated Wire Size:	10-AWG
Color:	Grey body
Spacing:	0.25 inch, maximum
Test Sockets:	One screw test socket 0.079-inch diameter
Manufacturer and Product:	Entrelec; Type M4/6.T

Terminal Block, Ground:

Wire Size:	22- to 10-AWG
Rated Wire Size:	10-AWG
Color:	Green and yellow body
Spacing:	0.25 inch, maximum
Grounding:	Ground terminal blocks electrically grounded to the mounting rail
Manufacturer and Product:	Entrelec; Type M4-6.P

Terminal Block, Blade Disconnect Switch:

Rated Voltage:	600V AC
Rated Current:	10-amp
Wire Size:	22- to 12-AWG
Rated Wire Size:	12-AWG
Color:	Grey body, orange switch
Spacing:	0.25 inch, maximum
Manufacturer and Product:	Entrelec; Type M4/6.SN.T

Terminal Block, Fused, 24V DC:

Rated Voltage:	600V DC
Rated Current:	16-amp
Wire Size:	22- to 10-AWG
Rated Wire Size:	10-AWG
Color:	Grey body
Fuse:	0.25 inch by 1.25 inch
Indication:	LED diode 24V DC
Spacing:	0.512 inch, maximum
Manufacturer and Product:	Entrelec; Type M10/13T.SFL

Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosure.

Power Distribution within Enclosures:

Feeder Circuits: One or more 120V AC, 60-Hz feeder circuits. Make provisions for feeder circuit conduit entry. Furnish terminal board for termination of wires.

Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel. Locate to provide clear view of and access to breakers when door is open.

Breaker sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker. Branch circuit

breakers shall be 15 amps to 250 VAC, maximum/

Breaker Manufacturers and Products: Square D, Type QO.

Circuit Wiring: Use following rules for actual circuit wiring:

Devices on Single Circuit: 20, maximum.

Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation do not group all units on the same branch circuit.

Branch Circuit Loading: 12 amperes continuous, maximum.

Panel Lighting and Service Outlets: Put on separate 15-amp, 120V AC branch circuit.

Provide 120-volt AC plugmold for panel components with line cords.

Signal Distribution:

Within Panels: 40 to 20 mA DC signals may be distributed as 1 to 5V DC.

Outside Panels: Isolated 4 to 20 mA DC only.

Signal Wiring: All signal wiring twisted in shielded pairs.

Signal Switching:

Use dry circuit type relays or switches.
No interruption of 4 to 20 mA loops during switching.
4 to 20 mA DC Signals: 0.2 mA, maximum.
1 to 5V DC Signals: 0.05V, maximum.

Power Supplies:

Furnish to power instruments requiring external DC power, including two-wire transmitters and DC relays. Convert 120V AC, 60-Hz power to DC power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances. Provide output over voltage and over current protective devices to:

Protect instruments from damage due to power supply failure.
Protect power supply from damage due to external failure.

Power supply enclosures shall be NEMA 1 rated in accordance with NEMA 250. Mount such that dissipated heat does not adversely affect other components.

Provide a fuse on the DC supply line to each individual two-wire transmitter in an indicating holder or terminal block. Mount so fuses can be easily seen and replaced.

Electrical Transient Protection:

The electrical transient protection device shall serve to protect elements of PICS against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.

Provide, install, coordinate, and inspect grounding of surge suppressors at:

Connection of AC power to PICS equipment including panels, console assemblies, and field mounted analog transmitters and receivers.

At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.

Connection of phone line to PICS equipment.

All surge suppressors and related enclosures shall be furnished by the PICS Contractor and installed under Division 26, ELECTRICAL. Install in accordance with manufacturer's instructions and installation details provided in the drawings.

Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, ELECTRICAL.

The electrical transient protection device shall be multistage hybrid type responding to a surge within 5 nanoseconds maximum. The device shall recover automatically and shall be suitable for operating within a temperature range of -20 degrees C to 85 degrees C.

Power supply (120 VAC, 60-Hz, single-phase) electrical transient protection devices shall be tested and rated for a minimum of 50 occurrences of IEEE Std 587 Category B test waveform and shall have a first-stage clamping voltage rating of 350 volts or less and second-stage clamping voltage rating of 210 volts or less.

The power supply electrical transient protection device shall be suitable for continuous operation 30 amps minimum at 130 V AC.

Encapsulate the devices in flame-retardant epoxy.

Test analog signal lines (1 - 5 VDC or 4 - 20 mA) electrical transient protection devices using a linear waveform, 8 microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half peak value in 20 microseconds. Test and rate the device for 50 occurrences of 2,000-amp peak test waveform.

The device shall exhibit DC clamping 20 to 40 percent above operating voltage for circuit with a tolerance of less than plus/minus 10 percent. The unit shall have a maximum loop resistance of 18 ohms per conductor.

The devices shall be suitable for both field and panel installation. The field-mounted device electronics shall be epoxy-potted (flame-retardant) and encased in a stainless-steel pipe nipple. The panel-mounted device electronics shall be epoxy-potted (flame retardant, suitable for panel or DIN rail mounting).

Field-mounted, two-wire devices shall be EDCO Model No. SS64-036-2, or equal.

Panel-mounted devices shall be EDCO Model No. PC642 or EDCO Model No. COHOP-036 mounted on compatible mounting blocks or equivalent.

Provide field-mounted four-wire transmitters, e.g. magnetic flowmeter or analyzers (indoor and outdoors) with units that afford hybrid AC power protection and signal line protection in a single NEMA 4X fiberglass enclosure. The combination surge protection units shall be EDCO Model No. SLAC-32036 or approved equal. All signal lines must have surge protections at both panel and field sensor end.

Wiring Within an Enclosure:

Restrain all wiring by plastic ties or ducts or metal raceways. Do not exceed manufacturer's fill recommendations when using plastic ducts or metal wireways. Secure wire passing over a hinged joint at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.

Arrange wiring neatly, cut to proper length, and remove surplus wire. Provide abrasion protection for wire bundles which pass through holes or across edges of sheet metal.

Use locking-fork-tongue or ring-tongue lugs when making connections to screw type terminals. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations. Terminate a maximum of one (1) wire per crimp lug, two (2) per screw terminal.

Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations when making connections to compression clamp type terminals. Terminate a maximum of one (1) wire per terminal.

Splice or tap of wires at device terminals or terminal blocks only.

Terminate 24V DC and analog signal circuits on separate terminal block from AC circuit terminal blocks.

Separate analog and DC circuits by at least 6 inches from AC power and control wiring except at unavoidable crossover points and at device terminations.

Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.

2.5.4 Grounding

Provide a solid copper ground bus for each control panel enclosure. Anchor the ground bus securely to the enclosure so as to effectively ground the entire structure. Clamp-type terminals sized large enough to carry the maximum expected current shall be provided on the ground bus for grounding cables. Where a definite circuit ground is required, a single wire not less than #10 AWG shall run independently to the panel ground bus and shall be fastened to the ground bus with a bolted terminal lug. Cases of instruments, relays and other devices shall be effectively grounded through the enclosures steel structure unless otherwise indicated. Insulated wiring having a continuous rated current of not less than the circuit fuse rating shall be used for grounding. Grounding terminals of power receptacles shall be solidly grounded to the panel enclosure.

2.5.5 Convenience Outlet

Provide one 120 volt ac, 20 amp, ground fault interruption (GFI) type duplex convenience outlet inside the panel. The outlet circuit shall be separate from the panel power circuit.

2.5.6 Panel Interior Light

Provide one 40 watt fluorescent light in any control panel 12 cubic feet in volume or greater. The light shall be operated by a manual on-off switch mounted on the interior door of the enclosure. The light shall be powered by the same circuit as the convenience outlet.

2.5.7 Temperature Control

Size enclosures to adequately dissipate heat generated by equipment mounted on or inside.

Provide and install thermostatically controlled heaters to maintain internal temperature above 40-degrees F for all enclosures located outside or in unheated areas.

PART 3 EXECUTION

3.1 SCADA APPLICATION DEVELOPMENT

3.1.1 Pre-Development Meeting

The Contractor and their SCADA Development Team shall meet with the Contracting Officer before commencing any programming or configuration efforts with respect to the SCADA Application. At this meeting the Contracting Officer will supply the Contractor with the Government's SCADA graphic and data standard, example graphical screen, Genies, Super Genies, Cicode functions, and metadata for use on this work. This submittal shall be reproducible, hard-copy as a minimum.

The Contracting Officer will confirm the version of the SCADA application software. At the time of publication, the SCADA application software is Citect Version 6.1.

3.1.2 50 Percent Development Coordination Meeting

The Contractor and the SCADA Application Development Team shall attend a meeting with the Contracting Officer and team to review the SCADA Application 50 Percent Development Submittal. At that meeting, the Contractor and SCADA Application Development Team shall be prepared to discuss options available to the Government with respect to the configuration, presentation, and control of data graphically on the Government's SCADA application. A consensus will be reached and forwarded onto the Contractor in writing after the meeting. These shall be implemented in the SCADA Application for this project and submitted as the SCADA Application 90 Percent Development Submittal.

3.1.3 90 Percent Development Coordination Meeting

The Contractor and the SCADA Application Development Team shall attend a meeting with the Contracting Officer and their team to review the SCADA Application 90 Percent Development Submittal. The Contractor and SCADA Application Development Team shall perform a live demonstration of the

SCADA Application developed for this project. Provide hardware (laptop computer) and software necessary for the demonstration. The Contracting Officer and team shall have the opportunity to operate the application to their satisfaction. A consensus will be reached and forwarded onto the Contractor in writing after the meeting. These shall be implemented in the SCADA Application for this project.

3.1.4 Field Testing

The Contractor and the SCADA Application Development Team shall demonstrate the operation of the SCADA Application in the field as part of the Performance Verification Test (PVT). The Contractor shall provide a computer, complete with Citect SCADA and the specific application developed for the work. The Contractor shall demonstrate to the Government the full function of the SCADA application while communicating with the FIC using the Government's standard communication protocol.

3.1.5 Transfer of SCADA Application

The Contractor shall deliver, in electronic format, a fully documented version of the SCADA Application, complete, to the Contracting Officer for integration in the Government's overall SCADA Application. The Government will perform the final integration of the SCADA Application project prepared for this work.

3.2 EQUIPMENT INSTALLATION REQUIREMENTS

3.2.1 Installation

Install system components and appurtenances in accordance with the manufacturer's instructions and shall provide necessary interconnections, services, and adjustments required for a complete and operable system. Instrumentation and communication equipment and cable grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Adjust or replace devices not conforming to the required accuracies. Factory sealed devices shall be replaced (rather than adjusted). Wiring in exposed areas, including low voltage wiring, shall be installed in metallic raceways or EMT conduit as specified in Division 26 ELECTRICAL. Wiring in air plenum areas installed without conduit shall be plenum-rated in accordance with NFPA 70.

3.2.1.1 Isolation, Penetrations and Clearance from Equipment

Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exteriors shall be made watertight. Holes in concrete, brick, steel and wood walls shall be drilled or core drilled with proper equipment; conduits installed through openings shall be sealed with materials which are compatible with existing materials. Openings shall be sealed with materials which meet the requirements of NFPA 70. Installation shall provide clearance for control-system maintenance. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.1.2 Device Mounting

Devices shall be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed in piping shall be provided with required gaskets, flanges, thermal compounds,

insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Any deviations shall be documented and submitted to the Government for approval prior to mounting. Damaged insulation shall be replaced or repaired after devices are installed to match existing work. Damaged galvanized surfaces shall be repaired by touching up with zinc paint.

3.3 INSTALLATION OF EQUIPMENT

Install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational control system.

3.3.1 Control Panels

Control panels shall be located as indicated on the drawings. Devices located in the control panels shall be as shown on the drawings or as needed to provide the indicated control sequences.

3.3.2 Flow Measuring Device

Fluid flow instruments shall be installed in accordance with manufacturer's recommendations, unless otherwise indicated in the specification. The minimum straight unobstructed piping for the flowmeter installation shall be 10.0 pipe diameters upstream and 5.0 pipe diameters downstream. Meters for gases and vapors shall be installed in vertical piping, and meters for liquids shall be installed in horizontal piping, unless otherwise recommended by the manufacturer or indicated in the specifications.

3.3.2.1 Turbine Meters

Turbine meters shall be installed so that the sensor is located in the center of the fluid flow pipe on the main axis. The minimum straight unobstructed piping for the flow meter installation shall be 10 pipe diameters upstream and 5 pipe diameters downstream.

3.3.2.2 Venturi Flowmeter

The flowmeter shall be installed with its top above the pipeline in horizontal pipe run installations. The direction of flow shall be upward in vertical pipe run installations. The flowmeter shall be aligned to the direction of the flow and shall be rigidly mounted and vibration free. The minimum straight unobstructed piping for the flow meter installation shall be 10 pipe diameters upstream and 5 pipe diameters downstream.

3.3.3 Level Instruments

Level instruments shall be installed in accordance with manufacturer's recommendations, unless otherwise indicated in the specifications.

3.3.3.1 Non-Mercury Float Switches

Switches shall be mounted in accordance with manufacturer's published instructions. Procedures shall be those used for equipment in hazardous locations.

3.3.3.2 Ultrasonic Sensor

Sensor shall be installed vertically in the top of the tank and in

accordance with the manufacturer's instructions. Switches shall be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket shall be provided for connection to the inside tank wall. Sensor shall be positioned to maximize the return echo signal and minimize vessel obstructions in the sensors line of sight. The minimum recommended distance from the tank fill opening and from the side of the tank shall be maintained .

3.3.4 Pressure Instruments

Pressure sensors and pressure transducers shall be verified by calibration. All pressure taps shall incorporate appropriate snubbers. Pressure sensors and pressure switches shall have valves for isolation, venting, and taps for calibration. Pressure switches and pressure transducers installed on liquid or steam lines shall have drains. Pressure transducers, differential pressure sensors and differential pressure switches shall have nulling valves. Pressure switches shall be adjusted to the proper setpoint and shall be verified by calibration. Switch contact ratings and duty shall be selected for the application.

3.3.5 Process Analytical Instrumentation

3.3.5.1 Water Quality Analyzer

Locate analyzer as shown on the drawings and install in accordance with the manufacturer's installation requirements.

3.3.6 Electric Power Devices

3.3.6.1 Potential and Current Transformers

Install potential and current transformers in enclosures unless otherwise shown. Current transformer leads shall be shorted when they are not connected to the measurement circuits.

3.3.6.2 Hour Meters

Meters shall be located in the control panel or as otherwise shown. Power to the meter shall be connected to the motor starter auxiliary contacts for pumps, blowers and other motor driven devices. For devices without motor starters, the meter shall be connected in parallel with the load. Where the meter voltage differs from the metered devices voltage, transformer shall be provided as necessary.

3.3.6.3 Transducers

Transducers shall be wired in accordance with the manufacturer's instructions, and installed in enclosures.

3.3.7 Output Devices

Output devices (transducers, relays, contactors, or other devices) which are not an integral part of the control panel, shall be mounted in an enclosure mounted adjacent to the control panel, unless otherwise shown. Where H-O-A and/or override switches on the drawings or required by the control sequence, the switches shall be installed so that the control system controls the function through the automatic position and other controls work through the hand position.

3.3.8 Enclosures

All enclosure penetrations shall be from the bottom of the enclosure, and shall be sealed to preclude entry of water using a silicone rubber sealant.

3.3.9 Transformers

Transformers for control voltages 120 vAc or less shall be fed from the nearest power panel or motor control center, using circuits provided for the purpose. Provide a disconnect switch on the primary side and a fuse on the secondary side. Transformers shall be enclosed in a steel cabinet with conduit connections.

3.4 WIRE, CABLE AND CONNECTING HARDWARE

3.4.1 Metering and Sensor Wiring

3.4.1.1 Power Line Surge Protection

Control panels shall be protected from power line surges. Protection shall meet the requirements of IEEE C62.41.1 and IEEE C62.41.2. Fuses shall not be used for surge protection.

3.4.1.2 Sensor and Control Wiring Surge Protection

Digital and analog inputs shall be protected against surges induced on control and sensor wiring. Digital and analog outputs shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. Fuses shall not be used for surge protection.

3.5 CONTROL DRAWINGS

Provide control drawings, reproducible, with corresponding CADD files for equipment furnished and for interfaces to equipment at each respective equipment location. 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 manually shall be prepared in typed form, reproducible, with corresponding word processor files and posted beside the diagrams. Diagrams and instructions shall be submitted prior to posting.

3.6 FIELD TESTING AND ADJUSTING EQUIPMENT

Provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Government will witness the PVT, and written permission shall be obtained from the Government before proceeding with the testing. Original copies of data produced, including results of each test procedure, during PVT shall be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test. The test procedures shall cover actual equipment and functions specified for the project.

3.6.1 Testing, Adjusting and Commissioning

Upon completion of the installation, test, adjust, and commission each control loop and system in accordance with NIST SP 250 and shall verify proper operation of each item in the sequences of operation, including hardware and software. Calibrate field equipment, including control

devices, adjust control parameters and logic (virtual) points including control loop setpoints, gain constants, constraints, and verify data communications before the system is placed online. Test installed ground rods as specified in IEEE Std 142. Calibrate each instrumentation device connected to the control system control network by making a comparison between the reading at the device and the display at the workstation, using a standard at least twice as accurate as the device to be calibrated. Verify operation of systems in the specified failure modes upon Control system network failure or loss of power, and verify that systems return to control system control automatically upon a resumption of control system network operation or return of power. Deliver a report describing results of functional tests, diagnostics, calibrations and commissioning procedures including written certification to the Government that the installed complete system has been calibrated, tested, adjusted and commissioned and is ready to begin the PVT. The report shall also include a copy of the approved PVT procedure.

3.6.2 Performance Verification Test (PVT)

Prepare test procedures for the PVT. The test procedure shall describe all tests to be performed and other pertinent information such as specialized test equipment required and the length of the PVT. The test procedures shall explain, in detail, step-by-step actions and the expected results, to demonstrate compliance with all the requirements of the drawings and this specification. The test procedure shall be site specific and based on the inputs and outputs, required calculated points and the sequence of control. Demonstrate that the completed Control system complies with the contract requirements. All physical and functional requirements of the project including communication requirements shall be demonstrated and shown. Demonstrate that each system operates as required in the sequence of operation. The PVT as specified shall not be started until after receipt by the Contractor of written permission by the Government, based on the Contractor's written report including certification of successful completion of testing, adjusting and commissioning as specified, and upon successful completion of training as specified. Upon successful completion of the PVT, deliver test reports and other documentation as specified to the Government.

3.7 MANUFACTURERS' FIELD SERVICES

Obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of the equipment.

3.8 FIELD TRAINING

Field training oriented to the specific system shall be provided for designated personnel. A copy of the training manual for each trainee plus two additional copies shall be delivered to the Contracting Officer. Manuals shall include an agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Furnish audiovisual equipment and other training supplies and materials. Copies of the audiovisuals shall be delivered with the printed training manuals. The Government reserves the right to videotape training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. Approval of the Contractor's training schedule shall be obtained from the Government at least 30 days before the

training.

3.8.1 Preliminary Operator Training

Prior to the start of field testing, preliminary operator training shall be taught at the project site for one training day. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include: general system architecture; functional operation of the system, including workstations; operator commands; application programs, control sequences, and control loops; database entry and modification; reports generation; alarm reporting; diagnostics; and historical files.

3.8.2 Additional Operator Training

Following the field testing, provide one 4-hour classroom instruction session for operator questions and training consisting of one 2-hour morning session and one 2-hour afternoon session. Instruction shall consist of "hands-on" training under the constant monitoring of the instructor. Classroom training shall include instruction on the specific hardware configuration of the installed control system and specific instructions for operating the installed system.

Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed control system. Each student should be able to start the system, operate the system, recover the system after a failure and describe the specific hardware architecture and operation of the system and be fully proficient in all system operations.

Report the skill level of each student at the end of this course.

3.8.3 Maintenance Training

Provide one 4-hour training session by a factory representative or a qualified Contractor trainer on maintenance of the equipment. The training shall include: physical layout of each piece of hardware, calibration procedures, preventive maintenance procedures, schedules, troubleshooting, diagnostic procedures and repair instructions.

3.9 ATTACHMENTS

3.9.1 Control Narratives

General: This section covers functions to be implemented at the project as a whole. These functions pertain to the coverall display and handling of data/events.

FIC Operator Interface

Display Alarm and Status events received as discrete inputs.

Display all monitored parameters received as analog inputs.

Provide LOCAL/REMOTE indication. LOCAL operations means control at the process equipment only. REMOTE operation means remote control via RTU only.

SCADA Application Display:

Display Alarm and Status events received as discrete inputs. Display all monitored parameters received as analog inputs. Provide LOCAL/REMOTE indication.

FIC Program Features:

Maintain all Operator entered values (i.e. set points, process, warnings, alarms, and notices).

Maintain Operator control commands (i.e. manual/automatic mode) control.

Upon restoration of power hold all valves at last position and STOP motors. Confirm that the motors have come to a complete stop and all instruments have completed their initialization. Restart the process in a controlled sequence. The sequence will be provided by the Contracting Officer. Restore control to meet current operating conditions and operator setpoint values. Maintain setpoint at values entered before power loss.

Maintain all ALARM and FAIL conditions until the alarming event has cleared and the condition is manually RESET local to the FIC.

Common Control Functions:

Below is a description of control function(s) to be used throughout the project regardless of unit process assignment. Where required, these functions will be referenced in the Sequence of Operation by the title(s) provided below. Implement the control functions in the FIC and implement the Operator Interface requirements both at the FIC Operator Interface Unit and the SCADA Application.

START/STOP Motor Control, Non-Reversing:

FIC Operator Interface

START/STOP/AUTO selection
ON/OFF status indication
FAIL alarm event

SCADA Application Display

ON/OFF status indication
FAIL alarm event

FIC Control Functions

Manual Mode: Continuously operate the motor whenever the START/STOP selector is in the START mode. Stop motor operation whenever the START/STOP selector is in the STOP mode. STOP the motor whenever a FAIL alarm event occurs (see below).

AUTO mode: START/STOP the motor in response to internal command signal. Command signal will be identified in Sequence of Operation. STOP the motor whenever a FAIL alarm event occurs (see below).

Establish a FAIL event when any of the following occur:

The START/STOP status is not achieved with an adjustable delay after the START/STOP command is issued.

Suction pressure is below a preset value for an operator adjustable period of time.

Differential pressure across the pump exceeds a preset value for an operator adjustable period of time.

The starter has a fail or fault condition.

3.9.2 Instrumentation List

Comp. Code	Tag No.	Component Title	Options	Installation Detail No.
A300		Ultraviolet Absorbance Analyzer and Transmitter	Process Variable & Range:	
			Free Ammonia: 0 - 5 mg/l	
			Mono-Chloramine: 0 to 5 mg/l	
			Total Free Chlorine: 0 to 5 mg/l	
			Mounting: As Specified	
			Process Liquid: Potable Water	

Comp. Code	Tag No.	Component Title	Options	Install-ation Detail No.
L5	20LIT-1B	Level Element and Transmitter, Ultrasonic	Range: 0 to 30 feet	13383A
			Connection: Flanged	13383B
			Element Material: PVDF	
			Process Liquid: Potable Water	
L8	20LSHH-1	Level Float Switch	Cable Length: 50 feet,	13248
	20LSH-1		Set Point: Coordinate In Field	
	20LSL-1		Mounting: Suspended	
	20LSLL-1		Process Liquid: Potable Water	
			Options: NSF 61 Certified	
P4	30PI-XA	Pressure Gauge	Range: 0 to 30 psig	
	X = 1 - 2		Mounting: As Specified	
			Dial Size: As Specified	
			Case Material: As Specified	
			Element Material: As Specified	
			Damping: Not Required	
			Process Liquid: Potable Water	
P4	30PI-XB	Pressure Gauge	Range: 0 to 160 psig	
	X = 1 - 2		Mounting: As Specified	
			Dial Size: As Specified	
			Case Material: As Specified	
			Element Material: As	
			Damping: Not required	
			Process Liquid: Potable Water	

Comp. Code	Tag No.	Component Title	Options	Installation Detail No.
P8	30PSL-X X = 1 - 2	Pressure Switch, Fixed Differential	Set Point: Field Diaphragm Material: As Specified Stem Material: As Specified Process Liquid: Potable Options: NSF 61 Certified	
P12	30PDSH-X X = 1 - 2	Differential Pressure Switch, Fixed Differential	Set Point: Field Adjustable Diaphragm Material: As Specified Stem Material: As Specified Process Liquid: Potable Water Options: NSF 61 Certified	
F28	35FIT-1	Flow Element and Transmitter, Turbine	Range: 5 to 450 gpm Line Size: 3-inch Process Liquid: Potable Water Unit Digit: 1,000 gallons Options: NSF 61 Certified	

Comp. Code	Tag No.	Component Title	Options	Install-ation Detail No.
P4	40PI-XA	Pressure Gauge	Range: 0 to 30 psig	
	X = 1 - 3		Mounting: As Specified	
			Dial Size: As Specified	
			Case Material: As Specified	
			Element Material: As Specified	
			Damping: Not Required	
			Process Liquid: Potable Water	
P4	40PI-XB	Pressure Gauge	Range: 0 to 160 psig	
	X = 1 - 3		Mounting: As Specified	
			Dial Size: As Specified	
			Case Material: As Specified	
			Element Material: As Specified	
			Damping: Not Required	
			Process Liquid: Potable Water	

Comp. Code	Tag No.	Component Title	Options	Installation Detail No.
P8	40PSL-X	Pressure Switch, Fixed Differential	Set Point: Field Adjustable	
	X = 1 - 3		Diaphragm Material: As Specified	
			Stem Material: As Specified	
			Process Liquid: Potable Water	
			Options: NSF 61 Certified	
P12	40PDSH-X	Differential Pressure Switch, Fixed Differential	Set Point: Field Adjustable	
	X = 1 - 3		Diaphragm Material: As Specified	
			Stem Material: As Specified	
			Process Liquid: Potable Water	
			Options: NSF 61 Certified	

Comp. Code	Tag No.	Component Title	Options	Installation Detail No.
F9	45FE-1	Flow Element, Venturi Tube, Insert	Range: 1,000 to 10,000 gpm Max Pressure Diff: 120 Throat Size: 12.06-inch Line Size: 20-inch Process Liquid: Potable Options: NSF 61 Certified	
P3	45FIT-1	Pressure Differential Transmitter	Range: 1.0 to 120 in WC Square Root Extraction: Zero: N/A Process Liquid: Potable Water Mounting: Pipe Mount Options: NSF 61 Certified	
P9	45PIT-1	Pressure Transmitter, Electronic	Range: 0 to 150 psig Mounting: As Specified Process Liquid: Potable Water Options: NSF 61 Certified	
P8	45PSL-1A	Pressure Switch, Fixed Differential	Set Point: Field Adjustable Diaphragm Material: As Specified Stem Material: As Specified Process Liquid: Potable Water Options: NSF 61 Certified	

Comp. Code	Tag No.	Component Title	Options	Installation Detail No.
F18		Flow Element & Transmitter, Propeller	Range: 150 to 1,500 gpm	
			Line Size: 16-inch	
			Process Liquid: Potable Water	
			Unit Digit: 1,000 gallons	
			Options: Bi-Directional Register, NSF 61 Certified	

3.9.3 PLC Input/Output List

Tag Number	Type	I/O	Description	PLC Register	Notes
W-5 Pump Station Field Interface Controller (FIC)					
10FCV-1 {Activate}	DISCRETE	OUTPUT	Ground Storage Tank Flow Control Valve Activate		
20LIT-1B	ANALOG	INPUT	Water Level, Ground Storage Tank		
20LSHH-1	DISCRETE	INPUT	Water Level HIGH HIGH, Ground Storage Tank		
20LSH-1	DISCRETE	INPUT	Water Level HIGH, Ground Storage Tank		
20LSL-1	DISCRETE	INPUT	Water Level LOW, Ground Storage Tank		
20LSLL-1	DISCRETE	INPUT	Water Level LOW LOW, Ground Storage Tank		
30 PSL-1	DISCRETE	INPUT	Suction Pressure LOW, Jockey Pump No. 1		
30 PDSH-1	DISCRETE	INPUT	Total Develop Head Pressure HIGH, Jockey Pump No. 1		
30QA-1 {PUMP FAIL}	DISCRETE	INPUT	Pump System FAULT, Jockey Pump No. 1		
30 HS-1 {RUN}	DISCRETE	OUTPUT	Pump System RUN Command, Jockey Pump No. 1		
30QS-1 {RUN}	DISCRETE	INPUT	Pump System RUN Status, Jockey Pump No. 1		
30 QS-1 {LOCAL}	DISCRETE	INPUT	Pump System In LOCAL Control Mode, Jockey Pump No. 1		
30 PSL-2	DISCRETE	INPUT	Suction Pressure LOW, Jockey Pump No. 2		
30PDSH-2	DISCRETE	INPUT	Total Develop Head Pressure HIGH, Jockey Pump No. 2		

Tag Number	Type	I/O	Description	PLC Register	Notes
30QA-2 {PUMP FAIL}	DISCRETE	INPUT	Pump System FAULT, Jockey Pump No. 2		
30 HS-2 {RUN}	DISCRETE	OUTPUT	Pump System RUN Command, Jockey Pump No. 2		
30QS-2 {RUN}	DISCRETE	INPUT	Pump System RUN Status, Jockey Pump No. 2		
30QS-2 {LOCAL}	DISCRETE	INPUT	Pump System in LOCAL Control Mode, Jockey Pump No. 2		
35LSH-1	DISCRETE	INPUT	Water Level High, Hydropneumatic Tank		
35LSL-1	DISCRETE	INPUT	Water Level Low, Hydropneumatic Tank		
35FIT-1	ANALOG	INPUT	Water Flow Rate, Cooling Towers		
35QA-1 {FAIL}	DISCRETE	INPUT	Compressor System FAULT, Hydropneumatic Tank		
40QA-1 {PUMP FAIL}	DISCRETE	INPUT	Pump System FAULT, High Service Pump No. 1		
40QA-1 {SSRV FAULT}	DISCRETE	INPUT	Pump Starter FAULT, High Service Pump No. 1		
40HS-1{RUN}	DISCRETE	OUTPUT	Pump System RUN Command, High Service Pump No. 1		
40QS-1 {RUN}	DISCRETE	INPUT	Pump System RUN Status, High Service Pump No. 1		
40QS-1 {LOCAL}	DISCRETE	INPUT	Pump System in LOCAL Control Mode, High Service Pump No. 1		
40PSL-2	DISCRETE	INPUT	Suction Pressure LOW, High Service Pump No. 2		
40PDSH-2	DISCRETE	INPUT	Total Develop Head Pressure High, High Service Pump No. 2		
40QA-2 {PUMP FAIL}	DISCRETE	INPUT	Pump System FAULT, High Service No. 2		

Tag Number	Type	I/O	Description	PLC Register	Notes
40QA-2 {SSRV FAULT}	DISCRETE	INPUT	Pump Starter FAULT, High Service No. 2		
40HS-2 {RUN}	DISCRETE	OUTPUT	Pump System RUN Command, High Service Pump No. 2		
40QS-2 {RUN}	DISCRETE	INPUT	Pump System RUN Status, High Service Pump No. 2		
40QS-2 {LOCAL}	DISCRETE	INPUT	Pump System in LOCAL Control Mode, High Service Pump No. 2		
40PSL-3	DISCRETE	INPUT	Suction Pressure LOW, High Service Pump No. 3		
40PDSH-3	DISCRETE	INPUT	Total Develop Head Pressure HIGH, High Service Pump No. 3		
40QA-3 {PUMP FAIL}	DISCRETE	INPUT	Pump System FAULT, High Service Pump No. 3		
40QA-3 {SSRV FAULT}	DISCRETE	INPUT	Pump Starter FAULT, High Service Pump No. 3		
40HS-3 {RUN}	DISCRETE	OUTPUT	Pump System RUN Command, High Service Pump No. 3		
40QS-3 {RUN}	DISCRETE	INPUT	Pump System RUN Status, High Service Pump No. 3		
40QS-3 {LOCAL}	DISCRETE	INPUT	Pump System in LOCAL Control Mode, High Service Pump No. 3		
45FIT-1	ANALOG	INPUT	Water Flow Rate, Distribution		
45PIT-1	ANALOG	INPUT	Pressure, Distribution		
40PSL-1A	DISCRETE	INPUT	Pressure LOW, Distribution		
	DISCRETE	INPUT	AC Power Off		

Tag Number	Type	I/O	Description	PLC Register	Notes
	DISCRETE	INPUT	Battery Low		
	DISCRETE	INPUT	NOT CLOSED Status, SLF & SATURN V Pressure Control Valve		
	DISCRETE	INPUT	Electrical Room Temperature HIGH		
Schwartz Road Water Quality Monitoring Field Interface Controller (FIC)					
60AIT-1 {TCL}	ANALOG	INPUT	Total Chlorine Residual		
60AIT-1 {NH_3}	ANALOG	INPUT	Total Free Ammonia Residual		
60AIT-1 NH_4 OCL}	ANALOG	INPUT	Total Mono Chloramine Residual		
	DISCRETE	INPUT	AC Power Off		
	DISCRETE	INPUT	Battery Low		

3.9.4 Component Specifications

A. A300 Ultraviolet Absorbance Analyzer and Transmitter:

1. General:

a. Function: Online Ultraviolet Absorbance Analysis.
b. Parts: Analyzer and Transmitter.

2. Performance:

a. Wavelength: 256nm.
b. Spectral Range: 200 to 450 nm.
c. Resolution: 0.5 percent of full scale.
d. Accuracy: 5 percent, plus or minus of full scale.
e. Response Time: User electable updated from 5 to 9999 minutes.
f. Operating Temperature: 32 to 122 degrees F

3. Analyzer/Transmitter:

a. Dynamic Range: 200 to 400 microns.

b. Sample Flow Rate: 0.132 to 0.40 gpm.
c. Sample Pressure, required: 10 psig minimum.
d. Operator Interface:
(1) Display: 2-line. 20-character backlit LCD.
(2) Data Entry: 4-by-4 keypad.
e. Enclosure:
(1) Suitable for wall mounting.
(2) NEMA 4X IP66, for electronics.
(3) NEMA 3R, for flow cell.
(4) Dimensions: 40 inches high by 20 inches wide by 12 inches deep, nominal.
f. Signal Interface:
(1) 4- to 20-mA DC isolated analog outputs; one per monitored parameter.
(2) Optional RS 232 serial using Modbus protocol.
g. Power: 115 volts AC, 3-wire grounded.

4. Manufacturer and Product:

a. Applied Spectrometry Associates, Inc.; Chemscan® UV 2150S Process Analyzer.
b. Or approved equal.

B. F9 Flow Element, Venturi Tube, Insert:

1. General:

a. Function: Provide differential pressure signal that is square of flow.
b. Type: Venturi type differential pressure producer, with entrance and exit cones, using pressure sensed at throat and inlet.

2. Service:

a. Fluid: Water unless otherwise noted.
b. Temperature: For water, 150 degrees F maximum upstream unless otherwise noted.

3. Performance:

a. Range: As noted.
b. Pressure Differential at Full Scale Flow: Approximately as noted.
c. Maximum Head Loss: Head loss at full scale flow, 10 percent of differential, approximately as noted.
d. Accuracy: Plus or minus 1 percent maximum over the flow range, uncalibrated.

4. Supporting Calculations:

a. Verify actual pipe inner diameter at submittal time.
b. Actual pressure differential and head loss.
c. Throat pressure and fluid saturation pressure for hot water or volatile fluids to show that cavitation will not occur.

5. Features:

a. Size: As noted.
b. Materials:

(1) Body: Thermosetting polyester resin reinforced with fiberglass.
(2) Throat: Integrally molded fiberglass or 304 stainless steel unless otherwise noted.
(3) Pressure Connection Bushing: Stainless steel, marked as "HIGH" and "LOW."
c. Pressure Rating: Meet or exceed flange rating.
d. Nameplate: Permanent stainless steel engraved with tag number, pipe inside diameter, throat inside diameter, flange size, and pressure rating and flow direction.

6. Process Connections:

a. Line Size: As noted. Verify actual pipe ID at submittal time.
b. Connection Type: 150-pound ANSI flange unless otherwise noted.
c. Connection Material: Integrally molded fiberglass or carbon steel unless otherwise noted.

7. Pressure Tap Connections:

a. Materials: Alloy 20 stainless steel, epoxy coated.
b. Diameter: 3/4-inch unless otherwise noted.
c. All necessary tubing, valves, and accessories between flow element and transmitter to be provided by the Contractor.

8. Manufacturer:

a. Primary Flow Signal; HVT.
b. BIF Model 20182.
c. Or approved equal.

C. F18 Flow Element and Transmitter, Propeller:

1. General:

a. Function: Measure flow rate of a process liquid.
b. Type: AWWA C704 propeller meter with magnetic coupled drive.

2. Service:

a. Fluid: Water or filtered wastewater.
b. Pressure: 150 psi standard, 250 psi when noted.
c. Temperature: 100 degrees F maximum.
d. Flow Direction: Bi-directional measurement when noted.

3. Performance:

a. Accuracy: Plus or minus 2 percent of flow rate.

4. Element:

a. Materials:
(1) Cover Plate: Carbon Steel.
(2) Propeller: High temperature thermoplastic.
(3) Impeller Shaft: 316 stainless steel.
(4) Bearings: Stainless steel.
b. Mounting:
(1) Type: In-line tube.
(2) Materials: Stainless steel.

c. Line Size: As noted.
d. Process Connections: AWWA 150-pound flanged end connections.

5. Totalizer:

a. Type: Six-digit, nonreset.
b. Unit Digit Value: As noted.

6. Indicator:

a. Type: Digital display
b. Scale Range: As noted.

7. Transmitter

a. Performance:
(1) Accuracy: 0.5 percent of full scale.
b. Type: Two-wire, requiring external dc power supply.
c. Signal Interface:
(1) Output: 4 to 20 mA dc for load impedance 0 to 400 ohms minimum for 24V dc supply without load adjustments.
d. Enclosure: Type: NEMA 4X

8. Manufacturers:

a. Sparling; Model FM104 with stainless steel wetted parts with a Series FT194 meter head.
b. McCrometer; Series MW500, with FC100 Series transmitter.

D. F-28 Class II Turbine Meter

1. General: All meters furnished shall be manufactured by a registered ISO 9001 quality standard facility.

2. Type: Meters shall be of the in-line, horizontal axis type in accordance with AWWA Class II meeting or exceeding the requirements of AWWA C701.

3. Capacity:

Size (inches)	Normal Flow Range (gpm)	Max Continuous flow (gpm)	Max Head Loss at Max Cont Flow (psi)	Max Intermittent Flow (gpm)
3	5-450	450	5	560
4	10-1200	1200	5.5	1500
6	20-2500	2500	5	3100
8	35-4000	4000	5	5000
10	50-6500	6500	3.5	8000

4. Case and Cover: The main case and cover shall be ANSI/NSF 61 certified no-lead alloy, containing a minimum of 85 percent copper. Main case or cover casting shall display meter size, model, and arrows indicating direction of flow using raised characters.

5. External Bolts: Casing bolts shall be AISI 316 stainless-steel.

6. Pipeline Connections: Meter line connections shall be flanged in compliance with requirements of AWWA C701.

7. Register: Registers shall be permanently rolled-sealed, straight-reading, indicating in gallons. A center sweep hand shall display the instantaneous flow rate, and a six-digit numerical display shall display the total flow. The register shall have a glass lens. Registers shall be serviceable without interrupting meter's operation.

8. Transmitter: Provide the meter assembly complete with a 2-wire device suitable to transmit the instantaneous flow rate as a 4 to 20 mA signal. The transmitter shall mount between the meter register and turbine measuring assembly. The meter assembly, complete, shall meet or exceed the requirements of AWWA C706.

9. Accuracy: The meter register and transmitter shall provide representative readings of the measured flow accurate to 0.5 percent of full scale.

10. Manufacturer and Model: Neptune Cold Water Meter Class II Turbine Type with Tricon/E® 3 transmitter, or approved equal.

E. L5 Level Element and Transmitter, Ultrasonic:

1. General:

a. Function: Provide continuous non-contacting level measurement with output proportional to level being sensed.
b. Type: Ultrasonic.
c. Parts: Integral level element and transmitter.

2. Service:

a. Medium: Liquids.
b. Pressure: 7.25 psig maximum.
c. Temperature Range: Operating within a range of minus 40 to 176 degrees F.

3. Performance:

a. Range: As noted.
b. Zero Reference: As noted.
c. Sonic Frequency: 54 Hz.
d. Accuracy: Plus or minus the greater of 0.15 percent of range or 0.24-inches.
e. Resolution: Less than 3 mm.
f. Repeatability: Less than 3 mm.
g. Blanking Distance: 10-inches.
h. Update time: less than 5 seconds.

4. Features:

a. Display: Integral, multi-segment display providing the following:
(1) Programmable primary variable:
(a) Alphanumeric.

(b) Multi-segment bar graph.
(2) Primary variable engineering units.
(3) Sonic echo status.
(4) Programmable auxiliary variable with engineering units. Must support signal current at a minimum.
b. Process Connections: As noted.
c. Materials of Construction:
(1) Probe Head: Polybutylene Terephthalate (PBT).
(2) Probe Element: As noted.
d. Environmental Rating: NEMA 4/4x.

5. Signal Interface:

a. Output: 4- to 20-mA dc signal for load impedance 0 to 500 ohm minimum for 24V dc supply without load adjustments.
b. Digital process variable signal superimposed on 4- to 20-mA signal; using HART ® protocol.

6. Manufacturers:

a. Siemens; SITRAN Probe LU.
b. Or Equal.

F. L8 Level Switch, Float:

1. General:

a. Function: Actuate contact at preset liquid level.
b. Type: Direct-acting mercury free float with integral cable.

2. Service:

a. Liquid: Water, wastewater, unless otherwise noted.
b. Pressure: Atmospheric.
c. Temperature: 0 to 50 degrees C.

3. Performance:

a. Set Point: As noted.
b. Differential: 1-inch maximum.
c. Temperature: 0 to 180 degrees F.

4. Features:

a. Entire Assembly: Watertight and impact-resistant.
b. Float Material and Size: Polyethylene/foam filled; 4.5-inch diameter tear drop.
c. Cable:
(1) Combination support and signal.
(2) Length as noted or as necessary per mounting requirements.
(3) Type SO nitrile PVC jacket, AWG No. 18/2 or No. 18/4.
d. Mounting: Pipe (or) suspended as noted.
e. Pipe:
(1) Cable-to-pipe clamp, corrosion-proof cable for 1-inch pipe.
(2) Pipe-to-wall bracket for 1-inch pipe.

5. Signal Interface:

a. Switch Type: Mercury tilt.
b. Switch Contacts:
(1) Isolated, rated 4.5 continuous at 120V ac.
(2) As required (for example 1NO, 1NO=1NC) to meet functional requirements, or as shown.

6. Manufacturers and Products:

a. Consolidated Electric Co., Model LS.
b. Anchor Scientific: Toto-Float, Type P/Type S.

G. P3 Pressure Differential Transmitter, Electronic:

1. General:

a. Function: Measure differential pressure and transmit signal proportional to differential pressure, flow, or level.
b. Type: Electronic variable capacitance, two-wire transmitter.
c. Parts: Transmitter and three-valve manifold.

2. Performance:

a. Range: As noted.
b. Maximum Adjustable Range: So that the noted range shall be between 40 and 80 percent of the maximum range.
c. Accuracy: Plus or minus 0.075 percent of calibrated span between 4 and 100 percent of input differential pressure.
d. Temperature: Operating range minus 20 degrees F to plus 150 degrees F, minimum.

3. Features:

a. Square Root Extraction: When noted.
b. Damping: Fluid or electronic type with adjustment.
c. Indicator: To match range.
d. Suppressed or Elevated Zero: When noted.
e. Materials: Wetted parts including process flanges and drain/vent valves, 316 stainless steel, unless otherwise noted.
f. Wetted O-Rings: Viton, unless otherwise noted.
g. Housing: Modular with separate compartments for electronics and field connections.
h. Fill Fluid: Silicone, unless otherwise noted.

4. Signal Interface:

a. 4- to 20-mA dc output for load impedance of 0 to 500 ohms minimum without load adjustment with 24V dc supply.
b. Digital process variable signal superimposed on 4- to 20-mA signal; using HART ® protocol.

5. Enclosure:

a. Type: NEMA 4X suitable for temporary submergence, unless otherwise noted.

6. Mounting: Pipe or wall as noted. Provide brackets with Series 300 stainless steel bolts.

7. Three-Valve Manifold:

a. Provide unless otherwise noted.
b. Materials: 316 stainless steel.

8. Manufacturers:

a. Rosemount; Model 3051CD, SMART transmitter.
b. Or Equal.

H. P4 Pressure Gauge:

1. General:

a. Function: Pressure indication.
b. Type:
(1) Direct reading bellows for ranges below 10 psig.
(2) Bourdon tube actuated for ranges 10 psig and above.

2. Performance:

a. Range: As noted. Compound scale when noted.
b. Accuracy: Plus or minus 0.5 percent of span.

3. Features:

a. Mounting: Lower stem, unless otherwise noted.
b. Dial: 4-1/2-inch diameter, unless otherwise noted.
c. Case Material: Phenolic plastic, unless otherwise noted.
d. Element Material: Phosphor-bronze, unless otherwise noted.
e. Dampening: Pulsation dampener when noted, piston type with multiple choice of piston placement to vary the desired amount of dampening.
f. Case Type: Solid front design with solid wall between window and element. Rear of case, gasketed pressure relief.
g. Pointer: Micrometer pointer with self-locking adjustment.
h. Movement: Stainless steel, rotary geared.

4. Process Connection:

a. Line Size: 1/2 inch.
b. Connection Type: Threaded.

5. Manufacturers:

a. Bellows Type: Ashcroft; General Service Series 1180, or equal.
b. Bourdon Tube Type: Ashcroft Duragauge Model 1279/1379, or equal.

I. P-8 Pressure Switch, Fixed Dead Band:

1. General:

a. Function: Monitor pressure and provide contact closure(s) when pressure is above/below set point, as noted.
b. Type: Diaphragm sealed piston actuator.

2. Performance:

a. Set Point: As noted.
b. Adjustable over full range.
c. Set as noted.
d. Range: The noted set point shall fall between 30 percent and 70 percent of the range.
e. Set Point Repeatability: Plus or minus 1 percent of range.

3. Features:

a. Diaphragm Material: Suitable for Process Liquid, Buna-N, minimum.
b. Pressure Connection: Type 304 Stainless Steel, unless otherwise noted.
c. Reset: Automatic, unless otherwise noted.

4. Enclosure: NEMA 4X, unless otherwise noted.

5. Signal Interface:

a. Contact Type: SPDT, snap action switch, rated for 15 amps at 120V ac.
b. Number of Switch Elements: One, unless otherwise noted.

6. Manufacturer and Model:

a. Ashcroft; B-Series.
b. United Electric Controls; 100 Series.
c. Or Equal.

J. P9 Pressure Transmitter, Electronic:

1. General:

a. Function: Measure pressure and transmit signal proportional to pressure or level.
b. Type: Electronic variable capacitance, two-wire transmitter.

2. Performance:

a. Range: As noted.
b. Maximum Adjustable Range: Such that the noted range shall lie between 40 and 80 percent of the maximum adjustable range.
c. Accuracy: Plus or minus 0.075 percent of calibrated span.
d. Temperature: Minus 20 degrees F to plus 200 degrees F, minimum.

3. Features:

a. Type: Gauge pressure, unless otherwise noted.
b. Damping: Fluid or electronic type with adjustment.
c. Indicator: When scale range is noted.
d. Suppressed or Elevated Zero: When noted.
e. Materials: Wetted parts including process flanges and drain/vent valves, 316 stainless steel, unless otherwise noted.
f. Wetted O-Rings: Viton, unless otherwise noted.
g. Housing: Modular with separate compartments for electronics and field connections.
h. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:

a. Line Size: 1/2 inch or 1/4 inch, selectable.
b. Connection Type: FNPT.

5. Signal Interface:

a. 4- to 20-mA dc output for load impedance of 0 to 500 ohms minimum without load adjustment with 24V dc supply.
b. Digital process variable signal superimposed on 4- to 20-mA signal; support HART protocol.

6. Enclosure:

a. Type: NEMA 4X, suitable for temporary submergence, unless otherwise noted.
b. Mounting: Pipe or wall as noted. Provide brackets with Series 300 stainless steel bolts.

7. Manufacturers:

a. Gauge Pressure Units: Rosemount; Alphaline, Model 3051 CG, SMART transmitter.
b. Absolute Pressure Units: Rosemount; Alphaline, Model 3051CA, SMART transmitter.

K. P-12 Differential Pressure Switch, Fixed Dead Band:

1. General:

a. Function: Monitor differential pressure and provide contact closure(s) when pressure is above/below set point, as noted.
b. Type: Diaphragm sealed piston actuator.

2. Performance:

a. Set Point: As noted.
b. Adjustable over full range.
c. Set as noted.
d. Range: The noted set point shall fall between 30 percent and 70 percent of the range.
e. Set Point Repeatability: Plus or minus 1 percent of range.

3. Features:

a. Diaphragm Material: Suitable for Process Liquid, Buna-N, minimum.
b. Pressure Connection: Type 304 Stainless Steel, unless otherwise noted.
c. Reset: Automatic, unless otherwise noted.

4. Enclosure: NEMA 4X, unless otherwise noted.

5. Signal Interface:

a. Contact Type: SPDT, snap action switch, rated for 15 amps at 120V ac.
b. Number of Switch Elements: One, unless otherwise noted.

6. Manufacturer and Model:

a. Ashcroft; D-Series.
b. United Electric Controls; 100-K Series.
c. Or Equal.

L. Y40 24 VDC Power Supply with Battery Back Up:

1. General:

a. Function: Converts 120 VAC to regulated 24 VDC power with 24 VDC battery back up during period of complete or partial interruption of incoming power. Unit serves to provide 'trickle-charge' to the battery during period when 120 VAC source is available.
b. Major Parts: Power Supply, sealed battery, and enclosure.

2. Performance:

a. Capacity: Ability to convert 120 VAC source to regulated 24 VDC with up to 10 A continuous current. Unit shall have capacity to provide 'trickle charge' for the battery.
b. Input Power: 120V ac, single phase, 60-Hz unless otherwise noted.
c. Output Power: 10A, 24 VDC, unless otherwise noted.
d. Battery: Two 7 Ah, 12 VDC lead gel back up type, wired in series.

3. Features:

a. Enclosure: Wall-mounted, passively ventilated cabinet, unless otherwise noted.
b. Isolated contact closures, suitable for external interface, to monitor the following conditions:
(1) AC FAIL.
(2) Low Battery.
(3) Battery Supervision.

4. Manufacturers:

a. Altronix, SMP10PMC24X.
b. Or Equal.

M. Y-55 Programmable Logic Controller (PLC)

1. General:

a. Function: Processor with communication ports.
b. Type: Capable of initiating communication
c. Parts: Processor, power supply, battery, I/O chassis, I/O modules and cabling.

2. Processor Features:

a. Central Processing Unit (CPU): Processor: 16 bit, minimum
b. Memory:
c. User Logic: 16 K words
Data: 24 Kbytes
d. Scan Time: Less than 1 msec per 1000 words

3. Communication:

a. Ports:
(1) One (1) RJ-45
(2) One (1) RS-232
b. Protocols
(1) Ethernet
(2) Data Highway (DH-485), DF1, ASCII

4. Diagnostics:

a. As a minimum, the CPU shall monitor the following system failures:
(1) Memory Failure
(2) Input/Output subsystem error
(3) Watchdog timer time out.
b. Upon failure detection, the CPU shall provide a discrete output.

5. Programming:

a. Programming Language: Ladder Logic
b. Minimum Basic Operations:
(1) Binary logic operation
(2) Timers and counters
(3) Shift registers
(4) Drum sequencers.
c. Enhanced Operations:
(1) Four-function integer math
(2) Word shift registers
(3) Word compare
(4) Word move
(5) Two (2) PID controllers, as a minimum

6. Data Input/Output:

a. Discrete Input:
(1) Quantity: 16 Inputs
(2) Type: AC
(3) Nominal Operating Voltage: 24V dc
(4) Status Indication: LED
b. Discrete Output:
(1) Quantity: 16 Outputs
(2) Type: Relay, rated 8.0 amperes continuous at 120V ac.
(3) Nominal Operating Voltage: 24V dc
(4) Status Indication: LED
c. Analog Input, Differential:
(1) Signal Quantity: 8 Inputs
(2) Type: 4 -20 mA
(3) Isolation:
(a) Between Channels: 200 V dc for 1 minute
(b) Between Channel and Ground: 1780V ac for 1 minute
(4) Resolution: 12 bit, minimum
(5) Status Indication: LED

d. Analog Output, Differential:
(1) Signal Quantity: 4 Outputs
(2) Type: 4 -20 mA

(3) Isolation:
(a) Between Channels: 200 V dc for 1 minute
(b) Between Channel and Ground: 1780V ac for 1 minute
(4) Resolution: 12 bit, minimum
(5) Status Indication: LED

7. Environmental Requirements:

a. Mount each PLC, its power supply, and I/O modules inside the specified control panels or as shown on the Drawings.
b. General Specifications

(1) Operating Temperature: 0 to 45 degrees C
(2) Humidity: 5 to 95 percent, non-condensing

8. Power Supply: PLC equipment shall operate on 120V ac, plus or minus 10 percent, single phase, 60-Hz, plus or minus 0.5-Hz power.

9. Manufacturer and Product:

a Allen Bradley SLC 5/05 Processor with Series 1746 I/O System.
b. Or Equal.

N. Y63 Operator Interface Unit:

1. General:

a. Function: Operator interface to PLC.
b. Type: Touchscreen.

2. Environmental:

a. Operating Temperature: 14 to 113 degrees F.
b. Humidity Rating: 10 to 90 percent, non-condensing.

3. Performance:

a. Enclosure:
(1) Size: 7.88 inches wide by 5.7 inches tall, nominally.
(2) Rating: NEMA 4.
b. Display:
(1) Type: 800 x 480 pixel High Definition TFT.
(2) Size: 6.1 inches wide by 3.4 inches tall, nominally.
(3) Backlight: LED; 30,000 hour life minimum.
(4) Brightness: 375 cd/m^2, minimum.
(5) Contrast: 500:1, minimum.
(6) Application Memory: 128 Mbyte Flash, minimum.
c. Touchscreen:
(1) Type: 4-wire, analog.
(2) Resolution: Continuous.
d. Features: Real Time Clock.
e. External Interface:
(1) Communication Ports:
(a) Network Port: RJ-45 EtherNet.
(b) Serial Port 1: RS 232 or RS 485 (DB9S).
(c) Serial Port 2: RS 232 (DB9P).
(d) Serial Port 3: USB.
(2) Communication Rates: 9600 baud, 19.2 kbaud, 38.4 kbaud, 57.6 kbaud, 115.2 kbaud.

f. Electrical Requirements: 24 VDC.
g. Accessories: Configuration software, MS Window compatible.
h. Manufacturer and Model:
(1) Maple Systems, HMI5070TH.
(2) Or approved equal.

O. Y58 Light Interface Unit (LIU), 12 Fiber:

1. General:

a. Function: LIU that interfaces fiber optic cable to electronic equipment.
b. Type: Uses flexible fiber optic cable assemblies (patch cords).
c. Parts: Interconnect center, two connector panels, patch cords, including spares.

2. Features:

a. Interconnect Center:
(1) 12-fiber modular unit.
(2) Two installed 6-fiber capacity connector panels.
(3) Adapters per each connector panel: Six SC compatible single-mode adapters with plastic insert installed.
(4) Wall-mounted.
(5) Strain relief for multiple cables.
b. Fiber Optic Cable Assemblies:
(1) Quantity: As required for application plus two spare zipcord cables per LIU.
(2) Length: As required.
(3) SC Compatible, PC Composite, multimode.
(4) Zipcord cable: 2 fibers per cable.
(5) Fiber type: 62.5 micrometers.
(6) Attenuation (db/km): 3.75/1.5.
(7) Bandwidth (MHz/km): 160/500.

3. Manufacturer and Model:

a. Corning Cable Systems: Wall-Mountable Interconnect Center (WIC).
b. Or Equal.

P. Y87 Media Converter, Ethernet

1. General:

a. Stand alone media converter used to convert 10/100/1000Base TX UTP to 1000Base FX Ethernet.
b. Fiber optic shall be single mode, unless otherwise noted.

2. Power: 12 VDC, 1.25 A unregulated, standard.

3. Physical Characteristics:

a. Physical Dimensions: 3.25 x 4.8 x 1 inches.
b. Connections:
(1) One RJ-45.
(2) One SC pair.
c. Status Indication:

(1) Power ON.
(2) TP (Duplex/Link/Activity).
(3) TP (10 Mbps, 100 Mbps, 1000 Mbps).
(4) LACT (Fiber Link/Active).

d. Enclosure: NEMA 1/IP20.
e. Temperature: 0 to 50 degrees C.
f. Humidity: 5 to 95%, noncondensing.

4. Performance:

a. Communication Protocol: Ethernet (IEEE Std 802.3, IEEE Std 802.3ab, IEEE Std 802.3u, IEEE Std 802.3z.
b. Fiber:
(1) Single Mode 9/125 um.
(2) Light wave length: 1310 nm.
(3) Optic link budget: 15 dB/25 km.
c. Electric link budget: 100 m.

5. Manufacturer and Product:

a. Transition Network, SGFEB10xx-12x.
b. Or Equal.

-- End of Section --