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| APPLICATION | | REVISION HISTORY | | | | | |
|---|---|---|---|---|---|---|---|
| NEXT ASSY | USED ON | PART NO. | ZONE | REV | DESCRIPTION | DATE | APPROVAL |
| | | | | A | Entire Specification Package Has Been Revised | 1-4-12 | |

# TECHNICAL SPECIFICATIONS FOR DRAWING 79K38877 REVISION A

**NASA KSC Export Control Office (ECO)**
**Export/SBU Determination Record**
EDDR#

**TITLE OF DOCUMENT:**

**SENSITIVE BUT UNCLASSIFIED (SBU)**
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| | Yes | No | SBU Reviewer's Signature | Date |
|---|---|---|---|---|
| Document contains SBU? | ☐ | ☒ | PING YU | 12-9-11 |

**EXPORT CONTROL (EC)**
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| ECO Reviewer's Name and Organization | ECO Reviewer's Signature | Date |
|---|---|---|
| PING YU, NASA TA-B3A | | 12-9-11 |

| | EXPORT DETERMINATION (☒ one box only) | |
|---|---|---|
| EAR 99 NLR | ☒ EAR 99 NLR | The information contained in the document is technical in content, but is not technical data as defined by the ITAR or the EAR, and therefore is EAR 99 NLR (no export license required). [General Prohibition Six (Embargo) applies to all items subject to the EAR, i.e. items on the CCL and within EAR 99 NLR. You may not make an export or re-export contrary to the provisions of part 746 (Embargos and Other Special Controls) of the EAR and 22 CFR part 126.1 of the ITAR.] |
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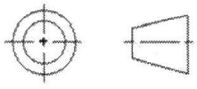
(Stamp Revision: (05-19-2009)

**UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994. TOLERANCES ON:**
FRACTIONS DECIMALS ANGLES

**THIRD ANGLE PROJECTION**



**CAD MAINTAINED. CHANGES SHALL BE INCORPORATED ONLY BY THE DESIGN ACTIVITY.**

| | | |
|---|---|---|
| SOFTWARE | ORIGINAL DATE OF DRAWING (YY/MM/DD) | |
| FILENAME | DRAFTSMAN | CHECKER |
| MATERIAL | ENGINEER | CHECKER |
| HEAT TREATMENT | ENGINEER | STRESS |
| FINAL PROTECTIVE FINISH | ENGINEER | |
| | SUBMITTED | |
| | APPROVED | |

**JOHN F. KENNEDY SPACE CENTER, NASA**
**KENNEDY SPACE CENTER, FLORIDA**

Revitalize Water/Wastewater Systems, Phase 4 - Volume 1 of 5, Volume 2 of 5, Volume 3 of 5, Volume 4 of 5, Volume 5 of 5
DP1 PCN:96968.3

| SIZE | CAGE CODE | DWG NO | REV |
|---|---|---|---|
| A | | 79K38878 | A |
| SCALE | | UNIT WEIGHT | SHEET 1 OF 1077 |

## Architect/Engineer of Record Certification

| | |
|---|---|
| Project Title: | Revitalize Water/Wastewater Systems, Ph 4, DP 1 |
| Project Control Number: | 96968.3 |
| Project Drawing Number: | 79K38877 |
| Project Specification Number: | 79K38878 |
| Project Calculations/Data Manual Number: | KSC-TA-11382 |

| Discipline | Name | ST | License No. | Signature |
|---|---|---|---|---|
| | | | | |
| | | | | |
| Civil | Robert W. Best, Jr. | FL | 69875 | Robert W. Best, Jr. |
| Instrumentation | David P. Fitzgerald | FL | 40976 | David P. Fitzgerald |
| Structural | Wenjun Li | FL | 56104 | Wenjun Li |
| Architecture | Roxana Constantinide | FL | 13445 | Roxana Constantinide |
| Electrical | Michael L. Clark | FL | 48898 | Michael L. Clark |
| Mechanical | Only Sections: 22 11 23.13, 21 13 17.00 10, 42 32 69 | | | |
| | Christopher C. Baggett | FL | 56047 | Christopher C. Baggett |
| Mechanical | All Sections Except: 22 11 23.13, 21 13 17.00 10, 42 32 69 | | | |
| | Robert W. Best, Jr. | FL | 69785 | Robert W. Best, Jr. |
| Environmental | Kim E. Rivera | FL | 65681 | Kim E. Rivera |
| Roadway | Walter A. Nickel | FL | 68638 | Walter A. Nickel |
| | | | | |
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-- End of Section Table of Contents --

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 throughout KSC. 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 automated flushing valves, analyzers, and associated piping and appurtenances in the vicinities of the Shuttle Landing Facility (SLF), the Visitors Information Center (VIC), Launch Complex (LC) -39A, and LC-39B. The purpose is to provide automated flushing based on a timer, water quality, and a hybrid of both time and water quality to reduce the volume of water used for flushing while maintaining chlorine residuals in the system.

3. The work consists of the installation of a new lift station in the vicinity of the Vehicle Assembly Building (VAB), as well as demolishing and replacing existing lift station components at 27 lift stations. Demolition includes, but is not limited to, dismantling, scrapping items, decommissioning utilities, preparation, and disposal. Replacement of components includes, but is not limited to, replacing pumps, valves, control panels, floats, riser pipes, and wet well. The lift station upgrades will include installation of SCADA Telemetry System components to monitor pressure, pump status, and alarms. The work also consists of the replacement of six lift stations in their entirety. The work also consists of the replacement of the control panels and installation of SCADA Telemetry System components to monitor pressure, pump status, and alarms at 26 lift stations.

4. The work includes the installing replacement force mains and associated appurtenances in the Industrial Area and the VAB Area. The work includes installing new HDPE force mains into the existing wastewater collection system, abandoning the existing AC force mains in place, and pipe-bursting the existing iron and plastic force mains.

5. The work includes the repair and replacement of gravity sewer manholes and pipelines in the Industrial Area and the HMF Area.

6. Installing a new booster pump station (BPS), W-1 Pump Station, adjacent to the existing W-1 Pump Station to replace the existing W-1 Pump Station. This project does not include demolishing the existing W-1 Pump Station. The W-1 Pump Station is intended to supplement pressure from the City of Cocoa during average and high demands (i.e., flushing events, fire events).

1.4.2 Location

The work shall be located throughout KSC, 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. 79K38877
Volume 1 of 5 Sheets 1 through 186
Volume 2 of 5 Sheets 1 through 91
Volume 3 of 5 Sheets 1 through 46
Volume 4 of 5 Sheets 1 through 54
Volume 5 of 5 Sheets 1 through 67

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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DIVISION 01 - GENERAL REQUIREMENTS

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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. Pick up and dispose of samples not incorporated into the work in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

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 start of construction (work) issuance of notice to proceed or commencing work on site or the start of the next major phase of the construction on a multi-phase contract. Includes schedules, 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 start of construction work start of construction work 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

Health and safety plan

Work plan

Quality control(QC) plan

Environmental protection plan

SD-02 Shop Drawings

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

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

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

SD-03 Product Data

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

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

SD-04 Samples

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

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

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

SD-05 Design Data

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

Design submittals, design substantiation submittals and extensions of design submittals.

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 MSDS concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must be

signed by an authorized official of a testing laboratory or agency and must state the test results; and indicate whether the material, product, or system has passed or failed the test.

Factory test reports.

SD-10 Operation and Maintenance Data

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

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

SD-11 Closeout Submittals

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

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

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

1.1.2 Approving Authority

Office or designated person authorized to approve submittal.

1.1.3 Work

As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, except those SD-01 Pre-Construction Submittals noted above, 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 (G)

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.

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," of this section. 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

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.

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

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

Number drawings in a logical sequence. 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.

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

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

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

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

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

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

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

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

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

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

Submit manufacturer's instructions prior to installation.

1.5.5 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.

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

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

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

1.5.7 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.

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

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

1.6 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

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

### 1.7.1 Considering Variations

Discussion with Contracting Officer prior to submission, after consulting with the DOR, will help ensure functional and quality requirements are met and minimize rejections and re-submittals. 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, including the DOR's written analysis and approval. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

### 1.7.3 Warranting That Variations Are Compatible

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

### 1.7.4 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. 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

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

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

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

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," of this section 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 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) 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 | (2010) Standard for Portable Fire Extinguishers |
| NFPA 51B | (2009; TIA 09-1) Standard for Fire Prevention During Welding, Cutting, and Other Hot Work |
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |
| NFPA 70E | (2009; Errata 2009) Standard for Electrical Safety in the Workplace |

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

| | |
|---|---|
| OSHA 7415 | OSHA Construction Industry Requirements: Awareness of Major Hazards and Prevention Strategies |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (2008) Safety and Health Requirements Manual |

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, A" designation.

SD-01 Preconstruction Submittals

Safety and Health Plan; G

Crane Critical Lift 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."

Crane Reports

SD-07 Certificates

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 meet the General Construction Safety training requirements of 29 CFR 1926 and must include the successful completion of the course entitled "Construction Safety Hazard Awareness Training for Contractors" or the course entitled "Construction Industry Requirements; Awareness of Major Hazards and Prevention Strategies (OSHA 7415)". 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 Certified Industrial hygienist (CIH)

Provide a Certified Industrial Hygienist (CIH) at the W-3 Pump Station work site to perform safety and occupational health management, surveillance, inspections, and safety enforcement for the Contractor.

1.5.1.4 Competent Person for Confined Space Entry

Provide a competent person for confined space.

1.5.1.5 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 Safety and Health Plan.

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.

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

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.

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 quality control report.

1.6 CRANE CRITICAL LIFT PLAN

Prepare and sign weight handling critical lift plans for lifts over 75 percent of the capacity of the crane or hoist (or lifts over 50 percent of the capacity of a barge mounted mobile crane's hoists) at any radius of lift; lifts involving more than one crane or hoist; lifts of personnel; and lifts involving non-routine rigging or operation, sensitive equipment, or unusual safety risks. Submit 15 calendar days prior to on-site work and include the requirements of USACE EM 385-1-1, paragraph 16.H. and the following:

(1) For lifts of personnel, demonstrate compliance with the requirements of 29 CFR 1926.550(g).

(2) For barge mounted mobile cranes, barge stability calculations identifying barge list and trim based on anticipated loading; and load charts based on calculated list and trim. The amount of list and trim shall be within the crane manufacturer's requirements.

a. Fall Protection and Prevention (FP&P) Program Documentation. The program documentation shall be site specific and address all fall hazards in the work place and during different phases of construction. Address how to protect and prevent workers from falling to lower levels when they are exposed to fall hazards above 6 feet. A qualified person for fall protection shall prepare and sign the program documentation. Include fall protection and prevention systems, equipment and methods employed for every phase of work, responsibilities, assisted rescue, self-rescue and evacuation procedures, training requirements, and monitoring methods. Keep and maintain the accepted Fall Protection and Prevention Program documentationat the job site for the duration of the project.

1.7 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.

1.8 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.

1.9 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<br>2nd and C Avenue<br>Hours: 7:00 a.m. to 5:00 p.m., Mon-Fri | 321-867-3346 |
| LC 39 Area Clinic<br>Utility Road and VAB Road<br>Hours: 7:00 a.m. to 3:30 p.m., Mon-Fri | 321-867-3360 |

1.10 REPORTS

1.10.1 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.

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.

1.10.2 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.

1.10.3 Crane Reports

Submit crane inspection reports required in accordance with USACE EM 385-1-1, Appendix I and as specified herein with Daily Reports of Inspections.

1.10.4 Certificate of Compliance

A Certificate of Compliance is required 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.

1.11 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.

1.12 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.

1.13 WELDING

Paints containing heavy metals or hazardous materials may exist on metals. The Contractor shall require employees to wear the proper PPE during welding activities.

1.14 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.

1.15 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.

1.16 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.

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. Existing 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 EQUIPMENT

3.5.1 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.

3.5.2 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, 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.

3.5.3 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.

3.5.4 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

3.6 EXCAVATIONS

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

3.6.1 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.

3.6.2 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.

3.6.3 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.

3.6.4 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.

3.7 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.

3.8 ELECTRICAL

3.8.1 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.

3.8.2 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.

3.9 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.

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

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

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)
2111 Wilson Blvd, Suite 500
Arlington, VA 22201
Ph: 703-600-0355
Fax: 703-562-1942
E-mail: fdietz@ahrinet.org
Internet: http://www.ahrinet.org

ALUMINUM ASSOCIATION (AA)
National Headquarters
1525 Wilson Boulevard, Suite 600
Arlington, VA 22209
Ph: 703-358-2960

Fax: 703-358-2961
Internet: http://www.aluminum.org

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

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

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)
1 Davis Drive
P.O. Box 12215
Research Triangle Park, NC 27709
Ph: 919-549-8141
Fax: 919-549-8933
E-mail: leonardc@aatcc.org
Internet: http://www.aatcc.org

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

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

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

AMERICAN IRON AND STEEL INSTITUTE (AISI)
1140 Connecticut Avenue, NW, Suite 705
Washington, DC 20036
Ph: 202-452-7100

Fax: 202-463-6577
E-mail: webmaster@steel.org
Internet: http://www.steel.org

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1819 L Street, NW, 6th Floor
Washington, DC 20036
Ph: 202-293-8020
Fax: 202-293-9287
E-mail: info@ansi.org
Internet: http://www.ansi.org/

AMERICAN PETROLEUM INSTITUTE (API)
1220 L Street, NW
Washington, DC 20005-4070
Ph: 303-397-7993
Fax: 303-397-2740
E-mail: greg.kallio@ihs.com
Internet: http://www.api.org

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)
1801 Alexander Bell Drive
Reston, VA 20191-4400
Ph: 703-295-6300 - 800-548-2723
Fax: 703-295-6333
E-mail: member@asce.org
Internet: http://www.asce.org

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

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

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

AMERICAN WELDING SOCIETY (AWS)
550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353 - 305-443-9353
Fax: 305-443-7559
E-mail: info@aws.org or customerservice@awspubs.com

Internet: http://www.aws.org

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)
P.O. Box 361784
Birmingham, AL 35236-1784
Ph: 205-733-4077
Fax: 205-733-4075
E-mail: email@awpa.com
Internet: http://www.awpa.com

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)
2025 M. Street, NW, Suite 800
Washington D.C. 20036-3309
Phone: (202) 367-1155
Email: info@americanbearings.org
Internet:

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

ASPHALT INSTITUTE (AI)
Research Park Drive
P.O. Box 14052
Lexington, KY 40512-4052
Ph: 859-288-4960
Fax: 859-288-4999
E-mail: info@asphaltinstitute.org
Internet: http://www.asphaltinstitute.org

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

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9500
Fax: 610-832-9555
E-mail: service@astm.org
Internet: http://www.astm.org

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

COMPRESSED GAS ASSOCIATION (CGA)
4221 Walney Road, 5th Floor
Chantilly, VA 20151
Ph: 703-788-2700
Fax: 703-961-1831
E-mail: cga@cganet.com
Internet: http://www.cganet.com

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)
933 North Plum Grove Road
Schaumburg, IL 60173-4758
Ph: 847-517-1200 or 800-328-6306
Fax: 847-517-1206
Internet: http://www.crsi.org/

ELECTRONIC INDUSTRIES ALLIANCE (EIA)
2500 Wilson Boulevard
Arlington, VA 22201-3834
Ph: 703-907-7500
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E-mail: infor@ecaus.org
Internet: http://www.eia.org

U.S. DEPARTMENT OF ENERGY (DOE)
1000 Independance Ave. SW
Washington, DC 20585
Ph: 800-342-5363
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Internet: http://www.eh.doe.gov/

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)
25 North Broadway
Tarrytown, NY 10591
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Internet: https://www.flrules.org/

FLORIDA DEPARTMENT OF COMMUNITY AFFAIRS (FDCA)
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100
Ph: 850-488-8466
Internet: http://www.dca.state.fl.us/

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (FDEP)
3900 Commonwealth Boulevard M.S. 49
Tallahassee, FL 32399
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FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)
605 Suwannee Street
Tallahassee, FL 32399-0450
Ph: 850-414-4100 or 1-866-374-FDOT (3368)
Fax: 850-414-5201
Internet:

FLORIDA STATUTES (FL-STAT)
Division of Legislative Information Services
Room 407 Claude Pepper Building
111 West Madison Street
Tallahassee, FL 32399-1400
Ph: 850-488-4371/800-342-1827
Email: leg.info@leg.state.fl.us
Internet: http://www.leg.state.fl.us/statutes/

FM GLOBAL (FM)
270 Central Avenue
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Johnston, RI 02919
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E-mail: servicedesk.myrisk@fmglobal.com
Internet: http://www.fmglobal.com

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E-mail: webmaster@pumps.org
Internet: http://www.pumps.org

ICC EVALUATION SERVICE, INC. (ICC-ES)
5360 Workman Mill Road
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Internet: http://www.icc-es.org

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Fax: 732-562-6380
E-mail: onlinesupport@ieee.org or ieeeusa@ieee.org
Internet: http://www.ieee.org

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
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Internet: http://www.icea.net

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Internet: www.iccsafe.org

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)
3166 South River Road, Suite 132
Des Plaines, IL 60018
Ph: 847-827-0830
Fax: 847-827-0832
Internet: http://www.icri.org

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

3050 Centre Ave. Suite 102
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E-mail: neta@netaworld.org
Internet: http://www.netaworld.org

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)
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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
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E-mail: central@iso.ch
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Internet: http://www.nasa.gov/centers/kennedy/home/index.html

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PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not used

-- End of Section --

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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 of NASA KSC policy. 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 wastewater management plan that identifies the methods and procedures for management and/or discharge of wastewaters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water,

hydrostatic test water, and water used in flushing of lines. If a settling/retention pond is required, the plan must include the design of the pond including drawings, removal plan, and testing requirements for possible pollutants. If land application will be the method of disposal for the wastewater, the plan must include a sketch showing the location for land application along with a description of the pretreatment methods to be implemented. If surface discharge will be the method of disposal, include a copy of the permit and associated documents as an attachment prior to discharging the wastewater. If disposal is to a sanitary sewer, the plan must include documentation that the Wastewater Treatment Plant Operator has approved the flow rate, volume, and type of discharge.

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 NASA KSC policy, 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 NASA KSC policy.

3.2.2 Wetlands

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

3.3 AIR RESOURCES

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

3.3.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from asphaltic batch plants; must be controlled at all times, including weekends, holidays and hours when work is not in progress. Maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area.

Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. Provide sufficient, competent equipment available to accomplish these tasks. Perform particulate control as the work proceeds and whenever a particulate nuisance or hazard occurs. Comply with all State and local visibility regulations.

3.3.2 Odors

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

3.3.3 Sound Intrusions

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

3.3.4 Burning

Burning is prohibited on the Government premises.

3.4 MATERIALS MANAGEMENT AND WASTE DISPOSAL

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

3.4.1 Solid Wastes

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

3.4.2 Chemicals and Chemical Wastes

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

3.4.3 Hazardous Materials and Universal Waste/Contractor General Hazardous Wastes

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

3.4.4 Fuel and Lubricants

Storage, fueling and lubrication of equipment and motor vehicles must be conducted in a manner that affords the maximum protection against spill and evaporation. Manage and store fuel, lubricants and oil in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded must be stored in marked

corrosion-resistant containers and recycled or disposed in accordance with 40 CFR 279, State, and local laws and regulations and NASA KSC policy.

3.4.5 Wastewater

Disposal of wastewater will be as specified below.

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

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

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 NASA KSC policy.

3.5 RECYCLING AND WASTE MINIMIZATION

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

3.6 NON-HAZARDOUS SOLID WASTE DIVERSION REPORT

Maintain an inventory of non-hazardous solid waste diversion and disposal of construction and demolition debris. Submit a report 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 NASA KSC policy.

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 NASA KSC policy.

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 14 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.

-- End of Section --

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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<br>Elongation (percent) | ASTM D 4632 | 100 lbs. min.<br>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.

-- End of Section --

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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.

Spare Parts Data

Two copies of list that indicates 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, and one set of the approved working Record drawings.

Record Drawings Geodatabase

At the conclusion of the project, the Contractor will deliver a geodatabase containing the CADD W/WW infrastructure data to KSC.

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 showing 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 northing and easting coordinates on the record drawings. Locate all fittings, valves, splice boxes and similar appurtenances by northing and easting coordinates. 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.

Record drawings shall also be submitted in CADD format. When submitting record drawings in CADD format, the original Contract Documents shall be used as an XREF file and not modified. The record drawings shall be developed as CADD layers drawn using the XREF as a base. The Contractor is to follow CADD standards developed by 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 RECORD DRAWINGS GEODATABASE

Using the CADD format Record Drawings developed Subpart entitled "PROJECT RECORD DRAWINGS" of this section, the Contractor is to provide a geodatabase of the Record Drawings based on the following.

1.4.1 Data Migration

The Contractor is to use the Record Drawings CADD layers which should be readable and georeferenced with real world coordinates.

Facility infrastructure data will be extracted from the provided CADD layers. Facility infrastructure data will be placed in the exact location as indicated by the CADD layers.

Infrastructure to be extracted will conform to a standard water/wastewater (W/WW) geodatabase schema. Features will be extracted into a standard W/WW geodatabase created by the Contractor. The Contractor is to notify the Contracting Officer if any infrastructure types that are encountered within the CADD layers do not conform to the schema. The provided list of infrastructure types and attributes identified in this document will be extracted wherever possible.

The Contractor will establish topology rules which will identify physical errors within the data such as gaps, overlaps, over/under shoots, and multipart features. These types of errors cause certain types of applications such as modeling and tracing to return unexpected and false results. Once errors are identified, the Contractor will correct them to the extent allowable by the supplied data.

Contained within Paragraphs entitled "Feature and Attribute Details - Wastewater" and "Feature and Attribute Details - Water & Reclaimed Water" are details on the creation and attribution of the Government owned and maintained features within a standard W/WW schema.

As with any network of features, points are dependent upon their relationships with lines. Therefore, as a matter of practice the line should be created first. In W/WW networks there are specific rules to follow while creating the linework:

a. All pipe lines split when intersecting another pipe line of another value. However, some lines appear to intersect but actually pass at different depths beneath the surface. These lines do not split.

b. A change in attribution requires a new section to be created. Even if the material, diameter and type are the same but the record set number or date of installation is different.

c. All connecting sections of pipe do so through a fitting or structure.

d. Valves do split pipe sections.

e. All terminating pipe lines are covered by some point feature.

f. Pipe lines do not end (nor should be split) just because they run off the as-built sheet.

The information available on each document pertaining to a type of W/WW infrastructure will be captured and stored with the feature in the correct W/WW geodatabase. The Contractor is to interpolate, extrapolate or analyze existing information to determine appropriate attribution for an infrastructure feature that is not clearly labeled in the provided CADD layers.

The following list contains common infrastructure types that may be extracted. Actual sub-types will be dependent upon existing facilities.

1.4.1.1 Water Distribution Network

a. Water (points)

1. Control Valves
   - Backflow Control
   - Blow Off
   - Air Release (ARV)
   - Reduced Pressure Backflow
   - Reduced Pressure Zone Assembly (RPZ)

2. System Valves
   - Butterfly
   - Gate
   - Hydrant Valve
   - Plug

3. Fittings
   - Bend
   - Cap
   - Coupling
   - Cross
   - Leak Detector
   - Mechanical Joint Tee (MJT)
   - Reducer
   - Saddle
   - Sleeve
   - Tap
   - Tee
   - Transition Gasket
   - Wye

4. Hydrants

5. Meters

6. Network Structures
   - Enclosed Storage Facility
   - Production Well
   - Pump Station
   - Treatment Plant

7. Sampling Stations

b. Water (lines)

1. Lateral Lines
   - Potable
   - Fire
   - Hydrant
   - Firex

2. Pressurized Mains
   - Bypass
   - Distribution Main
   - Transmission Main

1.4.1.2 Wastewater Network (Sewer)

a. Sewer (points)

1. Cleanouts

2. Control Valves
   - ARV
   - Backflow Control
   - Simple Check
   - Double Check
   - Pressure Vacuum
   - Vacuum Valve

3. System Valves
   - Gate
   - Plug

4. Fittings
   - Bend
   - Cap
   - Coupling
   - Cross
   - Leak Detector
   - MJT
   - Reducer
   - Saddle
   - Sleeve
   - Tap
   - Tee
   - Transition Coupling
   - Wye

5. Manholes

6. Network Structures
   - Enclosed Storage Facility
   - Production Well
   - Pump Station
   - Treatment Plant

7. Pumps
   - Axial flow

Rotary

b. Sewer (lines)

1. Lateral Lines

2. Pressurized Mains
Force
Pressure
Vacuum

3. Gravity Mains

1.4.2 Develop Geometric Network

The Contractor will establish geometric networks on the W/WW data. The geometric networks established will allow the Government to perform network trace operations such as upstream or downstream traces.

The Contractor will validate the geometric networks within the geodatabase for spatial and attribute inconsistencies. This will include establishing a method for reporting and correcting identifiable errors.

1.4.3 Quality Assurance

A visual survey will be conducted by the Contractor upon completion of the feature extraction to verify that the facility infrastructure is represented correctly in the geodatabase before delivery. Each infrastructure feature will be clearly labeled, symbolized and displayed during the visual survey. Network tracing will be used to check for gaps in connectivity. To the extent possible, with the provided source data, the Contractor will validate the existence of the required attributes for W/WW facility infrastructure. Automated routines will check for missing attribution and/or null values. The Contactor will then evaluate all null and blank column values in records to check for missing attribute data. Spatial and attribution errors identified during this process will be corrected.

Interim submittals will be delivered to the Government in a personal geodatabase format along with a list of CADD layers to be reviewed for Quality Assurance by the Contracting Officer. Comments from the Contracting Officer will be returned to the Contractor within a two-week period in the form of a point feature class. The Contactor will work with the Contracting Officer to define an appropriate comments attribute domain to facilitate the review process on both ends.

Project Deliverables

At the conclusion of the project, the Contractor will deliver a geodatabase containing the CADD W/WW infrastructure data to KSC.

1.4.4 Feature and Attribute Details - Wastewater

LssGravityMain - Gravity Mains are independent lines that begin and end at a manhole, cleanout, cap, or lift station. All gravity mains should be created with only two nodes, a beginning and an end (no additional vertices) where the beginning and end are normally manholes. In the rare case of terminating at a lift station site, the final gravity main section node will be a lift station (wet well is reserved for GPS points only). The

direction that the gravity main will be digitized is the direction of flow (down stream). The location of these pipe segments is generally in the center of roadways. Gravity mains will be split where pipe material changes or a direct tie-in of a force main occurs between access points (nodes; manholes). Gravity mains never have valves attached to them.

Subtypes:

Collector - Receive wastewater discharged from service laterals; this will be the only subtype used during digitizing unless specifically stated on the drawing.

Interceptor - Gravity mains larger than 8 inches in diameter that carry the wastewater discharged from one or more collector sewers.

Interconnect - This type of gravity main is identified as the primary trunk line that passes collections from one subsystem to the next. The interconnect can be described as the shortest distance from a lift station upstream to the next pressurized pipe.

Required Attribution:

Franchise_Code - Not applicable

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Collector, Interceptor, Interconnect.

InstallDate - Date of installation

Lifecycle Status - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Material - Mostly PVC or HDPE is used in new developments. There may be cases at road crossings to use DIP or CIP.

Slope - Do not calculate. If available on the record drawing.

Recordnumber - Not applicable

Comments - Any other pertinent notes.

Diameter - Available on the drawing. Almost all residential gravity mains are 8 inches. Do not assume.

UpstreamInvert - Highest elevation of the gravity main where it connects to a point feature.

DownstreamInvert - Lowest elevation of the gravity main where it connects to a feature.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Hyperlink-Scanned image used to digitize features from. This is

the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LssLateralLine - Lateral lines are services. They are the only other feature type that interacts directly with the gravity system for the Government. Snap the lateral line directly to the edge of the main (do not split main). Again, the direction of digitization here is important and should follow the direction of flow.

There are some lateral lines that branch upstream from the connection to the main. These types of laterals are servicing multiple sites such as you will find at industrial sites.

By request of the Government, LssLateralPoints will be the upstream node at the terminating end of lateral lines. For gravity systems, where lateral lines intersect other lateral lines, the connecting node will be a service tap. Where the lateral line connects to the collector (gravity main, interceptor, interconnect) the connecting node will be a service tap For vacuum systems a service tap will be the connecting node where lateral lines intersect other lateral lines.. Where the lateral line connects to the main (vacuum, low pressure force main, force main)the connecting node will be a tee, wye or a cross. A service tap will not be required where a lateral line connects directly into a manhole.

Lateral line subtypes are generally based on the facility it is serving.

Subtypes:

Not Applicable

Required Attribution:

Franchise_code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government -owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

Install Date - Date of installation

Lifecycle Status - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Material - Pipe material.

Diameter - Diameter of pipe.

Recordnumber - Not applicable

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure, or vacuum.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LssPressurizedMain - Pressurized Mains are like any other pressure system in a utility network. They change direction, size, material, and may curve (contains additional vertices). Logically, the source of a pressurized network of lines is a pump (at a lift station site). It transports waste into either another gravity system (into a manhole or gravity main) or directly to a treatment facility. Logically, as with other pressurized pipe networks, the location of these pipes is generally within an available right-of-way or easement but usually not located beneath a road.

Where a section of pressurized main intersects another section of pressurized main, all sections will be split. The connection points (terminating end) of a section of pipe will be covered by the appropriately selected fitting (i.e. a single pipe section connecting to another single pipe section will result in a split creating three pipes. The appropriate fittings will be a tee, wye or a cross.).

Subtypes:

Force - This type of pipe has sewage forced into it by pumps at a lift station site.

LowPressure - A low-pressure system

Vacuum - Pressurized mains that are part of vacuum systems.

AirRelease - This is a small diameter section of pipe that connects to the top main and provides a method of releasing air above ground via an air release control valve. . All air release diameters will be attributed as 2-inch.

Required Attribution:

Franchise_code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

Install Date - Date of installation.

LifecycleStatus - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Material - Pipe material.

Diameter - Diameter of pipe. All air release diameters will be attributed as 2-inch.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LssControlValve - A control valve is used to control the quality of pressure in pressurized pipe systems. A control valve will split a force main.

Subtypes:

AirIntake - Are used in vacuum sewer systems. Usually 4-inch, this valve is installed on the facility's sewer, downstream of any traps. It is necessary to provide the air resulting in a natural pressure differential that becomes the driving force of the system. These valves are rarely found on as-builts, however, they can be found near government and industrial facilities.

AirRelease - Used to automatically vent trapped air in any pipeline conveying fluid. Therefore, these valves are found in all water, sewer, and reclaimed water system types. All air release diameters will be attributed as 2-inch.

Required Attribution:

Franchise_Code - Not Applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - See list of subtypes above.

Installdate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Diameter - Available on the drawing for air intakes, air release diameter will be 2 inches.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in

the naming.

LssFitting - In sewer networks, fittings are used to connect pipe sections. Both ends of all pipe sections are covered by a fitting. On pressurized mains, fittings are frequent. The logic is the same, fittings connect pipe sections. Taps and saddles will be attributed as a tee and will split a pipe.

Subtypes:

Blowoff - Occurs at the end of a pressurized main; used for pressure relief of the system.

Wye - Used as the point of connection of two or three pipes where one pipe is non-perpendicular; lines connections usually occur at 45 and 22.5 degree connections. This fitting is the cousin of the tee; it does split pipes where used.

Tee - A point of connection for pressurized pipes. Tapping sleeves and saddles will be attributed as a tee. All tees split the connecting pipe section.

Sleeve - A point of connection for two pressurized pipes of the same diameter but may have different attribution somewhere else. A sleeve is used on pipe runs to show breaks in project phases where there is a change in record set numbers.

Reducer - A point of connection for two pressurized pipes of different diameters. The attribution (diameter) of the pipe section changes, therefore the reducer connects two individual line sections.

Cleanout - Found at the end of gravity mains and service lateral lines or sometimes at the connection point of multiple service lateral lines.

Bend - Bends will not be mapped.

Cap - These fittings are used as temporary termination points (at the ends) on a pressurized or gravity main. They are generally used when construction eliminates or re-routes service (cut and cap or stub-out and plug). They are sometimes used if expansion is unknown.

Cross - A cross occurs at the intersection of two pressurized system lines. Since these fittings require actually cutting the lines, the two system lines do split and become individual assets.

Coupling - Used as a point of connection when there is a change in material types along a pipe run.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above)

InstallDate - Date of installation.

LifecycleStatus - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Diameter1 - Diameter of pipe 1 (run or usually largest pipe size) intersecting at the fitting.

Diameter2 - Diameter of pipe 2 (run or usually largest pipe size) intersecting at the fitting.

Diameter3 - Diameter of pipe 3 (branch or usually smaller or same pipe size) intersecting at the fitting.

Diameter4 - Diameter of pipe 4 (branch or usually smaller or same size pipe) intersecting at the fitting.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LssLateralPoint - As defined by the Government, the lateral point will represent the service connection to the lateral line.

Subtypes:

Double Service - The lateral point serves two facilities.

Single Service - The lateral point serves one facility.

Service Tap - As defined by the Government, service taps will be used as the connection point of service lateral lines connecting to gravity mains. A service tap will be used to connect lateral lines to other lateral lines.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Diameter - Diameter of the lateral line.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LssLiftStation - This class is named for just one type of feature contained within it. Vacuum Pump stations, valve pits, and, grinders are also included. This feature class represents network features that details information that is not to be represented outside the point created. The point is captured at the site and the incoming and outgoing pipe sections are connected to it using a virtual "flow line." In the case of "control panels" (see below) this point will not be part of the network. Wet wells, valve pad/vaults and control panels are collected by RTK GPS only. Do NOT map.

Subtype:

LiftStation - A lift station is a structure in the sewer network that takes sewage deposited by gravity mains, lifts it, and transfers it to an elevated pipe where gravity creates a natural downward pressure. Many contractors call pump stations lift stations on the as-built sheets, though the pressure is created by a pump. Classify the feature by its nomenclature on the as-built and represent it using a single point. The point will be connected to the incoming and outgoing pipe line section using a virtual "flow line."

MasterVacuumPumpStation - A pump station uses pumps to transfer sewage from a gravity pipe section into a pressurized main. Pump stations are clearly identified within as-builts. Though sometimes incorrectly identified pump stations end up classified as lift stations, classification will be done according to the nomenclature used on the as-builts. The PumpStation subtype is reserved for master vacuum pump stations only.

WetWell

ValveVault

Grinder - This is a small type of lift / pump station belonging to the low pressure system at a service site. Its function is similar to the pump station but also has a grinding component to prepare the sewage for passage into a small (1-inch to 2-inch) pressurized pipe.

VacuumValvePit - Used in vacuum system at service sites where contained within are the air intake valve for the vacuum service. A 3-inch vacuum main will be mapped to connect valve pits to the primary vacuum main.

ControlPanel

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above)

InstallDate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Bottomelevation - Bottom elevation only populated for lift stations can usually be found on the detail sheet.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Topelevation - Attribution required for lift stations only. Usually found on lift station detail sheet.

Diameter - Attribution required for lift stations only. Diameter of lift station wet well and grinder stations can usually be found on the detail sheet.

Source - Populated as record drawing for all features.

InInvert - Populated for lift stations only.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LssManhole - A manhole is used for access to network gravity systems and control of flow through those systems. A manhole will always be found either initiating or connecting pipe lines used in the gravity network. Manholes are a critical component to all gravity systems; therefore, they are actively maintained and required for robust management programs.

Subtype:

Splitter - Is a component of the vacuum system. A 6-inch gravity main will be mapped to connect the splitter manhole to the valve pits. A 3-inch vacuum main will connect the valve pits to the

primary vacuum main These are rare and are clearly marked on the vacuum system record sets.

BufferTank - This is a component of the vacuum system.

InsideDrop - This is a standard manhole with an internal drop pipe and bowl used to control the rate of effluent inside the manhole. This will be clearly identifiable on the as-built drawing.

Terminal - This manhole is the farthest upstream manhole in a gravity branch. It is the highest point; it is not where the flow terminates but rather where the flow begins.

UnkManhole - Should not be used without complementing comments.

Discharge - Is a manhole that has a force main connecting to it.

OutsideDrop - This is a special manhole with an external drop pipe. This will be clearly identifiable on the as-built drawing.

Standard - The standard, or "typical" manhole.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Recordnumber - Not applicable.

Buffertype - This should be attributed for vacuum system features only. It will be labeled in the record set as a buffer tank.

Comments - Any other pertinent notes.

Rimelevation - Usually found on gravity system profile sheet.

Bottomelevation - Lowest invert elevation into the manhole.

Interconnect - This will this be captured for modeling purposes.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LssMeter - Is a force main master meter assembly used to meter flows when there is a force main interconnect with another utility Franchise.

Subtype:

FlowMeter - Force main master meter assembly.

Franchise Meter-Used when two different Franchises establish an interconnection.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Diameter - Diameter of pipe.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LssNetworkStructure - Network are large, clusters of features that exist at a site location. The details of the structure do not get captured in this database. For the purpose of delineating a sewer network, a structure point is captured at the site and the incoming and outgoing pipe sections are connected to it using a virtual "flow line."

Subtype:

TreatmentPlant - Wastewater treatment facility; final downstream destination of wastewater.

WRF - Wastewater treatment and reclamation facility, final downstream destination of wastewater and source of reclaimed water.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LssSystemValve - System valves are used to control the flow of fluid through a piping system. In general, system valves are not used on pipe sections less than 4 inches in diameter.

Subtype:

UnkSystemValve - Only use this subtype if the drawing does not clearly identify the valve type. Many times, the sheet may only indicate "valve" and may have to have the type identified using another sheet or logical deduction. This type should rarely be used if ever.

ButterflyValve - These valve types are isolation valves similar to the function of a gate valve (see below) but are generally reserved for larger diameter (12 inches and greater) pipe sections.

GateValve - Gate valves are used to isolate the flow of a fluid through a piping system. They are generally located at sites where more than two pipes connect and usually conform to a minimum distance requirement. In general, it is rare to see a gate valve more than 1000 feet from the site of a connecting pipe line. The larger (diameter) pipe, the greater the distance from the connection.

PlugValve - Plug valves are used for a variety of occasions. There are below-grade plug valves at lift stations and others used in combination with check valves for backflow prevention. Most often they are used on small pipes (4 inches and less). But they do produce plug valves for large pipes too.

BallValve - A ball valve is also an isolation valve that uses an internally set ball with a hole bored through it that is turned by a handle to regulate flow. These valve types are small (typically

1 to 2 inches), thus being part of a low-pressure service.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Sewage for all features.

Diameter - Diameter of the main passing through the valve.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as force main, gravity, low pressure or vacuum.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

1.4.5 Feature and Attribute Details - Water and Reclaimed Water

LwControlValve - A control valve is used to control the quality of pressure in pressurized pipe systems. A control valve will split a main line.

Subtypes:

AirRelease - Used to automatically vent trapped air in any pipeline conveying fluid. Therefore, these valves are found in all water, sewer, and reclaimed water system types. All air release diameters will be attributed as 2-inch.

BackflowPreventer

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - See list of subtypes above.

InstallDate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Water or Reclaimed Water for all features.

Diameter - Available on the drawing for air intakes, air release diameter will be 2 inches.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as fire line, potable or reuse.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LwFitting - In pressurized distribution systems, fittings are used to connect pipe sections. Both ends of most pipe sections are covered by a fitting. However distribution networks will initiate and eventually terminate at points other than fittings. Fittings are frequent throughout a pressurized piping system but not all fittings should split a pipe in a GIS. Bends are used as connectors to redirect a pipe's bearing, but do not split pipes, therefore, bends will not to be mapped. Taps and saddles will be attributed as a tee and will split a pipe.

Subtypes:

Bend

Cap - These fittings are used as temporary termination points (at the ends) on a pressurized main. They are generally used when construction eliminates or re-routes service (cut and cap or stub-out and plug). They are sometimes used if expansion is unknown.

Cleanout - Found at the end of gravity mains and service lateral lines or sometimes at the connection point of multiple service lateral lines.

Cross - A cross occurs at the intersection of two pressurized system lines. Since these fittings require actually cutting the lines, the two system lines do split and become individual assets.

Coupling - Used as a point of connection when there is a change in material types along a pipe run.

Reducer - A point of connection for two pressurized pipes of different diameters. The attribution (diameter) of the pipe section changes, therefore the reducer connects two individual line sections.

Sleeve - A point of connection for two pressurized pipes of the same diameter but may have different attribution somewhere else. A sleeve is used on pipe runs to show breaks in project phases where there is a change in record set numbers.

Tee - A point of connection for pressurized pipes. Tapping sleeves and saddles will be attributed as a tee. All tees split the connecting pipe section which results in the intersection of three pipes.

Wye - if present, are used as the point of connection of two or three pipes where one pipe is non-perpendicular; lines connections usually occur at 45 and 22.5 degree connections. This fitting is the cousin of the tee; it does split pipes where used.

Blowoff - Occurs at the end of a pressurized main; used for pressure relief of the system.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above)

InstallDate - Date of installation.

LifecycleStatus - Feature is active, abandoned or removed.

Watertype - Water or Reclaimed Water for all features.

Diameter1 - Diameter of pipe 1 (run or usually largest pipe size) intersecting at the fitting.

Diameter2 - Diameter of pipe 2 (run or usually largest pipe size) intersecting at the fitting.

Diameter3 - Diameter of pipe 3 (branch or usually smaller or same pipe size) intersecting at the fitting.

Diameter4 - Diameter of pipe 4 (branch or usually smaller or same size pipe) intersecting at the fitting.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as fire line, hydrant, irrigation, potable or reuse.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LwHydrant - Hydrants are terminal points within a hydrant assembly. The hydrant assembly is a collection of system features required to provide water to the hydrant from the connection with a pressurized main.

Generally the assembly consists of a tee or saddle (connection point at the main), a section of main, a gate valve and the hydrant.

Subtypes:

Hydrant - A hydrant subtype may be established but it is not necessary unless there exists a desire to track flushing hydrants from the rest.

FireDepartmentConnection - A type of hydrant found on Fire Lines and generally noted as a FDC in the record sets.

Require Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above)

InstallDate - Date of installation.

Lifecycle Status - Feature is active, abandoned or removed.

Watertype - Water for all features.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as Hydrant

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LwLateralLine - Lateral lines are basically lines connected to main distribution lines for the purpose of providing service(s). The distinction of these services vary and have been captured as subtypes that meet the needs of the Government (see below). Lateral lines can range from a single service line to a complex sub-network of distribution that stems off of the main distribution system. Lateral lines connect to main lines via a fitting, usually of the type tee, saddle or tap. The connection points for two or more lateral lines are also fittings but are sometimes not represented in the record set. in this case a service tap will be used.

Subtypes:

Potable

Fire

Firex

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

Lifecycle Status - Feature is active, abandoned or removed.

Watertype - Water or Reclaimed Water for all features.

Material - Pipe material.

Diameter - Diameter of pipe.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as reuse, fire line, potable or irrigation

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LwMeter - Meters are generally the terminating end of a lateral line. However, there are in-line meters on the main distribution system at the KSC boundaries known as Master Meters, in which case the Government's maintenance responsibility terminates but the main distribution system does not.

Subtypes:

Double Service - The terminating point of a lateral line servicing exactly two independent account services.

Single Service - The termination point of a lateral line servicing one account service.

Master Meter - The in-line main distribution point at which the Government maintenance responsibility ends but the distribution network does not.
Franchise Meter-Used when two different Franchises establish an interconnection.

Multiple - The termination point of a lateral line servicing multiple services (i.e. an apartment complex)
Service Meter- The termination point of a lateral line servicing a reuse service.

Service Tap - As defined by the Government, service taps will be

used as the connection point of service lateral lines connecting to water or reuse mains. A service tap will be used to connect lateral lines to other lateral lines when fittings are not clearly called out on the record set.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

Lifecycle Status - Feature is active, abandoned or removed.

Watertype - Water or Reclaimed Water for all features.

Diameter - The diameter of the meter will be recorded if available. If the diameter of the meter has not been recorded, the meter will inherit the diameter of the attached pipe section.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as reuse, fire line, potable or irrigation.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LwNetworkStructure -Network are large, clusters of features that exist at a site location. The details of the structure do not get captured in this database. For the purpose of delineating a water network, a structure point is captured at the site and the incoming and outgoing pipe sections are connected to it using a virtual "flow line."

Subtype:

TreatmentPlant - Water treatment facility; this is the initial point of the main distribution system where the water type is "potable".

EnclosedStorageFacility-This is for future underground storage structures.

PumpStation- Potable water booster station.

PotableWell- A domestic potable well.

ElevatedTank- this feature connects the potable system coming from the plant and the rest of an areas distribution system. The tank

is used to store water and provide pressure to a system continuously. Many of these tanks have been replaced with in-line booster stations.

Water Reclamation Facility - Wastewater treatment and reclamation facility, final downstream destination of wastewater and source of reclaimed water.

Pumping Station-Reuse pump station

Control Structure-Reuse pond control structure

Pump-Reuse irrigation pump located at reuse ponds.

Irrigation Well- Well used to supply a reuse system

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Water or Reclaimed Water for all features.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Populated as hydrant, fire line, potable or irrigation.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LwPressurizedMain - Pressurized Mains are like any other pressure system in a utility network. They change direction, size, material, and may curve (contains additional vertices). Logically, the source of a pressurized network of lines is a pump. Logically, as with other pressurized pipe networks, the location of these pipes is generally within an available right-of-way or easement but usually not located beneath a road.

Where a section of pressurized main intersects another section of pressurized main, all sections will be split. The connection points (terminating end) of a section of pipe will be covered by the appropriately selected fitting (i.e. a single pipe section connecting to another single pipe section will result in a split creating three pipes. The appropriate fittings will be a tee, wye or a cross.).

Subtypes:

FireLine- this pipe type is used to supply fire suppression and sprinkler systems to facilities, etc… This type could be addressed as a subtype of a lateral or service but is frequently identified within the main distribution system because of its size (diameter).

AirRelease- this is a small diameter section of pipe that connects to the top main and provides a method of releasing air above ground via an air release control valve. All air release diameters will be attributed as 2-inch.

DistributionMain- this is the primary type of main used within distribution systems. This will be the default main type during data creation. Pipe diameters of less than 12-inches.

HydrantLine- this is the main section used within a hydrant assembly (see hydrant above).

TransmissionMain- Pressurized pipes with diameter of 12-inches or greater.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

LifecycleStatus - Feature is active, abandoned or removed.

Watertype - Water or Reclaimed Water for all features.

Material - Pipe material.

Diameter - Diameter of pipe. All air release diameters will be attributed as 2-inch.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Reuse, hydrant, fire line, potable or irrigation.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

LwSamplingStation - Sampling stations are sites used to collect water samples. Will not be mapped.

Subtypes:

SamplingStation - these are "sites" not features used to collect water samples for testing of chemicals and other characteristics of the water. The sampling usually happens at an existing feature.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

LifecycleStatus - Feature is active, abandoned or removed.

Watertype - Water or Reclaimed Water for all features.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

LwSystemValve - System valves are used to control the flow of fluid through a piping system. In general, system valves are not used on pipe sections less than 4-inches in diameter.

Subtype:

UnkSystemValve - Only use this subtype if the drawing does not clearly identify the valve type. Many times, the sheet may only indicate "valve" and may have to have the type identified using another sheet or logical deduction. This type should rarely be used if ever.

ButterflyValve - These valve types are isolation valves similar to the function of a gate valve (see below) but are generally reserved for larger diameter (12 inches and greater) pipe sections.

GateValve - Gate valves are used to isolate the flow of a fluid through a piping system. They are generally located at sites where more than two pipes connect and usually conform to a minimum distance requirement. In general, it is rare to see a gate valve more than 1000 feet from the site of a connecting pipe line. The larger (diameter) pipe, the greater the distance from the connection.

PlugValve - Plug valves are used for a variety of occasions. There are below-grade plug valves at lift stations and others used in combination with check valves for backflow prevention. Most often they are used on small pipes (4 inches and less). But they do produce plug valves for large pipes too.

BallValve - A ball valve is also an isolation valve that uses an internally set ball with a hole bored through it that is turned by a handle to regulate flow. These valve types are small (typically 1 to 2 inches), thus being part of a low-pressure service.

HydrantValve- this valve is a gate valve only this one is part of the hydrant assembly and only isolates flow to the hydrant and has no other impact on the system.

Required Attribution:

Franchise_Code - Not applicable.

Private - Identifies privately owned and maintained infrastructures versus Government-owned and maintained infrastructures.

Subtype - Must be identified by creator (see above).

InstallDate - Date of installation.

Lifecyclestatus - Feature is active, abandoned or removed.

Watertype - Water or Reclaimed Water for all features.

Diameter - Diameter of the main passing through the valve.

Recordnumber - Not applicable.

Comments - Any other pertinent notes.

Source - Populated as record drawing for all features.

Usetype - Reuse, hydrant, fire line, potable or irrigation.

Hyperlink-Scanned image used to digitize features from. This is the image number along with dot tif or dot jpg depending on the image type. Do not include drive letters, file paths, or words in the naming.

## 1.5 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.

## 1.6 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.

## 1.7 WARRANTY MANAGEMENT

### 1.7.1 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 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.

1.7.2 Performance Bond

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

1.7.3 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 be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of its responsibilities in connection with other portions of this provision.

1.7.4 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-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 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.

1.7.5 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.

1.8 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.

1.9 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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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 78 23

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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 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 1 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 1

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)

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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, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI Guideline K | (2009) 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 | (2007; Rev K) 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 PROJECT DESCRIPTION

1.2.1 Demolition/Deconstruction Plan

Prepare a Demolition Plan and submit proposed salvage, demolition, deconstruction, and removal procedures for approval no later than 14 days before work is started. 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.

1.2.2 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 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.

1.3.1 Existing Construction Limits and Protection

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

1.3.2 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.

1.3.3 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.

1.3.4 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.

1.3.5 Facilities

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

1.4 BURNING

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

1.5 SUBMITTALS

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

SD-01 Preconstruction Submittals

Existing Conditions; G
Demolition Plan; G
Notification; 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

1.6 QUALITY ASSURANCE

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. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of NASA KSC policy, conform to the safety requirements contained in ASSE/SAFE A10.6. Comply with the Environmental Protection Agency and NASA/KSC requirements specified. Use of explosives will not be

permitted.

Use best management practices (BMPs) to prevent releases of metal and/or PCB contaminated paint chips to the environment. The following are offered as suggested BMPs:

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

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

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

d. 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.

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

1.6.1 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.

Use best management control measures to prevent the release of paint chips to the environment.

BMPs include, but are not limited to, the following:

a. Contain demolition debris where possible to impermeable surface.

b. Control stormwater runoff from the site with silt fencing.

c. Conduct daily housekeeping to limit potential paint chip migration.

d. Collect and remove all demolition debris from the project area.

e. Containerize and dispose of appropriate sediment collected adjacent to silt fence.

f. Upon completion of demolition, remove the first 6 inches of top soil from within and 6 feet beyond the project area and dispose of in the KSC landfill.

1.7 PROTECTION

1.7.1 Traffic Control Signs

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

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 shall comply with FAA AC 70/7460-1. Lights shall 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.

1.7.2 Protection of Personnel

Before, during and after the demolition and deconstruction work 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.

1.8 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 EXISTING CONDITIONS

Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal. 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.

PART 2 PRODUCTS

2.1 FILL MATERIAL

a. Comply with excavating, backfilling, and compacting procedures for soils used as backfill material to fill 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 onsite for reuse. Existing construction scheduled to be removed for reuse shall be disassembled. Dismantled and removed materials are to be separated, set aside, and

prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Materials shall be designated for reuse onsite whenever possible.

3.1.1 Structures

Remove existing structures indicated to the bottom of foundation walls. Interior walls shall be removed to 3 feet below grade. Remove sidewalks, curbs, and gutters.

Demolish structures in a systematic manner from the top of the structure to the ground.

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. Provide a detailed connect abandonment and demolition plan for all utilities to be removed from service. The plan shall include drawings detailing phases of work, anticipated facility impacts, tie-ins occurring concurrently, activity sequencing, and any potential issues anticipated by the Contractor. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.2.1.1 Water System Requirements

No facility shall be out of water service for more than 48 hours. Each facility shall experience a maximum of one shutdown of up to 48 hours. Potable temporary water piping may be necessary to maintain service to some facilities.

Service tie-ins to the new water mains are not considered shutdowns unless they exceed 6 hours of outage time.

Contractor may be required to perform multiple tie-ins concurrently in order to bring new system or parts of the new system online and decommission old lines.

Caps on existing lines or lines to be abandoned will require thrust restraint if they are pressurized after the time of cap installation.

When a water line is designed to be completely removed from the ground, the associated valves along that line will be completely removed from the ground. When a water line is designed to be abandoned in place, the associated valves along that line will be abandoned in place.

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 but are not indicated on the drawings, notify the Contracting Officer prior to further work in that area. Remove meters and related equipment and deliver to a location in accordance with instructions

of the Contracting Officer.

3.1.3 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 Diverted Aggregate Reclamation and Collection Yard (DARCY) in accordance with NASA KSC policy.

3.1.4 Roofing

Remove existing roof system and associated components in their entirety down to existing roof deck.

3.1.5 Masonry

Sawcut and remove masonry.

3.1.6 Concrete

Salvage removed concrete.

3.1.7 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.

3.1.8 Mechanical Equipment and Fixtures

Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Disconnect mechanical equipment and fixtures 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.

3.1.8.1 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, shall be steam cleaned. Seal openings with caps, plates, or plugs. Secure motors attached by flexible connections to the unit.

3.1.8.2 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.

3.1.9 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.

3.1.9.1 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: Manage ballasts that cannot be identified as being PCB-free as if they are PCB-contaminated.

3.1.9.2 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.

3.1.9.3 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.

3.1.9.4 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.

3.1.10 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

Comply with U.S. Export Control Laws. Deconstruct all facilities and associated equipment so that they can neither be reassembled nor recognized. 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 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

Make every practical effort to reclaim and segregate materials that have the ability to be recycled. Segregate all reclaimed concrete from other wastes and transport to the KSC Landfill (L7-0071) on Schwartz Road. Transport all unpainted concrete to DARCY. Transport all reclaimed scrap metal, not being recycled by the Contractor outside KSC, to the RRMF with a KSC Form 7-49. Turn these items and the KSC Form 7-29 into RRMF personnel to ensure the proper disposition of the materials before leaving the recycling area. For any other information regarding what materials can be recycled or other general information regarding recycling policies at KSC, 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 AHRI 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 NASA KSC policy. 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

3.3.7 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 and the special conditions.

3.4 CLEANUP

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

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from 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 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 NASA KSC policy.

## 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; G

SD-06 Test Reports

Submit the following:

Initial Exposure Assessments in accordance with 29 CFR 1926

Notification of Demolition/Renovation as part of the Implementation Plan.

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 Contracting Officer 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 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, 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 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, 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, and posting of warning signs 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, 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 Contracting Officer) 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, 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 Contracting Officer 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 |

NOTE: The Contractor shall 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, 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 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 Contracting Officer. 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

During ACM removal, confine equipment and employees to the designated work area(s).

Unless otherwise directed by the Contracting Officer, the Contractor is to establish and maintain a 25-foot access control barrier zone(s) around the designated work area(s).

3.2.1 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.

3.3 WASTE LOAD-OUT UNIT

Establish a waste load-out unit to provide for interim secure 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, or wrapped in polyethylene sheeting. 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 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.

3.5.1 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.

3.6 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.

## 3.7 DAILY HOUSEKEEPING

Maintain a clean work area in accordance with 29 CFR 1926. At the end of each shift or prior to leaving the work site unattended, prepare contaminated waste for disposal by packaging the waste and removing it from the work area.

## 3.8 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.

## 3.9 INSPECTION

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

### 3.9.1 Initial Inspection

The Contractor 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 Contracting Officer.

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

### 3.9.2 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 appropriate work practices are followed, appropriate protective clothing and equipment are used, and worker decontamination procedures are being followed.

Provide updated copies of the Air Monitoring Reports, Daily Site Inspection Logs and Waste Stream Inventory to the Contracting Officer 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 Government, the Contracting Officer will require the Contractor to stop work until the unsafe conditions are corrected.

3.9.3 Final Inspection

The thoroughness of asbestos removal is to be evaluated by visually inspecting for residual asbestos material and accumulated dust followed by air sampling. Evidence of residual asbestos or asbestos debris 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 to ensure no residual asbestos material, dust or debris remains. Document final inspections on the Asbestos Abatement Clearance Inspection Checklist (KSC Form 28-1231NS).

In no case may fewer than two (2) final samples be collected for any area.

3.10 ASBESTOS WASTE AND CONTAMINATED MATERIALS

3.10.1 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.

3.10.1.1 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.

3.10.2 Work Area Disposal

After final inspection has been completed and the work area is released for occupancy. 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.

3.10.3 Decontamination Area And Support Area Disposal

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

3.11 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.

3.12 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). Send copies to the Contracting Officer upon satisfactory completion of the work. Notify 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 the Contracting Officer. 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).

3.13 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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REMOVAL/CONTROL AND DISPOSAL OF PAINT WITH LEAD

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 Z88.2 | (1992) Respiratory Protection |

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

| | |
|---|---|
| HUD 6780 | (1995; Errata Aug 1996;Rev Ch. 7 - 1997) Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing |

JOHN F. KENNEDY SPACE CENTER (KSC)

| | |
|---|---|
| KNPR 8500.1 | KSC Environmental Requirements |

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

| | |
|---|---|
| 29 CFR 1926.103 | Respiratory Protection |
| 29 CFR 1926.21 | Safety Training and Education |
| 29 CFR 1926.33 | Access to Employee Exposure and Medical Records |
| 29 CFR 1926.55 | Gases, Vapors, Fumes, Dusts, and Mists |
| 29 CFR 1926.59 | Hazard Communication |
| 29 CFR 1926.62 | Lead |
| 40 CFR 261 | Identification and Listing of Hazardous Waste |
| 40 CFR 262 | Standards Applicable to Generators of Hazardous Waste |
| 40 CFR 745 | Lead-Based Paint Poisoning Prevention in Certain Residential Structures |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 586 | (2009) Standard for High-Efficiency Particulate, Air Filter Units |

1.2 DEFINITIONS

1.2.1 Abatement

Any set of measures designed to permanently eliminate lead-based paint hazards in accordance with standards established by appropriate Federal agencies. Such term includes:

a. The removal of lead-based paint and lead-contaminated dust, the permanent containment or encapsulation of lead-based paint, the replacement of lead-painted surfaces or fixtures, and the removal or covering of lead contaminated soil; and

b. All preparation, cleanup, disposal, and post-abatement clearance testing activities associated with such measures.

1.2.2 Action Level

Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period in a work environment.

1.2.3 Area Sampling

Sampling of lead concentrations within the lead control area and inside the physical boundaries, which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.

1.2.4 Competent Person (CP)

As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, State, and local regulations. A Certified Industrial Hygienist (CIH) certified for comprehensive practice by the American Board of Industrial Hygiene or a Certified Safety Professional (CSP) certified by the Board of Certified Safety Professionals is the best choice.

1.2.5 Contaminated Room

Refers to a room for removal of contaminated personal protective equipment (PPE).

1.2.6 Decontamination Shower Facility

That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.

1.2.7 Deleading

Activities conducted by a person who offers to eliminate lead-based paint or lead-based paint hazards or to plan such activities in commercial buildings, bridges or other structures.

1.2.8 Eight-Hour Time Weighted Average (TWA)

Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.

1.2.9 High Efficiency Particulate Air (HEPA) Filter Equipment

HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.

1.2.10 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps.

1.2.11 Lead-Based Paint (LBP)

Paint or other surface coating that contains lead.

1.2.12 Lead-Based Paint Activities

Lead-based paint activities include; a lead-based paint inspection, a risk assessment, or abatement of lead-based paint hazards.

1.2.13 Lead-Based Paint Hazard (LBP Hazard)

Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.

1.2.14 Paint with Lead (PWL)

Any paint that contains lead as determined by the testing laboratory using a valid test method. The requirements of this section does not apply if no detectable levels of lead are found using a quantitative method for analyzing paint using laboratory instruments with specified limits of detection (usually 0.01%). An X-Ray Fluorescence (XRF) instrument is not considered a valid test method.

1.2.15 Lead Control Area

A system of control methods to prevent the spread of lead dust, paint chips or debris to adjacent areas that may include temporary containment, floor or ground cover protection, physical boundaries, and warning signs to prevent unauthorized entry of personnel. HEPA filtered local exhaust equipment may be used as engineering controls to further reduce personnel exposures or building/outdoor environmental contamination.

1.2.16 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a workday, the PEL shall be determined by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day

1.2.17 Personal Sampling

Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a

hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and centered at the nose or mouth of an employee.

1.2.18 Physical Boundary

Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside the physical boundary."

1.3 DESCRIPTION

1.3.1 Description of Work

Remove/control lead-based/paint with lead as indicated on the drawings. Remove paint in accordance with this Section and recycle, handle, and/or dispose of materials with lead paint in accordance with Federal and State regulations, this Section, and Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION. If a painted surface has not been tested for lead paint, assume lead is present or sample and analyze the paint to determine if lead is present.

1.3.2 Coordination with Other Work

The contractor shall coordinate with work being performed in adjacent areas. Coordination procedures shall be explained in the Removal/Control Plan and shall describe how the Contractor will prevent lead exposure to other contractors and/or Government personnel performing work unrelated to lead activities.

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

Vacuum Filters; G

Respirators; G

SD-06 Test Reports

sampling results; G

Occupational and Environmental Assessment Data Report; G

SD-07 Certificates

Qualifications of CP; G

Testing Laboratory qualifications; G

Training Certification of workers and supervisors; G

Third Party Consultant Qualifications; G

lead-based paint/paint with lead removal/control plan including CP approval (signature, date, and certification number); G

Respiratory Protection Program; G

Hazard Communication Program; G

Clearance Certification; G

SD-11 Closeout Submittals

KSC Waste Management Contractor is responsible for disposal of all hazardous, controlled, and universal wastes.

KSC Waste Management Internal Manifest; G

Certification of Medical Examinations; G

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

1.5.1.1 Qualifications of CP

Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained, licensed, and certified in accordance with Federal, State, and local laws.

1.5.1.2 Training Certification

Submit a certificate for each employee and supervisor, signed and dated by the training provider meeting 40 CFR 745 (Subpart L) requirements, stating that the employee or supervisor has received the required lead training and is certified to perform or supervise deleading or lead removal. Submit proof the work will be performed by a certified firm.

1.5.1.3 Testing Laboratory

Submit the name, address, and telephone number of the testing laboratory selected to perform the air and wipe sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis. Laboratories selected to perform blood lead analysis shall be OSHA approved.

1.5.1.4 Third Party Consultant Qualifications

Submit the name, address, and telephone number of the third party consultant selected to perform the wipe sampling for determining concentrations of lead in dust or soil sampling. Submit proper documentation that the consultant is trained and certified as an inspector technician or inspector/risk assessor by the USEPA authorized State (or local) certification and accreditation program.

1.5.2 Requirements

1.5.2.1 Competent Person (CP) Responsibilities

a. Verify training meets all federal, State, and local requirements.

b. Review and approve lead-based paint/paint with lead removal/control plan for conformance to the applicable standards. Ensure work is performed in strict accordance with specifications at all times.

c. Continuously inspect lead-based paint removal/control work for conformance with the approved plan.

d. Perform air and wipe sampling.

e. Control work to prevent hazardous exposure to human beings and to the environment at all times.

f. Certify the conditions of the work as called for elsewhere in this specification.

1.5.2.2 Lead-Based Paint/Paint with Lead Removal/Control Plan (LBP/PWL R/CP)

Submit a detailed job-specific plan of the work procedures to be used in the removal/control of LBP/PWL. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include a description of equipment and materials, controls and job responsibilities for each activity from which lead is emitted. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that lead is not released outside the lead control area. Include site preparation, cleanup and clearance procedures. Include occupational and environmental sampling, training, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan. Include a description of arrangements made among contractors on multi-contractor worksites to inform affected employees and to clarify responsibilities to control exposures.

The Removal/Control Plan shall be developed by a certified planner/project designer.

In occupied buildings, the Removal/Control Plan shall also include an occupant protection program that describes the measures that will be taken during the work to protect the building occupants.

1.5.2.3 Occupational and Environmental Assessment Data Report

If initial monitoring is necessary, submit occupational and environmental sampling results to the Contracting Officer within three working days of collection, signed by the testing laboratory employee performing the analysis, the employee that performed the sampling, and the CP.

In order to reduce the full implementation of 29 CFR 1926.62, the Contractor shall provide documentation. Submit a report that supports the determination to reduce full implementation of the requirements of

29 CFR 1926.62 and supporting the Lead Removal/Control Plan.

a. The initial monitoring shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures per 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead for stated work.

b. Submit worker exposure data gathered during the task based trigger operations of 29 CFR 1926.62 with a complete process description. This includes manual demolition, manual scraping, manual sanding, heat gun, power tool cleaning, rivet busting, cleanup of dry expendable abrasives, abrasive blast enclosure removal, abrasive blasting, welding, cutting and torch burning where lead containing coatings are present.

c. The initial assessment shall determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the lead compliance plan per 29 CFR 1926.62.

1.5.2.4 Medical Examinations

Initial medical surveillance as required by 29 CFR 1926.62 shall be made available to all employees exposed to lead at any time (1 day) above the action level. Full medical surveillance shall be made available to all employees on an annual basis who are or may be exposed to lead in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, and 29 CFR 1926.103. Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.

1.5.2.5 Training

Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations where appropriate.

1.5.2.6 Respiratory Protection Program

a. Provide each employee required to wear a respirator a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62.

b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.

1.5.2.7 Hazard Communication Program

Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.

1.5.2.8 Waste Management

The Waste Management Plan shall be in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

1.5.2.9 Environmental, Safety and Health Compliance

In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, local authorities, and KNPR 8500.1 regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply. The following Federal and State laws, ordinances, criteria, rules and regulations regarding removing, handling, storing, transporting, and disposing of lead-contaminated materials apply:

a. 40 CFR 745 (Subpart L)

b. 29 CFR 1926.62

Licensing and certification in the State of Florida is required.

1.5.3 Pre-Construction Conference

Along with the CP, meet with the Contracting Officer to discuss in detail the waste management plan and the lead-based paint/paint with lead removal/control plan, including work procedures and precautions for the removal plan.

1.6 EQUIPMENT

1.6.1 Respirators

Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.

1.6.2 Special Protective Clothing

Furnish personnel who will be exposed to lead-contaminated dust with proper disposable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.

1.6.3 Rental Equipment Notification

If rental equipment is to be used during lead-based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the Contracting Officer.

1.6.4 Vacuum Filters

UL 586 labeled HEPA filters.

1.6.5 Equipment for Government Personnel

Furnish the Contracting Officer with two complete sets of personal

protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. The Government will provide respiratory protection for the Contracting Officer.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Protection of Existing Work to Remain

Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.

PART 2 PRODUCTS

Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

3.1.1.1 Notification

a. Notify the Contracting Officer 20 days prior to the start of any paint removal work.

3.1.1.2 Boundary Requirements

a. Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that lead will not escape outside the lead control area.

b. Warning Signs - Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.

3.1.1.3 Heating, Ventilating and Air Conditioning (HVAC) Systems

Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area.

3.1.1.4 Decontamination Facility

Provide clean and contaminated change rooms in accordance with this specification and 29 CFR 1926.62.

3.1.1.5 Eye Wash Station

Where eyes may be exposed to injurious corrosive materials, suitable

facilities for quick drenching or flushing of the eyes shall be provided within the work area.

3.1.1.6 Mechanical Ventilation System

a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.

b. To the extent feasible, use local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be evaluated and maintained in accordance with 29 CFR 1926.62.

c. Vent local exhaust outside the building only and away from building ventilation intakes.

d. Use locally exhausted, power actuated, paint removal tools.

3.1.1.7 Personnel Protection

Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

3.2 ERECTION

3.2.1 Lead Control Area Requirements

Establish a lead control area by situating critical barriers and physical boundaries around the area or structure where LBP/PWL removal/control operations will be performed.

3.3 APPLICATION

3.3.1 Work Procedures

Perform removal of lead-based paint in accordance with approved lead-based paint/paint with lead removal/control plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-based paint is removed in accordance with 29 CFR 1926.62. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), State, and local requirements.

3.3.2 Lead-Based Paint Removal/Control/Deleading

Manual or power sanding of interior and exterior surfaces is not permitted unless tools are equipped with HEPA attachments or wet methods. The dry sanding or grinding of surfaces that contain lead is prohibited. Provide methodology for LBP removal/control in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.

Provide methodology for LBP/PWL removal and abatement/control and processes to minimize contamination of work areas outside the control area with lead-contaminated dust or other lead-contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous

concentrations of lead. Describe this LBP/PWL removal/control process in the LBP/PWL R/CP.

3.3.2.1 Outdoor Paint Removal

Perform outdoor removal as indicated in federal, State, and local regulations and in the LBP/CPR/CP. The worksite preparation (barriers or containments) shall be job dependent and presented in the LBP/PWL R/CP.

3.3.3 Personnel Exiting Procedures

Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.

b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.

c. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

3.4 FIELD QUALITY CONTROL

3.4.1 Tests

3.4.1.1 Air and Wipe Sampling

Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.

a. The CP shall be on the job site directing the air and non-clearance wipe sampling and inspecting the lead-based paint removal/control work to ensure that the requirements of the contract have been satisfied during the entire lead-based paint removal operation.

b. Collect personal air samples on employees who are expected to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.

c. Submit results of air samples, within 72 hours after the air samples are taken.

d. Before any work begins, a third party consultant shall collect and analyze baseline wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead-based paint removal/control.

e. Collect surface wipe samples at a location no greater than 10 feet outside the lead control area at a frequency of once per day while lead removal work is conducted. Surface wipe results shall meet criteria in paragraph "Clearance Certification."

3.4.1.2 Air Sampling During Paint Removal Work

Conduct area air sampling daily, on each shift in which lead-based paint

removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the Contracting Officer immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after the CP and the Contracting Officer give approval. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3.4.1.3 Sampling After Paint Removal/Control

After the visual inspection, collect wipe samples according to the HUD protocol contained in HUD 6780 to determine the lead content of settled dust and dirt in micrograms per square meter foot of surface area.

3.4.1.4 Testing of Removed Paint and Used Abrasive

Test removed paint and used abrasive in accordance with 40 CFR 261 for hazardous waste.

3.5 CLEANING AND DISPOSAL

3.5.1 Cleanup

Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

3.5.1.1 Clearance Certification

The CP shall certify in writing that air samples collected outside the lead control area during paint removal operations are less than 30 micrograms per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of material and dust containing lead left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the Contracting Officer's acknowledgement of receipt of the CP certification.

For lead-based paint hazard abatement work, surface wipe and soil sampling shall be conducted and clearance determinations made according to the work practice standards presented in 40 CFR 745.227.

3.5.2 Disposal

a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing that may produce airborne

concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 262. Dispose of lead-contaminated waste material in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION paragraph "Materials Management and Waste Disposal", and NASA KSC policy.

b. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

3.5.2.1 Disposal Documentation

In accordance with NASA KSC policy, provide all KSC Waste Management internal manifest copies upon completion of the project to the Contracting Officer.

-- End of Section --

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DIVISION 03 - CONCRETE

SECTION 03 01 30.71

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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 | (2009a) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C 881/C 881M | (2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete |

1.2 DEFINITIONS

1.2.1 Epoxy Resin Binder

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

1.2.2 Epoxy Concrete

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

-- End of Section --

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SECTION 03 30 00

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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 | (2010) Manual of Concrete Practice Part 1 |
| ACI/MCP-2 | (2010) Manual of Concrete Practice Part 2 |
| ACI/MCP-3 | (2010) Manual of Concrete Practice Part 3 |
| ACI/MCP-4 | (2010) Manual of Concrete Practice Part 4 |

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 322M/M 322 | (2007) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 185/A 185M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete |
| ASTM A 496/A 496M | (2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement |
| ASTM A 497/A 497M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete |
| ASTM A 615/A 615M | (2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A 82/A 82M | (2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement |
| ASTM A 996/A 996M | (2009b) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement |
| ASTM C 1107/C 1107M | (2008) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |

| | |
|---|---|
| ASTM C 143/C 143M | (2009) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C 150/C 150M | (2009) Standard Specification for Portland Cement |
| ASTM C 156 | (2009a) Standard Test Method for Water Retention by Concrete Curing Materials |
| ASTM C 171 | (2007) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C 172 | (2008) Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C 173/C 173M | (2009) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |
| ASTM C 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/C 33M | (2008) Standard Specification for Concrete Aggregates |
| ASTM C 39/C 39M | (2009a) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C 42/C 42M | (2004) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| ASTM C 494/C 494M | (2008a) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C 618 | (2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |

| | |
|---|---|
| ASTM C 881/C 881M | (2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete |
| ASTM C 920 | (2008) Standard Specification for Elastomeric Joint Sealants |
| ASTM C 932 | (2006) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering |
| ASTM C 94/C 94M | (2011) Standard Specification for Ready-Mixed Concrete |
| ASTM C 989 | (2009a) Standard Specification for Slag Cement for Use in Concrete and Mortars |
| ASTM C 990 | (2009) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM D 1557 | (2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D 1751 | (2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |
| ASTM D 1752 | (2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion |
| ASTM D 4397 | (2009) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications |
| ASTM D 5759 | (1995; R 2005) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses |
| ASTM D 6690 | (2007) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements |
| ASTM E 1155 | (1996; R 2008) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers |
| ASTM E 329 | (2009) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction |
| ASTM E 648 | (2009a) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems |

Using a Radiant Heat Energy Source

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP (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

Reinforcing Steel; G

Reproductions of contract drawings are unacceptable.

SD-03 Product Data

Joint sealants
Epoxy Bonding Compound

Submit manufacturer's product data, indicating VOC content. Manufacturer's catalog data for the following items must include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders.

Waterstops

SD-05 Design Data

Concrete Mix design; G

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, ground slag, and admixtures; and applicable reference specifications.

SD-06 Test Reports

Compressive strength tests

Air Content

Slump

Air Entrainment

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Drawings

1.6.1.1 Reinforcing Steel

ACI/MCP-4. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars.

1.6.2 Test Reports

1.6.2.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been

successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. Include mill test and all other test for cement, aggregates, and admixtures in the laboratory test reports.

1.7 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Perform concrete testing by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency must meet the requirements of ASTM E 329.

PART 2 PRODUCTS

2.1 CONCRETE

2.1.1 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/C 33M Maximum Nominal Aggregate (Size No.) | Range of Slump (inches) | Maximum Water-Cement Ratio (by weight) | Air Entr. (percent) |
|---|---|---|---|---|---|
| Slab on Grade | 3000 | 3/4-inch | | | |
| 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.

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/C 150M, Type I or II blended cement except as modified herein. Provide blended cement that consists of a mixture of ASTM C 150/C 150M, Type II, cement and one of the following materials: ASTM C 618 pozzolan or fly ash, ASTM C 989 ground granulated blast-furnace slag. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. Supplier must certify that no hazardous waste is used in the fuel mix or raw materials. Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants are discharged. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

2.2.1.1 Fly Ash and Pozzolan

ASTM C 618, Type N, F, or C, except that the maximum allowable loss on

ignition must be 6 percent for Types N and F. Add with cement. Fly ash content must be a minimum of 15 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C 311. Evaluate and classify fly ash in accordance with ASTM D 5759.

High contents of supplementary cementitious materials can have some detrimental effects on the concrete properties, such as slowing excessively the strength gain rate, and delaying and increasing the difficulty of finishing. The recommended maximum content (by weight of the total cementitious material) for these materials are:

1. For ground granulated blast-furnace (GGBF) slag: 50 percent

2. For fly ash or natural pozzolan: 40 percent (25 percent in cold climates)

3. For silica fume: 10 percent

2.2.1.2 Portland Cement

Provide cement that conforms to ASTM C 150/C 150M, Type I, IA, II, or IIA. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.2.2 Water

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementitious materials (cement plus pozzolans), and in general, improve workability by adjusting the grading rather than by adding water. Water must be fresh, clean, and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.2.3 Aggregates

ASTM C 33/C 33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement.

2.2.4 Nonshrink Grout

ASTM C 1107/C 1107M.

2.2.5 Admixtures

ASTM C 494/C 494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures.

2.2.5.1 High Range Water Reducer (HRWR) (Superplasticizers)

ASTM C 494/C 494M, Type F.

2.2.5.2 Pozzolan

Provide fly ash or other pozzolans used as admixtures that conform to ASTM C 618.

2.2.6 Vapor Barrier

ASTM D 4397 polyethylene sheeting, minimum thickness indicated in drawings.

2.2.7 Materials for Curing Concrete

Consider agents that are not toxic and emit low or no Volatile Organic Compounds (VOC).

2.2.7.1 Liquid Membrane-Forming Compound

ASTM C 309, white-pigmented, Type 2, Class B.

2.2.8 Expansion/Contraction Joint Filler

ASTM D 1751. Material must be 1/2 inch thick, unless otherwise indicated.

2.2.8.1 Preformed Joint Filler Strips

Provide nonextruding and resilient bituminous type filler strips conforming to ASTM D 1751.

2.2.9 Joint Sealants

Use concrete penetrating sealers with a low VOC content.

2.2.9.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D 6690 or ASTM C 920, Type M, Class 25, Use T.

2.2.9.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C 920, Type M, Grade NS, Class 25, Use T.

2.2.9.3 Waterstops

Provide waterstops made of rubber and that conform to ASTM D 1752 or provide waterstops made of polyvinylchloride (PVC) and that conform to ASTM C 990.

2.2.9.4 Joint Sealant Compound

Provide hot-poured, elastic type compound conforming to ASTM D 6690.

2.2.10 Epoxy Bonding Compound

ASTM C 881/C 881M. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if placement temperature is below 40 degrees F; Class B if placement temperature is between 40 and 60 degrees F; or Class C if placement temperature is above 60 degrees F.

2.2.11 Biodegradable Form Release Agent

Provide form release agent that is colorless, biodegradable, and with a low VOC content. A minimum of 85 percent of the total product must be biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

2.3 REINFORCEMENT

2.3.1 Reinforcing Bars

ACI/MCP-2 unless otherwise specified. Use deformed steel. ASTM A 615/A 615M and AASHTO M 322M/M 322 with the bars marked A, S, W, Grade 60; or ASTM A 996/A 996M with the bars marked R, Grade 60, or marked A, Grade 60.

2.3.2 Wire

ASTM A 82/A 82M or ASTM A 496/A 496M.

2.3.2.1 Welded Wire Fabric

ASTM A 185/A 185M or ASTM A 497/A 497M. Provide flat sheets of welded wire fabric for slabs and toppings.

2.3.3 Reinforcing Bar Supports

Provide bar ties and supports of coated or non corrodible material.

2.3.4 Supports for Reinforcement

Supports include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcing bars and wire fabric in place.

Provide wire bar type supports conforming to ACI/MCP-3, ACI/MCP-4 and CRSI 10MSP.

Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

2.4 BONDING MATERIALS

2.4.1 Concrete Bonding Agent

Provide aqueous-phase, film-forming, nonoxidizing, freeze and thaw-resistant compound agent suitable for brush or spray application conforming to ASTM C 932.

2.4.2 Epoxy-Resin Adhesive Binder

Provide two-component, epoxy-polysulfide polymer type binder with an amine-type curing-agent conforming to FS MMM-A-001993, Type I or ASTM C 881/C 881M.

2.5 CLASSIFICATION AND QUALITY OF CONCRETE

2.5.1 Concrete Classes and Usage

Provide concrete classes, compressive strength, requirements for air entrainment, and usage as follows:

| CONCRETE CLASS | MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER SQ. IN. | REQUIREMENT FOR AIR ENTRAINMENT | USAGE |
|---|---|---|---|
| 3A | 3,000 | Air-entrained | For foundation |
| 4A | 4,000 | Air-entrained | For structural concrete work exposed to freezing and thawing, unless otherwise indicated or specified, such as exterior columns and spandrels |

2.5.2 Limits for Concrete Proportions

Provide limits for maximum water/cement ratio and minimum cement content for each concrete class as follows:

| CONCRETE CLASS | MAX. WATER/CEMENT RATIO BY WEIGHT | MIN. CEMENT FOR 3- TO 4-INCH SLUMP, (NO. OF 94-POUND SACKS) PER CU. YD. |
|---|---|---|
| 3A | 0.45 | 6.0 |
| 4A | 0.46 | 6.0 |

* Weight of water to weight of cement in pounds in one cubic yard of concrete

2.5.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, must be as follows:

| MAXIMUM SIZE OF AGGREGATE | ASTM C 33/C 33M SIZE NUMBER | TYPE OF CONSTRUCTION |
|---|---|---|
| 3/4 inch | 67 | Reinforced walls, columns, girders, beams, and other formed sections having a dimension between forms of not 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 |

| MAXIMUM SIZE OF AGGREGATE | ASTM C 33/C 33M SIZE NUMBER | TYPE OF CONSTRUCTION |
|---|---|---|
| | | other flatwork having a depth of not less than 2-1/2 inches and a clear distance between reinforcing bars of not less than 1 inch |
| 1/2 inch | 7 | Concrete joist construction, beams, reinforced walls, and other formed work having a clear distance between reinforcing bars and face of form of less than 1 inch |

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

2.5.4 Slump

Provide slump for concrete at time and in location of placement as follows:

| TYPE OF CONSTRUCTION | SLUMP |
|---|---|
| Columns, beams, reinforced walls, monolithic slabs | Not less than 1 inch nor more than 4 inches |

2.5.5 Total Air Content

Air content of exposed concrete and interior concrete must be in accordance with ASTM C 260 and/or as follows:

| LIMITS CONCRETE EXPOSURE | REQUIREMENT FOR AIR ENTRAINMENT | MAXIMUM SIZE OF AGGREGATE | TOTAL AIR CONTENT BY VOLUME |
|---|---|---|---|
| Exposed to freezing and thawing or subjected to hydraulic pressure | Air-entrained | 1-1/2 or 2 inches | 4 to 6 percent |
| | | 3/4 inch | 5 to 7 percent |
| | | 1/2 or 3/8 inch | 6 to 8.5 percent |

Provide concrete exposed to freezing and thawing or subjected to hydraulic pressure that is air-entrained by addition of approved air-entraining admixture to concrete mix.

PART 3 EXECUTION

3.1 EXAMINATION

Do not begin installation until substrates have been properly constructed; verify that substrates are plumb and true.

If substrate preparation is the responsibility of another installer, notify AContracting Officer of unsatisfactory preparation before processing.

Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Contracting Officer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, ice, and other deleterious substances before start of concrete placing.

Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, seal subgrade surface by covering surface with specified water barrier subgrade cover; this may also be used over semiporous, dry subgrade material instead of water sprinkling.

3.2.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

Previously constructed subgrade or fill must be cleaned of foreign materials and inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 12 inches of subgrade soil material-in-place must not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D 1557.

| SOIL MATERIAL | PERCENT MAXIMUM DENSITY |
|---|---|
| Drainage fill | 100 |
| Cohesionless soil material | 100 |
| Cohesive soil material | 95 |

Finish surface of drainage fill under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

Prepare subgrade or fill surface under exterior slabs on ground as specified for subgrade under foundations and footings.

3.2.4 Formwork

Complete and approve formwork. Remove debris and foreign material from interior of forms before start of concrete placing.

3.2.5 Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.6 Reinforcement and Other Embedded Items

Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

3.3 FORMS

ACI/MCP-2. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris. Forms submerged in water must be watertight.

3.3.1 General

Construct forms to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms must be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

3.3.2 Design and Construction of Formwork

Provide formwork design and construction that conforms to ACI/MCP-2, Chapter 4.

Provide forms that are tight to prevent leakage of cement paste during concrete placing.

Support form facing materials by structural members spaced close to prevent deflection of form facing material. Fit forms placed in successive units for continuous surfaces to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, camber formwork for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Chamfer exposed joints, edges, and external corners a minimum of 3/4 inch by moldings placed in corners of column, beam, and wall forms.

Provide shores and struts with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations. Obtain adjustment with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, provide trussed supports.

Provide temporary openings in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Provide forms that are readily removable without impact, shock, or damage to concrete.

3.3.3 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.3.4 Reshoring

Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, reshore slabs and beams over 10 feet in span and cantilevers over 4 feet for the remainder of the specified time period in accordance with paragraph entitled "Removal of Forms." Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Provide reshoring elements with the same load-carrying capabilities as original shoring and spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.3.5 Reuse

Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

3.3.6 Forms for Standard Rough Form Finish

Give rough form finish concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish must be the specified concrete form plywood or other approved form facing material that produces concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 1-inch nominal thickness lumber may be used. Provide horizontal joints that are level and vertical joints that are plumb.

3.3.7 Forms for Standard Smooth Form Finish

Give smooth form finish concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish must be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form

plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales must not exceed 0.0025 times the span.

Provide arrangement of form facing sheets that are orderly and symmetrical, and sheets that are in sizes as large as practical.

Arrange panels to make a symmetrical pattern of joints. Horizontal and vertical joints must be solidly backed and butted tight to prevent leakage and fins.

3.3.8 Form Ties

Provide ties that are factory fabricated metal, adjustable in length, removable or snap-off type that do allow form deflection or do not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts must be at least 1-1/2 inches back from concrete surface. Provide form ties that are free of devices that leave a hole larger than 7/8 inch or less than 1/2 inch in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.3.9 Tolerances for Form Construction

Construct formwork to ensure that after removal of forms and prior to patching and finishing of formed surfaces, provide concrete surfaces in accordance with tolerances specified in ACI/MCP-1 and ACI/MCP-2.

3.3.10 Removal of Forms and Supports

After placing concrete, forms must remain in place for the time periods specified in ACI/MCP-4. Do not remove forms and shores (except those used for slabs on grade and slip forms) until the Contracting Officer determines that the concrete has gained sufficient strength to support its weight and superimposed loads. Base such determination on compliance with one of the following:

a. The plans and specifications stipulate conditions for removal of forms and shores, and such conditions have been followed, or

b. The concrete has been properly tested with an appropriate ASTM standard test method designed to indicate the concrete compressive strength, and the test results indicate that the concrete has gained sufficient strength to support its weight and superimposed loads.

Prevent concrete damage during form removal. Clean all forms immediately after removal.

3.3.10.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if ASTM C 39/C 39M test results of field-cured samples from a representative portion of the structure indicate that the concrete has reached a minimum of 85 percent of the design strength.

3.4 WATERSTOP SPLICES

Fusion weld in the field.

## 3.5 FORMED SURFACES

### 3.5.1 Preparation of Form Surfaces

Coat contact surfaces of forms with form-coating compound before reinforcement is placed. Provide a commercial formulation form-coating compound that does not bond with, stain, nor adversely affect concrete surfaces and impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Do not allow excess form-coating compound to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete is placed. Make thinning of form-coating compound with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

### 3.5.2 Tolerances

ACI/MCP-4 and as indicated.

### 3.5.3 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Do not use material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which can impair the texture of the concrete surface.

## 3.6 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI/MCP-2. Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

### 3.6.1 General

Provide details of reinforcement that are in accordance with ACI/MCP-3 and ACI/MCP-4 and as specified.

### 3.6.2 Vapor Barrier

Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tape or cement joints. Remove torn, punctured, or damaged vapor barrier material and provide with new vapor barrier prior to placing concrete. Concrete placement must not damage vapor barrier material.

### 3.6.3 Reinforcement Supports

Place reinforcement and secure with galvanized or non corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use

concrete or other non corrodible material, having a compressive strength equal to or greater than the concrete being placed.

3.6.4 Splicing

As indicated. For splices not indicated ACI/MCP-2. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 2 inches.

3.6.5 Cover

ACI/MCP-2 for minimum coverage, unless otherwise indicated.

3.6.6 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.6.7 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.6.8 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.6.9 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

Provide fabrication tolerances that are in accordance with ACI/MCP-1, ACI/MCP-2 and ACI/MCP-3.

Provide hooks and bends that are in accordance with ACI/MCP-3 and ACI/MCP-4.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Tolerance on nominally square-cut, reinforcing bar ends must be in accordance with ACI/MCP-3.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal

with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances

b. Bends or kinks not indicated on drawings or approved shop drawings

c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.6.10 Placing Reinforcement

Place reinforcement in accordance with ACI/MCP-3 and ACI/MCP-4.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire fabric on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

Contractor must cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor must notify the Contracting Officer so that conflicts may be reconciled before placing concrete. Anchors and embedded items must be positioned and supported with appropriate accessories.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Provide supports for reinforcing bars that are sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI/MCP-3, ACI/MCP-4 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

Equip supports on ground and similar surfaces with sand-plates.

Support welded wire fabric as required for reinforcing bars.

Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

With the exception of temperature reinforcement, tied to main steel approximately 24 inches on center, reinforcement must be accurately placed, securely tied at intersections with 18-gage annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to ACI/MCP-3.

Bending of reinforcing bars partially embedded in concrete is permitted only as specified in ACI/MCP-3 and ACI/MCP-4.

3.6.11 Spacing of Reinforcing Bars

Spacing must be as indicated. If not indicated, spacing must be in accordance with ACI/MCP-3 and ACI/MCP-4.

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to approval.

3.6.12 Concrete Protection for Reinforcement

Concrete protection must be in accordance with the ACI/MCP-3, ACI/MCP-4, and ASTM E 648.

3.7 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C 94/C 94M, and ACI/MCP-2, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.7.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

3.7.2 Mixing

ASTM C 94/C 94M and ACI/MCP-2. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.7.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.8 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather

conditions prevent proper placement, consolidation, and finishing; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

3.8.1 General Placing Requirements

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation.

Concrete to receive other construction must be screeded to proper level to avoid excessive skimming or grouting.

Do not use concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Use of retempered concrete is permitted. Remove rejected concrete from the site.

3.8.2 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

3.8.3 Vibration

ACI/MCP-2. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 9,000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 20 inches apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 24 inch maximum vertical lifts. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

3.8.4 Pumping

ACI/MCP-2. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course

aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.8.5 Cold Weather

ACI/MCP-2. Do not allow concrete temperature to decrease below 50 degrees 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 | (2010) 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 A48/A48M | (2003; R 2008) Standard Specification for Gray Iron Castings |
| ASTM A536 | (1984; R 2009) Standard Specification for Ductile Iron Castings |
| ASTM A 615/A 615M | (2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A 82/A 82M | (2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement |
| ASTM C 1064/C 1064M | (2008) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete |
| ASTM C 1107/C 1107M | (2008) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C 1116/C 1116M | (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 14 | (2007) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe |
| ASTM C 143/C 143M | (2009) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C 1478 | (2008) Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals |
| ASTM C 150/C 150M | (2009) Standard Specification for Portland Cement |
| ASTM C 171 | (2007) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C 173/C 173M | (2009) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |
| ASTM C 192/C 192M | (2007) Standard Practice for Making and Curing Concrete Test Specimens in the |

| | |
|---|---|
| | Laboratory |
| ASTM C 231 | (2009a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C 260 | (2006) Standard Specification for Air-Entraining Admixtures for Concrete |
| ASTM C 309 | (2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C 31/C 31M | (2009) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C 33/C 33M | (2008) Standard Specification for Concrete Aggregates |
| ASTM C 330 | (2005) Standard Specification for Lightweight Aggregates for Structural Concrete |
| ASTM C 39/C 39M | (2009a) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C 443 | (2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C 478 | (2009) Standard Specification for Precast Reinforced Concrete Manhole Sections |
| ASTM C 494/C 494M | (2008a) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C 595/C 595M | (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 920 | (2008) Standard Specification for Elastomeric Joint Sealants |
| ASTM C 923 | (2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals |
| ASTM C 989 | (2009a) Standard Specification for Slag Cement for Use in Concrete and Mortars |
| ASTM C 990 | (2009) Standard Specification for Joints |

| | |
|---|---|
| | for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS SS-S-210 | (Rev A, Notice 3) Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints |

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

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

## 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. The use of self-consolidating concrete is permitted, provided that mix design proportions and constituents meet the requirements of this specification.

1.2.4.2 Concrete Strength

Provide precast concrete units with a 28-day compressive strength (f'c) of 5000 psi.

1.2.4.3 Water-to-Cement Ratio

Furnish concrete, that will be exposed to freezing and thawing, containing entrained air and with water-cement ratios of 0.45 or less. Furnish concrete which will not be exposed to freezing, but which is required to be watertight, with a water-cement ratio of 0.48 or less if the concrete is exposed to fresh water, or 0.45 or less if exposed to brackish water or sea water. Furnish reinforced concrete exposed to deicer salts, brackish water or seawater with a water-cement ratio of 0.40 or less for corrosion protection.

1.2.4.4 Air Content

The air content of concrete that will be exposed to freezing conditions shall be within the limits given below.

| NOMINAL MAXIMUM AGGREGATE SIZE | AIR CONTENT % SEVERE EXPOSURE | MODERATE EXPOSURE |
|---|---|---|
| 10 mm (3/8 inch) | 6.0 to 9.0 | 4.5 to 7.5 |
| 13 mm (1/2 inch) | 5.5 to 8.5 | 4.0 to 7.0 |
| 19 mm (3/4 inch) | 4.5 to 7.5 | 3.5 to 6.5 |
| 25 mm (1.0 inch) | 4.5 to 7.5 | 3.0 to 6.0 |
| 38 mm (1.5 inch) | 4.5 to 7.0 | 3.0 to 6.0 |

Note: For specified compressive strengths greater than 5000 psi, air content may be reduced 1 percent

1.3 SUBMITTALS

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

SD-01 Preconstruction Submittals

Quality Control Procedures

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

SD-03 Product Data

Standard Precast Units; G

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

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-06 Test Reports

Test Reports

1.4 QUALITY ASSURANCE

Demonstrate adherence to the standards set forth in NPCA QC Manual and/or ACPA QPC. Meet requirements written in the subparagraphs below.

1.4.1 NPCA and ACPA Plant Certification

The precast concrete producer shall be certified by the National Precast Concrete Association's and/or the American Concrete Pipe Association's Plant Certification Program prior to and during production of the products for this project.

1.4.2 Qualifications, Quality Control and Inspection

1.4.2.1 Qualifications

Select a precast concrete producer that has been in the business of producing precast concrete units similar to those specified for a minimum of 3 years. The precast concrete producer shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis.

1.4.2.2 Quality Control Procedures

Show that the following QC tests are performed as required and in accordance with the ASTM standards indicated.

a. Slump: Perform a slump test for each 150 cu yd of concrete produced, or once a day, whichever comes first. Perform slump tests in accordance with ASTM C 143/C 143M.

b. Temperature: Measure the temperature of fresh concrete when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C 1064/C 1064M.

c. Compressive Strength: Make at least four compressive strength specimens for each 150 cubic yards of concrete of each mix in accordance with the following Standards: ASTM C 31/C 31M, ASTM C 192/C 192M, ASTM C 39/C 39M.

d. Air Content: Perform tests for air content on air-entrained, wet-cast concrete for each 150 cu yd of concrete, but not less often than once each day when air-entrained concrete is used. Determine the air content in accordance with either ASTM C 231 or ASTM C 173/C 173M for normal weight aggregates and ASTM C 173/C 173M for lightweight aggregates.

e. Unit Weight: Perform tests for unit weight a minimum of once per week to verify the yield of batch mixes. Perform unit weight tests for each 100 cu yd of lightweight concrete in accordance with ASTM C 138/C 138M.

Submit test reports as Follows:

a. Copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

b. Copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze thaw durability, abrasion and absorption. Clearly detail in the specifications special tests for precast concrete or cast-in items.

c. Sufficient documentation, when the use of self-consolidating concrete (SCC) is proposed, showing a minimum of 30-days production track records demonstrating that SCC is appropriate for casting of the product.

d. Copies of in-plant QA/QC inspection reports, upon the request of the Contracting Officer.

1.4.2.3 Inspection

The Contracting Officer may place an inspector in the plant when the units covered by this specification are being manufactured. The precast concrete producer shall give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver precast units to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite, all precast concrete units will be inspected by the Contracting Officer for quality and final acceptance.

1.5.2 Storage

Store units off the ground or in a manner that will minimize potential damage.

1.5.3 Handling

Handle, transport, and store products in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Perform lifting with methods or devices intended for this purpose as indicated on shop drawings.

PART 2 PRODUCTS

2.1 MATERIALS

Except as otherwise specified in the following paragraphs, conform materials to Section 03 30 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

e. Grade Rings: Use precast concrete grade rings to support and adjust manhole frames. Grade rings shall conform to ASTM C 478 and shall be set in a full bed of mortar.

2.1.12 Pipe Entry Connectors

Pipe entry connectors shall conform to ASTM C 923 or ASTM C 1478.

2.1.13 Grout

Nonshrink grout shall conform to ASTM C 1107/C 1107M. Cementitious grout shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.

2.1.14 Precast Concrete Manholes

Precast concrete manholes shall conform to ASTM C 478.

2.1.14.1 Manhole Bases

Manhole bases shall be precast concrete. Their design and fabrication shall conform to the general requirements of this Section and the provisions of ASTM C 478. The bases shall conform to the dimensions shown on the drawings. The horizontal joint at the top of the base shall be compatible with that of the precast wall sections.

The precast bases shall be manufactured to contain openings in the wall of minimum size to receive the ends of the pipe. All penetrations shall be cast in at the concrete precast plant. Drilled openings shall not be permitted. These openings shall be accurately set to conform to line and grade of pipe.

All precast concrete bases shall be free from cracks, damaged joints, exposed reinforcing, aggregate pockets, spalls, and dimensional distortions or other irregularities. Any units rejected by the Contracting Officer shall be tagged and removed from the job site immediately.

2.1.14.2 Manhole Wall and Top

Precast concrete walls shall be made up of straight, circular sections and eccentric tops if manhole steps are required. The total height of precast wall required for each manhole shall be determined in the field and shall be such that the vertical distance between the top of the assembled precast units and the bottom of the installed cast-iron manhole frame is a minimum of 4 inches and a maximum of 12 inches to allow for masonry work or precast concrete grade rings.

All precast units shall be laid up plumb and level. Minimum longitudinal and circumferential reinforcing steel shall be in conformance with ASTM C 478.

All precast concrete sections shall be free from cracks, damaged joints, exposed reinforcing, aggregate pockets, spalls, dimensional distortions, or other irregularities. Any units rejected by the Contracting Officer shall be tagged and removed from the job site immediately.

Precast reinforced concrete slab tops for manholes shall be 8 inches thick and manufactured in accordance with ASTM C 478. Openings shall be eccentric when manholes are furnished with steps and concentric if they have no steps and of the proper diameter to receive the frame specified. Slab tops shall be set in a full bed of mortar.

2.1.14.3 Manhole Bench Walls

The flow channels in each manhole shall be carefully shaped following the details on the drawings. They shall match the inverts and size of pipes which connect to the manhole, creating a channel of gradual slope and curvature so that a smooth, uninterrupted flow through the manhole is ensured. The inverts of these channels shall be construction of half pipe sections or concrete. For bends, short sections of half pipe may be cut and used to form the channel. Refer to drawings for details. The bench surface itself shall extend laterally to the manhole walls, pitching slightly toward the flow channel.

Minimum concrete Class C mix shall be used for bench walls and all exposed surfaces shall receive a steel-troweled finish. Horizontal surfaces shall then be brush finished.

2.1.14.4 Manhole Frames and Covers

Frames and covers shall have 24-inch openings and shall be heavy duty, non-penetrating pickhole type of non-rocking design and shall have machined bearing surfaces to prevent rocking and rattling under traffic loads.

Material shall be gray cast iron conforming to ASTM A48/A48M, Class 30; or shall be ductile cast iron conforming to ASTM A536, Grade 60-40-18.

Castings shall be manufactured true to pattern and shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage distortion, or other defects. Components shall fit together completely.

Covers shall have cast-in, 1-1/2-inch-wide, raised letters with lettering as shown in the drawings.

The finish shall be smooth and well cleaned by shot-blasting or by some other approved method.

Frames shall be firmly seated in a full bed of mortar and be positioned to conform to the adjacent finished grade or to the specific elevation shown on the drawings. Frames shall be set parallel to surface slopes. Covers shall seat uniformly in any position in the frame without rocking.

2.1.14.5 Manhole Steps

When shown on the drawings, manhole steps shall be copolymer polypropylene plastic with 1/2-inch Grade 60 steel reinforcement as manufactured by M.A. Industries, Inc., or equal.

Steps are to be cast in or grouted solid into the precast units at intervals of 12 inches. Steps shall be in conformance with OSHA requirements, having drop front or equivalent. Bolted-on types are not acceptable.

2.1.14.6 Jointing Precast Sections

Seal tongue-and-groove joints of precast manhole sections with either rubber O-ring gaskets or preformed flexible joint sealant. O-ring gaskets shall conform to ASTM C 443 and FS SS-S-210. Preformed flexible joint sealant shall be Kent Seal No. 2 by Hamilton-Kent, Ram-Nek by Henry, or equal.

After the joints are assembled the gap between sections shall be packed on the inside and outside with Anti-Hydro "Axpandaretes," Masterflow 713 by Master Builders or Five Star Grout by U.S. Grout Corp. and shall be troweled smooth so that no projections remain on the inside.

The completed joint shall withstand 15-psi internal water pressure without leakage or displacement of gasket or sealant.

2.1.14.7 Pipe Connections to Manholes

Connect pipe to manholes in the following ways:

Flexible sleeve - integrally cast the sleeve in a precast manhole section or install the sleeve in a formed or cored opening. Fasten pipe in sleeve with stainless steel clamp(s). Coat stainless steel

clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve, Kor-N-Seal connector, or equal.

Compression gasket - integrally cast the compression gasket in a precast manhole section. Insert pipe into compression gasket. The compression gasket shall be A-Lok or equal.

At the discretion of the Contracting Officer the following procedure may be allowed:

Grout-in-place - precast manhole sections shall have a formed, tapered circular opening larger than the pipe outside diameter. Grout shall be non-shrink and waterproof equal to Hallemite, Waterplug, or Embeco. Plastic pipe shall have a waterstop gasket secured to the pipe with a stainless steel clamp before grouting.

2.1.14.8 Drop Sections

Whenever the invert of a pipe entering a manhole is 24 inches or more in height above the invert of the lowest pipe leaving the manhole, it shall be connected to the manhole with a drop section as shown on the drawings. The manhole shall be constructed in the normal manner, except that the concrete base shall be extended for outside drop pipes and a straight clean-out pipe shall be connected through the wall as detailed on the drawings.

Fittings and special adapters required for the outside drop section shall be of the same material and class as the pipe entering the manhole. After installing the outside drop section and pipe connections into the manhole, encase the entire vertical, outside assembly in concrete, as shown, using Concrete Class "C" mix.

2.1.14.9 Dampproofing

Apply two coats of bituminous waterproofing material to the exterior surfaces of precast concrete structures by brush or spray and in accordance with the manufacturer's recommendations. Dampproofing shall be Hydrocide 648 by Sonneborn Building Products, Dehydratine 4 by A.C. Horn Inc., RIW Marine Liquid by Toch Brothers, or equal.

2.1.14.10 Lining and Coating

Refer to Section 09 97 24 CONCRETE REPAIR AND HYDROGEN SULFIDE PROTECTIVE COATING for the lining and coating specifications.

2.1.15 Precast Valve Vaults

Precast valve vaults shall be sized as shown on the Drawings and shall conform to the requirements of ACI 318. The vaults shall also meet the permeability requirements specified by ASTM C 14.

The units shall be cured as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall not be shipped until at least 10 days after casting. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the outside of each precast section.

All pipe openings and access accessories shall be cast in at the precast plant.

The manufacturer shall reinforce the valve vaults to meet all applicable codes. Alternatively, the valve vaults may be redesigned using the applicable backfill, surcharge, and dead loads. Minimum live load shall be an equivalent lateral fluid pressure of 100 psf per foot of depth.

Access plate shall be as specified in Contract Drawings and Section 05 50 13, MISCELLANEOUS METAL FABRICATIONS.

The valve vault and access hatch shall be integral with the sidewalls with slab reinforcing tied to wall steel.

PART 3 EXECUTION

3.1 FABRICATION AND PLACEMENT

Perform fabrication in accordance with NPCA QC Manual and/or ACPA QPC unless specified otherwise.

3.1.1 Forms

Use forms, for manufacturing precast concrete products, of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Construct forms so that the forces and vibrations to which the forms will be subjected can cause no product damage. Clean forms of concrete build-up after each use. Apply form release agents according to the manufacturers recommendations and do not allow to build up on the form casting surfaces.

3.1.2 Reinforcement

Follow applicable ASTM Standard or ACI 318 for placement and splicing. Fabricate cages of reinforcement either by tying the bars, wires or welded wire fabric into rigid assemblies or by welding, where permissible, in accordance with AWS D1.4/D1.4M. Position reinforcing as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover shall be one-third of that specified but not more than 1/2 inch. Provide concrete cover not less than 1/2 inch. Take positive means to assure that the reinforcement does not move significantly during the casting operations.

3.1.3 Embedded Items

Position embedded items at locations specified in the design documents. Perform welding in accordance with AWS D1.1/D1.1M when necessary. Hold rigidly in place inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products so that they do not move significantly during casting operations.

3.1.4 Synthetic Fiber Reinforced Concrete

Add fiber reinforcement to the concrete mix in accordance with the applicable sections of ASTM C 1116/C 1116M and the recommendations of the manufacturer, and in an amount of 0.1 percent by volume.

3.2 CONCRETE

3.2.1 Concrete Mixing

Mixing operations shall produce batch-to-batch uniformity of strength,

consistency, and appearance.

3.2.2 Concrete Placing

Deposit concrete into forms as near to its final location as practical. Keep the free fall of the concrete to a minimum. Consolidate concrete in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Use vibrators to consolidate concrete with frequencies and amplitudes sufficient to produce well consolidated concrete.

3.2.2.1 Cold Weather Concreting

Perform cold weather concreting in accordance with ACI 306.1.

a. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.

b. Free from frost all concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact.

c. Do not use frozen materials or materials containing ice.

d. In cold weather the temperature of concrete at the time of placing shall not be below 45 degrees F. Discard concrete that freezes before its compressive strength reaches 500 psi.

3.2.2.2 Hot Weather Concreting

Recommendations for hot weather concreting are given in detail in ACI 305R. During hot weather, give proper attention to constituents, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing shall not exceed 90 degrees F.

3.2.3 Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing.

3.2.3.1 Curing by Moisture Retention

Prevent moisture evaporation from exposed surfaces until adequate strength for stripping is reached by one of the following methods:

a. Cover with polyethylene sheets a minimum of 6 mils thick in accordance with ASTM C 171.

b. Cover with burlap or other absorptive material and keep continually moist.

c. Use of a membrane-curing compound applied at a rate not to exceed 200 square ft/gallon, or in accordance with manufacturers' recommendations according to ASTM C 309.

3.2.3.2 Curing with Heat and Moisture

Curing with heat and moisture is not permitted.

3.2.4 Surface Finish

Finish unformed surfaces of wet-cast precast concrete products as specified. If no finishing procedure is specified, finish such surfaces using a strike-off to level the concrete with the top of the form.

3.2.4.1 Formed Non-Architectural Surfaces

Cast surfaces against approved forms following industry practices in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be accepted but no major imperfections, honeycombs or other major defects will be permitted.

3.2.4.2 Unformed Surfaces

Finish unformed surfaces with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be accepted but no major imperfections, honeycombs, or other major defects shall be permitted.

3.2.4.3 Special Finishes

Troweled, broom or other finishes shall be according to the requirements of project documents and performed in accordance with industry standards or supplier specifications. Submit finishes for approval when required by the project documents. The sample finishes shall be approved prior to the start of production.

3.2.5 Stripping Products from Forms

Do not remove products from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal.

3.2.6 Patching and Repair

No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.

3.2.6.1 Repairing Minor Defects

Defects that will not impair the functional use or expected life of a precast concrete product may be repaired by any method that does not impair the product.

3.2.6.2 Repairing Honeycombed Areas

When honeycombed areas are to be repaired, remove all loose material and cut back the areas into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Use proprietary repair materials in accordance with the manufacturer's instructions. If a proprietary repair material is not used, saturate the area with water. Immediately prior to repair, the area should be damp, but free of excess water. Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

3.2.6.3 Repairing Major Defects

Evaluate, by qualified personnel, defects in precast concrete products which impair the functional use or the expected life of products to determine if repairs are feasible and, if so, to establish the repair procedure.

3.2.7 Shipping Products

Do not ship products until they are at least 5 days old, unless it can be shown that the concrete strength has reached at least 75 percent of the specified 28-day strength, or that damage will not result, impairing the performance of the product.

3.3 INSTALLATION

3.3.1 Site Access

It is the Contractor's responsibility to provide adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.

3.3.2 Precast Structure Installation

Precast section ends shall be clean of foreign materials and carefully inspected for chips or cracks. Any sections with damaged joint tongue shall not be used. Preformed plastic gaskets and joint sealant shall be installed in strict conformance with the manufacturer's recommendations. Only primer furnished by the gasket manufacturer will be approved.

Invert elevations shall be in strict conformance with the drawings. All sharp edges or rough sections that obstruct flow shall be removed.

Access door framing shall be cast in top slabs in methods approved by the Contracting Officer and shall be flush and level with the top of concrete. Reference Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS for additional criteria.

Set precast concrete sections vertical and in true alignment. Install O-ring rubber gasket in the recess in the base of previously set section or prime and double seal joint surfaces with "RAM-NEK" premolded plastic joint sealer or Contracting Officer-approved equal.

Completely plug, seal, and smooth all holes in sections used for their handling and the annular space between the wall and entering pipe with nonshrink grout. Finish grout smooth and flush with the adjoining interior and exterior manhole wall surfaces and make watertight.

All structures shall be installed plumb.

3.3.2.1 Dampproofing

Paint outer surfaces of precast structure with two coats of bituminous dampproofing at the rate of 30 to 60 square feet per gallon, in accordance with the manufacturer's instructions.

3.3.3 Manhole Installation

Manholes shall be constructed to the dimensions shown on the drawings and as specified in this Section. Protect all work against flooding and flotation.

Place the manhole base on a bed of 12-inch crushed stone as shown on the drawings. Minimum diameter of the stone foundation shall be the outside diameter of the base plus 2 feet. Set the manhole base grade so that a maximum grade adjustment of 12 inches is required to bring the manhole frame and cover to final grade.

Use precast concrete producer's instructions. In the absence of such instructions, install underground utility structures grade rings or brick and non-shrink mortar to adjust the manhole frame and cover to final grade.

Set precast concrete manhole sections plumb with a 1/4-inch maximum out-of-plumb tolerance allowed. Seal joints of precast barrel sections with either a rubber O-ring set in a recess or preformed flexible joint sealant in sufficient quantity to fill 75 percent of the joint cavity. Fill the outside and inside joint with non-shrink mortar and finish flush with the adjoining surfaces. Caulk the inside of any leaking barrel section joint with lead wool or non-shrink grout to the satisfaction of the Contracting Officer.

Allow joints to set for 14 hours before backfilling unless the Contracting Officer specifically approves a shorter period.

Plug holes in the concrete barrel sections required for handling with a non-shrinking grout or non-shrinking grout in combination with concrete plugs. Finish flush on the inside.

The ends of the pipe shall be accurately positioned in the openings and properly secured against movement.

Backfill carefully and evenly around manhole sections.

3.3.3.1 Manhole Pipe Connections

Construct manhole pipe connections, including pipe stubs, as specified above. Close or seal pipe stubs for future connections with a gasketed watertight plug.

3.3.3.2 Mortar

Mix mortar only in such quantity as may be required for immediate use. Use mortar before initial set has taken place. Mortar shall be used within 1-1/2 hours and shall be constantly worked with hoe or shovel until used. Anti-freeze mixtures shall not be included in the mortar. Install masonry when the outside temperature is above 40 degrees F unless provisions are made to protect the mortar and finished work from frost by heating and enclosing the work with tarpaulins or other suitable material. The Contracting Officer's decision regarding the adequacy of protection against freezing shall be final.

3.3.3.3 Setting Manhole Frame and Cover

Set manhole covers and frames in a full mortar bed so that the space between the top of the manhole masonry and the bottom flanges of the frame will be completely filled and made watertight. Precast concrete grade rings a maximum of 12 inches thick shall be used to ensure that the frame

and cover are set to the finished grade. Set the manhole frame and cover to final grade before placing permanent paving. Install curb inlet stones as shown on the drawings.

Set manhole frames and covers flush with finish pavement or 3 inches above the finished grade in unpaved areas. Place a ring of mortar around the outside of the bottom flange at least 1 inch thick and pitched to shed water away from the frame. Extend mortar to the outer edge of the masonry and finish smooth and flush with the top of the flange.

3.3.3.4 Dampproofing

Paint outer surfaces of manholes with two coats of bituminous dampproofing at the rate of 30 to 60 square feet per gallon, in accordance with the manufacturer's instructions.

3.3.4 Leakage Tests

Test each sewer manhole and wetwell for leakage by one of the methods described below. The Contracting Officer shall observe each test.

3.3.4.1 Exfiltration Test

Assemble precast structure in place; fill and point all lifting holes and exterior joints within 6 feet of the ground surface with an approved non-shrinking mortar. Test before placing the shelf and invert and before filling and pointing the horizontal joints below 6 feet of depth. Lower the groundwater table below the bottom of the structure for the duration of the test. Plug all pipes and other openings into the precast structures and brace to prevent blow out.

Fill the manhole or wetwell with water to the top of the structure. If the excavation has not been backfilled and no water is observed moving down the surface of the structure, the manhole or wetwell is satisfactorily watertight. If the test as described above is unsatisfactory as determined by the Contracting Officer or if the excavation has been backfilled, continue the test. A period of time may be permitted to allow for absorption. Following this period, refill the manhole or wetwell to the top of the structure, if necessary, and wait at least 8 hours. At the end of the test period, refill the manhole or wetwell to the top of the structure again, measuring the volume of water added. Extrapolate the refill amount to a 24-hour leakage rate. The leakage for each manhole or wetwell shall not exceed 1 gallon per vertical foot for a 24-hour period. If the manhole or wetwell fails this requirement, but the leakage does not exceed 3 gallons per vertical foot per day, the Contractor may make repairs by approved methods as directed by the Contracting Officer. If leakage due to a defective section of joint exceeds 3 gallons per vertical foot per day, the structure shall be rejected. Uncover the rejected structure as necessary to disassemble, reconstruct, or replace it as directed by the Contracting Officer. Retest the manhole or wetwell and, if satisfactory, fill and paint the interior joints.

No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorptions, etc. It will be assumed that all loss of water during the test is a result of leaks through the joints or through the concrete.

3.3.4.2 Infiltration Test

An infiltration test may be substituted for an exfiltration test if the groundwater table is above the highest joint in the manhole. If the Contracting Officer determines there is no leakage into the manhole, the manhole will be considered watertight. If the Contracting Officer is not satisfied, the Contractor shall perform an exfiltration or air testing.

3.3.4.3 Vacuum Test

Vacuum testing shall conform to ASTM C 1244.

If the pressure drop exceeds the acceptable limits, the Contractor will be allowed to make necessary repairs, as approved by the Contracting Officer. The manhole shall then be re-tested.

When a successful vacuum test has been completed, fill and point the interior and exterior joints.

3.3.4.4 Leakage Tests for Drain Manholes

The Contracting Officer will visually inspect drain manholes for possible leaks before backfilling is allowed. All joints shall be sealed to the satisfaction of the Contracting Officer.

The Contracting Officer may require an exfiltration test as described for sewer manholes on any structure for which the Contracting Officer deems such a test appropriate.

3.4 CLEANING

The Contractor shall thoroughly clean all precast structures of all silt, debris, and foreign matter of any kind before final inspections.

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SECTION 03 63 00

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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 1 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

Not used.

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 | (2009b) 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 | (2011) Standard Specification for Ready-Mixed Concrete |
| ASTM C 989 | (2009a) Standard Specification for Slag Cement 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 | |
|---|---|
| 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 |

TOLERANCES

| 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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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 | (2010) 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 | (2009a) 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 | (2010) Standard Specification for 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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SECTION 05 21 19

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 | (2010) 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 D100 | (1991; R 2008) Cold-Formed Steel Design Manual |
| AISI SG03-3 | (2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2010) Structural Welding Code - Steel |
| AWS D1.3/D1.3M | (2008; Errata 2008) Structural Welding Code - Sheet Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M | (2011) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened |
| ASTM A123/A123M | (2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A36/A36M | (2008) Standard Specification for Carbon Structural Steel |
| ASTM A653/A653M | (2010) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A780/A780M | (2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A792/A792M | (2010) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process |

FM GLOBAL (FM)

| | |
|---|---|
| FM APP GUIDE | (updated on-line) Approval Guide http://www.approvalguide.com/ |
| FM DS 1-28 | (2002) Design Wind Loads |

STEEL DECK INSTITUTE (SDI)

| | |
|---|---|
| SDI 31 | (2007) Design Manual for Composite Decks, Form Decks, and Roof Decks |
| SDI DDMO3 | (2004; Errata 2006; Add 2006) Diaphragm Design Manual; 3rd Edition |
| SDI DDP | (1987; R 2000) Deck Damage and Penetrations |
| SDI MOC2 | (2006) Manual of Construction with Steel Deck |

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Paint 20 | (2002; E 2004) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic) |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-301-01 | (2010) Structural Engineering |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 209 | (2005; Reprint 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 | (2011) 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

Powder-Actuated Tool Operator

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 Certification of Powder-Actuated Tool Operator

Manufacturer's certificate attesting that the operators are authorized to use the low velocity powder-actuated tool.

1.3.3 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.

1.3.4 Regulatory Requirements

1.3.4.1 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 APP GUIDE, and so labeled.

1.3.4.2 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 3-301-01.

1.3.5 Fabrication Drawings

Show type and location of units, location and sequence of connections, bearing on supports, methods of anchoring, attachment of accessories, adjusting plate details, size and location of holes to be cut and reinforcement to be provided, the manufacturer's erection instructions and other pertinent details.

1.4 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 D100.

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 A653/A653M 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 A36/A36M, merchant quality, Grade Designation SAE/AISI 1023 or SAE/AISI 1025, and hot-dip galvanized in accordance with ASTM A123/A123M.

2.1.4 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 A780/A780M.

2.2 ACCESSORIES

Provide accessories of same material as deck, unless specified otherwise. Provide manufacturer's standard type accessories, as specified.

2.2.1 Adjusting Plates

Provide adjusting plates, or segments of deck units, of same thickness and configuration as deck units in locations too narrow to accommodate full size units. Provide factory cut plates of predetermined size where possible.

2.2.2 End Closures

Fabricated of sheet metal by the deck manufacturer. Provide end closures minimum 0.028 inch thick to close open ends at 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 listed by the Steel Deck Institute and ICC-ES, 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 A792/A792M or ASTM A1008/A1008M for deck used in conjunction with insulation and built-up roofing. Fabricate roof deck units of 0.028 inch design thickness or thicker steel in conformance with ASTM A653/A653M, 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 A780/A780M. 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 31, 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 31. Clamp or weight deck units to provide firm contact between deck units and structural supports while performing or 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/D1.3M using methods and electrodes recommended by the manufacturers of the base metal alloys being used. Ensure only operators previously qualified by tests prescribed in AWS D1.1/D1.1M and AWS D1.3/D1.3M make welds. Immediately recertify, or replace qualified welders, that are producing unsatisfactory welding. Conform to the recommendations of the Steel Deck Institute and the steel deck 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 A780/A780M finish with the manufacturer's standard touch-up paint.

3.2.1.2 Fastening

Anchor deck to structural supports and adjoining units with mechanical fasteners as listed by the Steel Deck Institute, ICC-ES, the fastener and steel deck manufacturers, and approved by the Contracting Officer.

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

Provide in locations too narrow to accommodate full-size deck units and install as shown on shop drawings.

3.2.4.2 End Closures

Provide end closure to close open ends of cells at columns, walls, and openings in deck.

3.2.4.3 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.

-- End of Section --

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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 DAF-45 | (2003; Reaffirmed 2009) 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 | (2010) Structural Welding Code - Steel |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B18.2.1 | (2010) Square and Hex Bolts and Screws (Inch Series) |
| ASME B18.2.2 | (2010) Standard for Square and Hex Nuts |
| ASME B18.21.1 | (2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series) |
| 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 Chain |
| ASTM A 47/A 47M | (1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings |
| 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 | (2010) 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 780/A 780M | (2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A 786/A 786M | (2005; R 2009) 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 C 1513 | (2004; E 2009; R 2009) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections |
| 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/NACE No.3 (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 information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Embedded angles and plates, installation drawings; G

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.

Submit templates, erection and installation drawings indicating thickness, type grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-03 Product Data

Access doors and panels; G

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 4,000 lb.

b. Minimum allowable shear value shall be 5,000 lb.

2.1.7.2 Lag Screws and Bolts

ASME B18.2.1, type and grade best suited for the purpose.

2.1.7.3 Toggle Bolts

ASME B18.2.1.

2.1.7.4 Bolts, Nuts, Studs and Rivets

ASME B18.2.2 or ASTM A 307.

2.1.7.5 Screws

ASME B18.2.1, ASME B18.6.2, ASME B18.6.3 and ASTM C 1513.

2.1.7.6 Washers

Provide plain washers to conform to ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers to conform to ASME B18.21.1.

2.1.8 Aluminum Alloy Products

Conform to ASTM 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.

2.1.9 Gratings

Design floor gratings to withstand a live load of 250 pounds per square foot for the span indicated with a maximum deflection of L/240.

2.2 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/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete shall be free of dirt and grease. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints, but coat with rust preventative applied in the shop.

2.2.4.2 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. 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 ACCESS DOORS AND PANELS

Provide flush type access doors and panels unless otherwise indicated. Fabricate frames for access doors of steel not lighter than 14 gage with welded joints and anchorage for securing into construction. Provide access doors with a minimum of 14 by 20 inches or as indicated on the drawings and of not lighter than 14 gage steel, with stiffened edges and welded attachments. Provide access doors hinged to frame and with a flush-face, turn-screw-operated latch. Provide exposed metal surfaces with a shop applied prime coat. Design access door to withstand a minimum of 250 psf live load with maximum deflection of L/240.

2.4 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.

2.5 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.

2.6 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.

2.7 PORTABLE CRANE

Provide a 3-ton portable crane for use with the new W-1 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 ACCESS PANELS

Install a removable access panel not less than 12 by 12 inches directly below each valve, flow indicator, damper, or air splitter that is located above the ceiling, other than an acoustical ceiling, and that would otherwise not be accessible.

3.8 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 3,000 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 | (2010) 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 | (2009e2) 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 | (2010b) 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 |

| | PRODUCTS | ENGLISH UNITS | METRIC UNITS |
|---|---|---|---|
| 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

SECTION 07 60 00

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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 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 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

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 Stainless Steel

ASTM A 167, Type 302 or 304, 2D Finish, fully annealed, dead-soft temper.

2.1.4 Aluminum Alloy Sheet and Plate

ASTM B 209, anodized clear form alloy, and temper appropriate for use.

2.1.5 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B 221.

2.1.6 Solder

ASTM B 32, 95-5 tin-antimony.

2.1.7 Polyvinyl Chloride Reglet

ASTM D 1784, Type II, Grade 1, Class 14333-D, 0.075 inch minimum thickness.

2.1.8 Bituminous Plastic Cement

ASTM D 4586, Type I.

2.1.9 Roofing Felt

ASTM D 226/D 226M Type I.

2.1.10 Asphalt Primer

ASTM D 41.

2.1.11 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 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.

3.1.2.2 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.3 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 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 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.

3.1.7 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.

3.1.8 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.

3.1.9 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.

3.1.10 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.

3.1.10.1 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.

3.1.11 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.

3.1.12 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.

3.1.12.1 Floor and Wall Expansion Joints

Provide U-shape with extended flanges for expansion joints in concrete and

masonry walls and in floor slabs.

3.1.13 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.

3.1.14 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 | Aluminum producer's recommended hard setting sealant for locked aluminum |

TABLE II. SHEET METAL JOINTS

| | TYPE OF JOINT | | |
|---|---|---|---|
| | | expansion joint | joints. Fill 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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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 | (2010b) 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 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.

3.2 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 concrete or masonry: | | |
| 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 | (2010) 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 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.

2.7.3 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.

2.7.3.1 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.

-- End of Section --

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SECTION 08 33 23

OVERHEAD COILING DOORS

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2.1.7 Overhead Drum
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2.2.1 Guides
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3.2.1 Maintenance and Adjustment
3.2.2 CLEANING

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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 | (2010) 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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3.3 INSTALLATION
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-- End of Section Table of Contents --

SECTION 08 45 23

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 | (2010b) 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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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 | (2012; 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 (2011) 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 | | McKinney/Pemko |
| 1 | Raindrip | MCK236 C 40 | | McKinney/Pemko |
| 1 | Weatherseal | MCK303 AV 84 | | McKinney/Pemko |
| 1 | Threshold | MCK2001 AV 40 | | McKinney/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 | | | |

-- End of Section --

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SECTION 08 91 00

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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SECTION 09 83 13

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 | (2010b) 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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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 A780/A780M | (2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM C 920 | (2008) Standard Specification for Elastomeric Joint Sealants |
| ASTM D 2697 | (2003; R 2008) Volume Nonvolatile Matter in Clear or Pigmented Coatings |

MASTER PAINTERS INSTITUTE (MPI)

| | |
|---|---|
| MPI 3 | Primer, Alkali Resistant, Water Based |
| MPI 4 | (Jan 2004) Interior/Exterior Latex Block Filler |
| MPI 47 | (Oct 2009) Interior Alkyd, Semi-Gloss, MPI Gloss Level 5 |
| MPI 54 | (Oct 2009) Interior Latex, Semi-Gloss, MPI Gloss Level 5 |
| MPI 79 | (Oct 2009) Alkyd Anti-Corrosive Metal Primer |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-P-21035 | (1991; Rev B; Notice 2 2003) Paint, High Zinc Dust Content, Galvanizing Repair (Metric) |

NATIONAL ASSOCIATION OF PIPE FABRICATORS (NAPF)

| | |
|---|---|
| NAPF 500-03-04 | (2006) Surface Preparation Standard for Abrasive Blast Cleaning of Ductile Iron Pipe |

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC SP 1 | (1982; E 2004) Solvent Cleaning |

| | |
|---|---|
| SSPC SP 3 | (2004; E 2004) Power Tool Cleaning |
| SSPC SP 6/NACE No.3 | (2007) Commercial Blast Cleaning |
| SSPC SP 10/NACE No. 2 | (2007) Near-White Blast Cleaning |
| SSPC SP 11 | (1987; E 2004) Power Tool Cleaning to Bare Metal |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FED-STD-595 | (Rev C, 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.

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.

2.2 INTERIOR PRODUCTS

| | FEDERAL SPECIFICATION | PITTSBURGH | SHERWIN WILLIAMS | ICI / GLIDDEN |
|---|---|---|---|---|
| Inhibitive Metal Primer, MPI 79 | FS TT-P-664<br>FS TT-P-664 | -- | B50NN26<br>B50W21 | 4100<br>4160 |
| Enamel MPI 47 | FS TT-E-508<br>FS TT-E-509 | 6-110 | B34W251 | 1507 |
| Acrylic Latex MPI 54 | FS TT-P-1511 | 6-500 | B48 Series | 1406<br>1407 |

2.3 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 |
| Enamel | FS TT-P-102 | 1-934 | A-2 | 2518 |

| | FEDERAL SPECIFICATION | PITTSBURGH | SHERWIN WILLIAMS | ICI / GLIDDEN |
|---|---|---|---|---|
| Inhibitive Metal Primer, MPI 79 | FS TT-P-664<br>FS TT-P-664 | -- | B50NN26<br>B50W21 | 4160 |
| Masonry Primer/Sealer, MPI 3 | FS TT-S-223 | 6-14 | A 24W300 | 3030 |

Elasometric Masonry Coating Basis of Design: TEXCOTE Super Cote Cool Walls Textured Coating.

2.4 HIGH PERFORMANCE PRODUCTS

2.4.1 Submerged and Alternately Submerged Metal Coating Systems

System No. 1: Submerged and alternately submerged metal - raw water (nonpotable) or raw sewage with shop applied primer:

a. Type: hydrophobic aromatic polyurethane, 2-coat system.

b. Service Conditions: For use with metal pipes or structures alternately submerged in raw sewage or raw water (nonpotable) and exposed to a moist saturated hydrogen sulfide atmosphere, as in raw sewage wet wells. Minimum temperature resistance of the coating shall be 140 degrees F for moist heat conditions.

1. All ferrous metal surfaces inside of raw sewage wetwells and valve vaults.

c. Surface Preparation (Shop): Brush-off blast cleaning in accordance with NAPF 500-03-04 to a minimum surface profile of 1.5 mils.

d. Shop Prime: Apply Tnemec Series N69 Hi-Build Epoxoline II polyamidoamine epoxy at 4.0 to 6.0 mils dft.

e. Spot Prime: Pressure wash to remove all dirt grease and contamination. Power Tool clean all bare and damaged areas per SSPC SP 3. Featheredge to tightly adhered coating. Thoroughly abrade the entire surface before proceeding. All surfaces must be clean, dry and thoroughly abraded prior to the application of any coatings. Spot prime all bare areas with one coat of Tnemec Series 446 Perma-Shield MCU hydrophobic aromatic polyurethane at 4.0 to 6.0 mils dft

f. Intermediate Coat: Apply Tnemec Series 446 Perma-Shield MCU hydrophobic aromatic polyurethane at 7.0 to 9.0 mils dft.

g. Finish Coat: Apply Enemec Series 446 Perma-Shield MCU hydrophobic aromatic polyurethane at 7.0 to 9.0 mils dft.

2.4.2 Exposed Metal Coating Systems

System No. 10: Exposed Metal, Corrosive Environment:

a. Type: High-build epoxy intermediate coat having a minimum volume solids of 84 percent, with an inorganic zinc prime coat and a pigmented polyurethane finish coat having a minimum volume solids of 73 percent.

b. Service Conditions: For use with metal structures or pipes subjected to water condensation, chemical fumes such as hydrogen sulfide, salt spray, and chemical contact.

c. Surface Preparation: Solvent clean in accordance with SSPC SP 1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP 10/NACE No. 2.

d. Prime Coat: Self-curing, two-component inorganic zinc-rich coating recommended by the manufacturer for overcoating with a high-build epoxy finish coat. Minimum zinc content shall be 12 pounds per gallon. Apply to a thickness of 3 mils. Products: Tnemec Series 90-97; Sherwin-Williams Zinc-Clad II Plus, or equal.

e. Intermediate Coat: Tnemec Series 135; Sherwin-Williams Macropoxy 646 B58-600/B58V600 or equal. Film thickness 5.0 to 8.0 mils/coat. Minimum solids by volume should be 84 percent.

f. Finish Coat: Two-component pigmented acrylic or aliphatic polyurethane, recommended by the manufacturer for overcoating a high-build epoxy coating. Apply to a thickness of at least 3 mils. Products: Tnemec Series 740 Sherwin-Williams Hi-Solids Polyurethane B65-300 Series/B60V30; or equal

System No. 18: Exposed Metal Organic Zinc Primer for Shop Coating and Field Touch-Up:

a. Type: Organic zinc primer having a minimum zinc content of 14 pounds per gallon.

b. Service Conditions: For use as a shop-applied primer or field touch-up primer over inorganic zinc prime coatings on exposed metal

c. Surface Preparation: Solvent clean in accordance with SSPC SP 1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP 10/NACE No. 2.

d. Coating: Coating shall be of the two- or three-component converted epoxy, epoxy phenolic, or urethane type. Products: Tnemec 90-97; Sherwin-Williams Zinc-Clad III HS B69A100/B69D11/B69D11; or equal. Applied to a minimum dry-film thickness of 3 mils. Organic zinc primer shall be manufactured by the prime coat manufacturer.

2.4.3 Buried Metal Coating Systems

System No. 21: Buried Metal:

a. Type: High solids Cycloaliphatic Amine epoxy or phenolic epoxy having minimum volume solids of 80 percent (ASTM D 2697).

b. Service Conditions: Buried metal, such as valves, flanges, bolts, nuts, structural steel, and fittings.

c. Surface Preparation: Solvent clean in accordance with SSPC SP 1 to remove contaminants from the surface. Abrasive blast in accordance with SSPC SP 10/NACE No. 2.

d. Coating System: Apply three or more coats of Tnemec 104 HS (6.0 to

8.0 mils per coat); Sherwin-Williams Tank Clad HS B62-80 Series/B60V80 Series at 5.0 to 8.0 mils/coat; or equal; 30 mils total. Maximum thickness of an individual coating shall not exceed the manufacturer's recommendation.

System No. 24: Buried Metal:

a. Type: Corrosion-resisting grease.

b. Service Conditions: Buried metal, such as bolts, bolt threads, tie rods, and nuts.

c. Surface Preparation: Solvent clean in accordance with SSPC SP 1 to remove contaminants from the surface. Power Tool Clean in accordance with SSPC SP 3 as a minimum. Abrasive blasting in accordance with SSPC SP 6/NACE No.3 is preferred.

d. Coating: NO-OX-ID GG-2 as manufactured by Sanchem, Inc. Apply to a minimum thickness of 1/4-inch.

2.4.4 PVC, CPVC, and FRP Coating System

System No. 41: PVC, CPVC, and FRP, Ultraviolet Exposure or Color Coding:

a. Type: Epoxy primer with minimum volume solids of 54 percent and a pigmented polyurethane enamel having a minimum volume solids of 73 percent.

b. Service Conditions: PVC or CPVC or FRP exposed to sunlight.

c. Surface Preparation: Clean the surface in accordance with SSPC SP 1. Then, lightly abrade the surface with medium-grain sandpaper.

d. Prime Coat: One coat of Tnemec Series N69 Epoxoline; Sherwin-Williams Macropoxy 646 B58 Series/B58V600; or equal. Apply to a minimum dry-film thickness of 4 mils.

e. Finish Coat: One coat of Tnemec Series 740; Sherwin-Williams Hi-Solids Polyurethane B65-300 Series/B60V30; or equal. Apply to a dry-film thickness of 3 to 5 mils.

2.4.5 Coating Systems for Nonferrous Metals

System No. 51: Insulate Aluminum (Insulation) from Concrete and Carbon Steel:

Type: Bituminous paint having a minimum volume solids of 68 percent coal-tar pitch based.

b. Service Conditions: Coat areas of aluminum grating, stairs, structural members or aluminum fabrications, in contact with concrete or carbon steel with this system.

c. Surface Preparation: Solvent or steam clean in accordance with SSPC SP 1; do not use alkali cleaning. Then dust blast. Option to hand or power scarify.

d. Finish Coat: Tnemec 46-465; or equal. Apply two coats to a minimum dry-film thickness of 8.0 to 12.0 mils per coat.

System No. 55: Repair of Galvanized Steel Surfaces:

a. Type: Cold galvanizing compound consisting of paint containing oils, solvents, and zinc dust and complying with MIL-P-21035. Minimum metallic zinc content in the cured coating shall be 90 percent.

b. Service Conditions: Repair of damaged galvanized coatings on steel surfaces.

c. Surface Preparation: Clean damaged surfaces in accordance with SSPC SP 1 and SSPC SP 11.

d. Coating System: Apply Z.R.C. Galvanizing Compound; RAMCO Specialty Products "Zinckit"; NuWave "Galv-Match-Plus"; Devcon "Cold Galvanizing"; Clearco "Cold Galvanizing Spray"; or equal; to a minimum dry-film thickness of 3 mils. Apply as specified in ASTM A780/A780M, Annex A2.

## PART 3 EXECUTION

### 3.1 GENERAL

Manufacturer's recommendations for surface preparation, thinning, mixing, handling, and applying his product shall be considered a part of this specification. In case of conflict between the manufacturer's recommendations and the requirements of this specification, the latter shall take precedence.

### 3.2 PROTECTION

Contractor shall remove and reinstall, or provide acceptable protection for, all hardware, accessories, lighting, and electrical components, factory-finished materials, plumbing fixtures and fittings, and any other materials that may become splattered or damaged by the painting work. "WET PAINT" signs shall be posted to indicate newly painted surfaces.

Every precaution shall be taken to prevent damage to adjacent buildings, shrubs and motor vehicles. Roping, barricading or covering to preclude damage to personal and real property during surface preparation and painting shall be the Contractor's responsibility. When spray painting, the Contractor must give 24 hours advance warning, coordinated with the Contracting Officer or his representative, and post signs to ensure parking arrangements can be made. Repairs to damaged surfaces shall be effected at no additional cost to the Government.

### 3.3 SURFACE PREPARATION

#### 3.3.1 General Surface Preparation

All surfaces shall be clean, dry, and free from contaminants and foreign matter. Mildew and chalking shall be removed and the surface thoroughly sterilized. All chipped, peeling, or blistered paint shall be removed and the surface spot-primed. Hard, glossy surfaces shall be dulled and roughened to ensure proper adhesion.

#### 3.3.2 Metal Surfaces

All heavy rust and loose mill scale shall be removed from steel in

accordance with SSPC SP 3, Power Tool Cleaning.

Minor aluminum oxide film and corrosion shall be removed by hand or power tool cleaning.

Previously unpainted galvanized and aluminum surfaces shall be treated with wash primer in accordance with manufacturer's instructions.

3.3.3 Masonry Surfaces

All surfaces shall be free from form-release compounds, laitance, and other contaminants.

Large cracks, voids and other major surface imperfections shall be repaired before painting. All repairs to cracks and openings in cement block or masonry surfaces shall require preparation of a "V" type opening with the top of the "V" one-half the depth of the crack or opening. All non-tenacious material shall be removed, then the "V" shall be filled using epoxy gel grout in accordance with manufacturer's instructions.

3.3.4 Sealing

All cracks, crevices, and joints such as those along the perimeter of windows and doors shall be sealed with a paintable latex type caulking conforming to ASTM C 920.

3.4 MIXING AND APPLICATION

3.4.1 General

All painting shall be accomplished in accordance with the painting schedule.

No exterior painting shall be allowed in rainy weather or when rain is imminent. No paints or coatings shall be applied when the temperature or humidity is outside the limits recommended by the manufacturer.

Paints and coatings shall be applied by brush, roller, or airless spray.

Each coat of material applied shall be free from runs, sags, bubbles, and foreign contaminants; variations in color, gloss and texture; dry overspray, brush, and roller marks; holidays (missed areas); or other evidence of poor application.

All paints and coatings shall be thoroughly worked into corners and crevices.

Paints and coatings shall be neatly "cut-in" around doors, windows, ceilings, etc.

All newly painted surfaces shall be adequately protected from damage.

3.4.2 Procedures

Coatings shall be applied as follows:

a. Material shall be thoroughly stirred to produce a uniform mixture.

b. Material shall be thinned for workability and improved spray characteristics, but only according to the manufacturer's

instructions.

c. Each coat shall be applied uniformly at the minimum wet-film thickness specified by the manufacturer.

d. Special attention shall be given when coating sharp edges, corners, and crevices to ensure complete coverage.

e. Finish coats shall show good hiding characteristics and uniform appearance.

3.4.3 Exterior Surfaces

Metal surfaces shall be primed with alkyd primer in accordance with manufacturer's instructions, and topcoated with two coats enamel in accordance with manufacturer's instructions.

Paint shall be allowed to dry overnight before re-coating.

3.4.4 Interior Surfaces

Wood and metal surfaces shall have two coats of enamel paint applied in accordance with manufacturer's instructions. A twelve hour drying time shall be required between coats. Surfaces to be painted with enamel paint include any metal or wood paintable surface. Items to be painted include (but are not limited to) doors, jambs, handrails, and grilles.

Masonry surfaces shall have two coats of epoxy paint applied in accordance with manufacturer's instructions on wall surfaces, ceilings and appurtenances (excluding vinyl cove base) with colors other than that specified. A twelve hour drying time shall be required between coats. One coat of epoxy shall be applied on areas where existing color is the same as that specified. Areas requiring only one coat of epoxy shall be patched and spot primed or touched up before painting to insure one coat coverage. A four hour minimum drying time shall be required between the spot primed coat and the finish coat. Surfaces to painted with epoxy paint include concrete, concrete masonry, gypsum drywall systems and plaster. Items to be painted include (but are not limited to) walls, ceilings, pipes and columns.

3.5 SPOT-PAINTING

Spot-painting to correct damaged surfaces will be allowed only when touchup area blends into the surrounding finish. Otherwise, the entire area shall be recoated. Touchup shall be accomplished using the same method of application as was used to apply the original material.

3.6 ACCEPTANCE PROVISIONS

3.6.1 Inspection

Contractor shall provide for inspection of his work to ensure that the requirements of this section have been fulfilled.

3.6.2 Cleanup

Contractor shall be responsible for removal of all paint or coating splatter and spills from floors, adjacent walls, hardware, and all other finished surfaces.

Contractor shall leave the work area clean and free from all rubbish and accumulated material left from his work.

3.7 PAINT SCHEDULE

3.7.1 Exterior Paint Schedule

Colors shall be in accordance with FED-STD-595.

| SURFACE | PRIMER | FINISH COAT | FINISH COLOR AND SHEEN |
|---|---|---|---|
| Exterior masonry (rough/ porous) | Latex block filler | Acrylic emulsion latex | Gray - flat |
| Exterior metal - Metal paint shall be with System No. 10. | Inorganic zinc primer | Intermediate and finish high-build epoxy | Gray - semi-gloss |

3.7.2 Interior Paint Schedule

Colors shall be in accordance with FED-STD-595 manufacturer's product name/number.

| SURFACE | PRIMER | FINISH COAT | FINISH COLOR AND SHEEN |
|---|---|---|---|
| Interior metal - Metal paint shall be with System No. 10. | Inorganic zinc primer | Intermediate and finish high-build epoxy | Semi-gloss |

3.7.3 Process Piping Paint Schedule

The exact coating to be applied in any location is not designed by the descriptive phrases in the coating system titles such as "corrosive environment," "buried metal," or "submerged metal." The Contractor shall coat surfaces with the specific coating systems as described below:

A. Coat mechanical equipment such as pumps, fans, and air compressors as described in the various mechanical equipment specifications. The color of finish coat shall match the color of the connecting piping or as designated by the Government.

B. Coat aboveground and exposed piping or piping in vaults and structures as described in the various piping specifications as shown in the Process Paint Schedule below. The color of the finish coat shall be as shown in the Process Paint Schedule below.

C. Coat valves as described in the various valve specifications. System No. 10 shall be used if coating is not specified in the valve

specification. Aboveground valves, or valves in vaults and structures, shall match the color of the connecting piping.

D. Refer to Section 09 96 35 CHEMICAL-RESISTANT COATINGS, for coating concrete surfaces in chemical secondary containment service.

E. Coat aluminum surfaces in contact with concrete according to System No. 51.

F. Coat buried flanges, nuts and bolts, valves, flexible piping couplings, exposed rebar in thrust blocks, and valve boxes as specified in the particular specifications for the above items. If the particular specifications do not specify a coating system, coat buried bolt threads, tie bolt threads, and nuts according to System No. 24.

| Service | Pipe/Duct Material | Pipe Material Abbrev | Exposed Pipe Paint System | Color Code |
|---|---|---|---|---|
| Ammonium Sulfate | Polyvinyl Chloride | PVC | 41 | Light Green Bands |
| Ammonium Sulfate | Reinforced Polyvinyl Chloride Hose | PVC Hose | N/A | Light Green Bands |
| Ammonium Sulfate Containment | Polyvinyl Chloride | PVC | 41 | Light Green Bands |
| Sodium Hypochlorite | Polyvinyl Chloride | PVC | 41 | Yellow |
| Sodium Hypochlorite | Reinforced Polyvinyl Chloride Hose | PVC Hose | N/A | Yellow Bands |
| Sodium Hypochlorite Containment | Polyvinyl Chloride | PVC | 41 | Yellow Bands |
| Water Main | Ductile Iron | DI | 10 | Dark Blue |
| Fire Protection | Ductile Iron or Steel | DI or STL | 10 | Red |

-- End of Section --

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SECTION 09 96 35

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PART 3 EXECUTION (NOT USED)

-- End of Section Table of Contents --

SECTION 09 96 35

CHEMICAL-RESISTANT COATINGS

PART 1 GENERAL

1.1 DESCRIPTION

This Section includes materials and installation of a chemical-resistant coating for concrete and steel subject to corrosive environments or in chemical secondary containment service. The coating systems specified herein are based on products by Tnemec, and this Section is intended to show the quality of the products and the level of preparation and application detail that will be required of other manufacturers in order to be considered equal coating systems.

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 350.1 | (2004; Errata 2010) Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures |
| ACI 503R | (1993; R 2008) Use of Epoxy Compounds with Concrete |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D 4138 | (2007; Rev A) Standard Practices for Measurements of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means |
| ASTM D 4258 | (2006) Standard Practice for Surface Cleaning Concrete for Coating |
| ASTM D 4259 | (1988; R 2006) Standard Practice for Abrading Concrete |
| ASTM D 4261 | (2005) Standard Practice for Surface Cleaning Concrete Masonry Units for Coating |
| ASTM D 4263 | (1983; R 2005) Indicating Moisture in Concrete by the Plastic Sheet Method |
| ASTM D 4541 | (2009e1) Pull-Off Strength of Coatings Using Portable Adhesion Testers |
| ASTM D 4787 | (2008) Standard Practice for Continuity Verification of Liquid or Sheet Linings A pplied to Concrete Substrates |

NACE INTERNATIONAL (NACE)

| | |
|---|---|
| NACE SP0188 | (1999; R 2006) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates |

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

| | |
|---|---|
| ICRI CSP | (1997) Concrete Surface Profile |

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC SP 13/NACE No. 6 | (1997; R 2003) Joint Surface Preparation Standard: Surface Preparation of Concrete |
| SSPC SP 6/NACE No. 3 | (2007) Commercial Blast Cleaning |

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

SD-03 Product Data

The manufacturer's data sheets in accordance with the paragraph entitled "DATA SHEETS."

SD-04 Samples

Color Selection Chart; G

SD-07 Certificates

Certification (G) conforming to the paragraph entitled "CERTIFICATES."

1.4 PROTECTION OF SURFACES NOT TO BE COATED

Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be coated.

Provide drop cloths to prevent coating materials from falling on or marring adjacent surfaces.

Protect working parts of mechanical and electrical equipment from damage during surface preparation and coating process.

Mask openings in motors to prevent coating and other materials from entering the motors.

1.5 WEATHER CONDITIONS

Adhere to the following regarding coating and weather conditions:

a. Do not coat in the rain, wind, snow, mist, and fog or when surface temperatures are less than 5 degrees F above the dew point.

b. Do not apply coatings when the relative humidity is above 85 percent or the temperature is above 90 degrees F.

c. Do not coat when temperature of concrete to be painted is above 120 degrees F.

d. Do not apply coatings if air or surface temperature is below 60 degrees F or expected to drop below 60 degrees F in 24 hours.

1.6 CERTIFICATES

Certification shall show that the applicator has been certified or approved by the coating manufacturer to apply the coating systems. To demonstrate the applicator's experience, submit a list of projects that have been constructed in Florida and that have used the specified coating products. Include references with the project list.

1.7 DATA SHEETS

The manufacturer's data sheets shall show the following information:

Percent solids by volume of coating compound.

Number of coats required to give the specified dry thickness.

Minimum recommended dry thickness per coat for prime, intermediate, and finish coats.

Recommended surface preparation.

Recommended surface tensile strength of the concrete surface.

Recommended procedures for storage of the materials including temperature limitations.

Application instructions including recommended equipment and application atmospheric limitations such as temperature and humidity.

Application detailed drawings showing the recommended systems for the treatment of bridging concrete expansion joints, control joints, and structural cracks for vertical and horizontal surfaces. Also include detailed drawings showing recommended treatment systems for bridging or sealing the following at a minimum:

a. Concrete corners.

b. Equipment and piping supports with anchors that penetrate into the concrete surfaces.

c. Tank bottoms to concrete support pads and foundations.

d. Pipe penetrations through walls.

e. Sumps.

f. Recessed areas for grating support.

Curing requirements and instructions.

PART 2 PRODUCTS

2.1 PREAPPLICATION PREPARATION

Arrange a preapplication meeting with the Contracting Officer and the coating manufacturer's representative at the jobsite to review the application procedures and the overall plan for applying and inspecting the chemical resistant coatings.

Ensure that all liquid materials are stored below 75 degrees F before application or in accordance with the manufacturer's instructions.

Precut scrum cloth and carefully roll up and store the cloth until it is required. Store the cloth in a moisture-protected environment.

Do not apply coatings to concrete when the concrete is outgassing. Apply coatings only when the concrete surface temperature is stable or dropping.

Ensure that surface and ambient temperatures are above 50 degrees F during application and cure.

2.2 COATING APPLICATION

When applying multiple coats, each successive coating shall be different in color from the previously applied coat.

The entire coating shall be pinhole free.

Apply coatings and treatments in accordance with the manufacturer's recommended procedures for the types of surfaces and transitions.

2.3 SURFACE PREPARATION OBSERVATION, COATINGS OBSERVATION, AND DRY-FILM THICKNESS TESTING

Measure coating thickness specified for concrete or masonry surfaces in accordance with ASTM D 4138. Test the finish coat of concrete and masonry surfaces in accordance with NACE SP0188 or ASTM D 4787. Patch coatings at the points of thickness measurement or holiday detection.

Check each coat for the correct dry-film thickness. Do not measure within 8 hours of the application of the coating.

Make five separate spot measurements spaced evenly over each 100 square feet of area (or fraction thereof) to be measured. The average of the five spot measurements for each such 100-square-foot area shall not be less than the specified thickness. No single spot measurement in any 100-square-foot area shall be less than 80 percent or more than 120 percent of the specified thickness.

The chemical-resistant coating manufacturer's representative shall make periodic site visits to the jobsite to observe progress during each step of the coating process to observe the applicator's work and to provide written

reports to the Contracting Officer noting deficiencies and recommending corrective actions if any are deemed necessary.

2.4 SURFACE PREPARATION: CONCRETE

Prepare concrete and masonry surfaces in accordance with SSPC SP 13/NACE No. 6 and the following:

a. Do not apply coating until concrete has cured at least 30 days. Finish concrete surfaces in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Do not use curing compound on surfaces that are to be coated.

b. Concrete surfaces on which coating is to be applied shall be of even color: gray or gray-white. The surface shall have no pits, pockets, holes, or sharp changes of surface elevation. Scrubbing with a stiff-bristle fiber brush shall produce no dusting or dislodging of cement or sand. Sprinkling water on the surface shall produce no water beads or standing droplets. Concrete and masonry shall be free of laitance and slick surfaces. The grain of the concrete surface to touch shall not be rougher than that of 40- to 60-grit sandpaper.

c. Before preparation, repair or replace damaged or poorly cast concrete as specified in Section 03 30 00 CAST-IN-LACE CONCRETE.

d. Remove all grease, oil, dirt, dust, mold, mildew, and other soluble contaminants before proceeding. Detergent clean the concrete or masonry surface with trisodium phosphate as detailed in ASTM D 4258 or ASTM D 4261.

e. Test for surface strength in accordance with ASTM D 4541, as modified by ACI 503R. Provide one test for every 500 square feet. The minimum surface tension shall be 300 psi unless the coating manufacturer recommends a higher value.

f. Before coating new concrete walls and ceilings, determine the presence of capillary moisture according to ASTM D 4263.

g. Acceptance criteria for concrete surfaces shall be in accordance with SSPC SP 13/NACE No. 6 Table 1 "Severe Service".

h. Test concrete for contamination and porosity with water. When water is applied to horizontal surfaces, the water should spread out and penetrate immediately. On vertical surfaces, a stream of water should zig-zag, spread out, and penetrate. This is a good indication that the surface has been properly prepared. If water beads up on horizontal surfaces and moves in a rapid straight line down a vertical surface, the surface is contaminated with oil, curing compounds, or other contaminant.

i. Some manufacturers' systems may require treatments to certain transitions before coatings are applied. Apply the manufacturer's recommended treatments to these transitions as required before applying coatings as recommended by the coatings manufacturer. The coating manufacturer's factory representative shall observe the conditions of the concrete and treatments and provide the Contracting Officer with written notice that the substrate has been properly prepared and is suitable for coating before applying coatings. If the manufacturer's representative notes deficiencies, a deficiency list shall be provided

in writing to the Contractor and the Contracting Officer and the Contractor shall be responsible for making corrections at no additional cost to the Government until the manufacturer's representative provides the Contracting Officer with written acceptance of the substrate and treatments.

j. Abrasive blast surfaces (brush-off blast) in accordance with ASTM D 4259. Provide a surface profile equivalent to ICRI CSP 3-4. After blast cleaning, wash surfaces with water to remove dust and salts as specified in ASTM D 4258 or ASTM D 4261. Rinse thoroughly to achieve a surface pH of 7 to 11. Take at least two pH readings for each 500 square feet or portion thereof. Neutralize if necessary (reference SSPC SP 13/NACE No. 6).

k. Apply first coat as soon as possible to avoid contamination of the surface.

2.5 COATING SYSTEM: CONCRETE

Apply Tnemec Series 218 MortarClad epoxy modified mortar to all vertical surfaces to fill voids and bugholes and to resurface concrete to an average of 1/6-inch. Tnemec Series 201 may be used when mixed with fumed silica to make a patching slurry. Contact Tnemec if deeper resurfacing is required.

a. First Coat: Apply one coat of Tnemec Series 201 Epoxoprime, modified polyamine epoxy, at 8.0-10.0 mils dft for horizontal surfaces and 4.0-6.0 mils dft for vertical surfaces.

b. Second Coat: Apply one coat of Tnemec Series 275 Stranlok, polyamine novolac epoxy, at 30.0-35.0 mils dft. For a non-skid surface, broadcast 5 pounds per 150 square feet of 30-50 mesh clean and dry silica.

c. Final Coat: Apply one coat of Tnemec Series 282 Tneme-Glaze, polyamine novolac epoxy, at 6.0-8.0 mils dft.

Allow the coating system to cure a minimum 5 days at 75 degrees F before subjecting to chemical spillage. Light walking traffic may resume after a 24-hour cure.

2.6 SURFACE PREPARATION AND COATING: STEEL

Abrasive blast all ferrous metal to a minimum commercial blast finish ( SSPC SP 6/NACE No. 3). Prime as soon as possible the same day before rust bloom forms.

a. First Coat: Apply one coat of Tnemec Series 104 H.S. Epoxy, cycloaliphatic amine epoxy at 8.0-10.0 mils dft.

b. Stripe Coat: Brush apply one coat of Tnemec Series 104 H.S. to all welds, edges, overlaps, etc.

c. Final Coat: Apply one coat of Tnemec Series 104 H.S. Epoxy, cycloaliphatic amine epoxy at 8.0-10.0 mils dft.

For color coding, or where gloss and color retention are required, i.e. handrails, etc, apply one coat of Tnemec Series 1074 Endura-Shield II gloss aliphatic acrylic polyurethane at 2.0-4.0 mils dft.

2.7 HOLIDAY (CONTINUITY) TESTING OF APPLIED COATING

Each coat of primer and finish coating shall be inspected in accordance with ASTM D 4787 to determine integrity. Each coating application shall be checked and deficiencies shall be marked. After observing the specified recoat time, apply additional coating materials over areas having any holidays or pinholes. After the correction of deficiencies, reinspect those areas to determine the acceptability of the additional coating. Each coating application shall be 100 percent to the satisfaction of the coating manufacturer's representative and the Contracting Officer before succeeding coats are applied.

2.8 LEAKAGE TESTING OF SECONDARY CONTAINMENT STRUCTURES

Perform hydraulic leakage testing of each secondary containment structure in accordance with ACI 350.1 Chapter 2 after chemical-resistant coatings application, holiday testing, and repairs, if necessary, have been completed. Leakage testing shall meet the HST-NML (no measurable loss) tightness criteria specified in ACI Chapter 2, Part 2.1.1. Repair any leaks as required and retest if necessary.

PART 3 EXECUTION (NOT USED)

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SECTION 09 97 24

CONCRETE REPAIR AND HYDROGEN SULFIDE PROTECTIVE COATING

PART 1 GENERAL

1.1 SCOPE OF WORK

Furnish all labor, materials, equipment, and incidentals required to install and test, complete, and ready for operation, the repair and protective coating/lining of existing and new concrete structure(s) as specified herein and as shown on the drawings, including existing manholes, new manholes, existing lift stations/wet wells, and new lift stations/wet wells.

Provide all labor, materials, equipment, and incidentals required:

a. To meet all of the OSHA requirements for performing work in a confined space.

b. To provide positive ventilation in the confined space.

c. To provide all bypass pumping to perform the required work.

d. To provide all wastewater flow control(s) and diversion(s) to properly isolate the work area(s).

Concrete repair or concrete preparation work of 1/2 inch depth or less shall be the subsidiary/ancillary obligation of the Contractor and no additional payment shall be made for this work.

A National Association of Corrosion Engineers (NACE) certified inspector is required to observe the application and the testing of the protective epoxy lining coats, provide daily reports, and certify that the protective epoxy lining coats were applied in accordance with the manufacturer's recommendations. The NACE inspector shall be appropriate certified in the inspection of the application and testing of coatings.

1.2 RELATED WORK

Concrete work is included under Division 3.

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.

ACI INTERNATIONAL (ACI)

ACI 308R (2001; R 2008) Guide to Curing Concrete

ASTM INTERNATIONAL (ASTM)

ASTM D 4787 (2008) Standard Practice for Continuity Verification of Liquid or Sheet Linings

Applied to Concrete Substrates

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

| | |
|---|---|
| ICRI 03732 | (1997) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays |
| ICRI CSP 5 | (1997) Concrete Surface Profile 65-70 mils |
| ICRI CSP 6 | (1997) Concrete Surface Profile 70-75 mils |
| ICRI CSP 8 | (1997) Concrete Surface Profile 80-85 mils |

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC SP 1 | (1982; E 2004) Solvent Cleaning |
| SSPC SP 10/NACE No. 2 | (2007) Near-White Blast Cleaning |
| SSPC SP 5/NACE No. 1 | (2007) White Metal Blast Cleaning |
| SSPC VIS 1 | (2002) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning |

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

Certified Shop Drawings; G

SD-03 Product Data

Product Data; G

SD-06 Test Reports

High Voltage Spark Testing; G

SD-07 Certificates

NACE Certification; G

SD-08 Manufacturer's Instructions

Non-conforming aspects; G

1.5 SHOP DRAWINGS

Submit certified shop drawings showing all important details of concrete repair and protective coating installation.

Submit product data including descriptive literature, bulletins, and/or

catalogs of the protective coating and concrete repair materials and cleaning procedures.

## 1.6 QUALIFICATIONS

Furnish all of the protective coating material specified herein from a single manufacturer who regularly engages in the production of this type of hydrogen sulfide protective coating material who is fully experienced, reputable, and qualified in the manufacture of the coating to be furnished. If resurfacing greater than 1/2 inch in depth is required, a different manufacturer may be used for these deep concrete repairs. Ensure that material furnished under this specification is new and unused, of the type, components, and efficiency installed on previous projects and the product of a manufacturer having a successful record of operation, manufacturing and service for a minimum of 5 years before bid date. The manufacturer shall supply the Contracting officer with previous installation details including references with current phone numbers for a minimum of 10 previous projects which used the specified protective coating/lining system(s).

The protective coating manufacturer shall instruct the protective coating manufacturer applicator or the Contractor in the proper procedures in applying the protective coatings. The Contractor shall guarantee that the prepared surfaces to be coated and the application of the protective coating are suitable for the purpose intended and free from defects of material and workmanship. The protective coating manufacturer shall provide a certification to the Contracting Officer that the surfaces were properly prepared and properly coated.

The protective coating shall be Tnemec Series 218 MortarClad/Tnemec Series 434 Perma-Shield/Tnemec Series 435 Tnemec-Glaze by Tnemec Company, Sauereisen series F-120 or 121/210T or RS/210G by Sauereisen Inc., or approved equal.

If it is impossible to conform to certain details of the specifications due to different manufacturer's products, describe all non-conforming aspects and the reason for non-conformance.

## 1.7 DELIVERY, STORAGE, AND HANDLING

Properly protect all materials so that no damage or deterioration occurs during a prolonged delay from the time of shipment until installation is completed.

Properly protect all materials, equipment, and parts against any damage during a prolonged period at the site.

Properly mark each box or package to show its net weight in addition to its contents.

## 1.8 SITE CONDITIONS

### 1.8.1 Weather Constraints

Maintain substrate temperatures and air temperature before, during, and after installation in accordance with the protective coating manufacturer's written recommendations and instructions. Protect areas to be coated from the elements of direct weather (sunlight, rain, wind, etc.) and inclement weather during the application and curing period of the coatings.

Provide adequate ventilation during application and curing periods.

1.9 WARRANTIES

Warranties shall be in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS. Additionally, the protective coating manufacturer shall warranty its products as free from material defects for a minimum period of one year.

The Contractor shall warranty the installed protective coating/lining system as free from material and workmanship.

1.10 PATENTS AND LICENSES

The Contractor is responsible for all patents or licenses that exist on the materials that are provided.

The Contractor and manufacturer shall assume all costs of patent fees or licenses for the materials or process and shall safeguard and save harmless the Government from all damages, judgments, claims, and expenses arising from license fees or claimed infringement of any letters, patent or patent rights, or fees for the use of any equipment or process structural feature or arrangement of any of the component parts of the installation and the price bid shall be deemed to include payment of all such patent fees, licenses, or other costs pertaining thereto.

PART 2 PRODUCTS

2.1 MATERIALS

The protective lining system shall be a multi-component protective lining system, including:

a. Concrete restoration where required with epoxy or cementitious resurfacing/underlayment materials as specified herein and in accordance with protective coating/lining manufacturer's recommendations.

b. A basecoat of trowelable or sprayable aggregate filled epoxy lining at 125 mils dry film thickness (dft) for corrosion and abrasion resistance against the physical and chemical attack phenomena typically associated with municipal wastewater service conditions.

c. Epoxy sealer coat at 15 to 20 mils dft to provide a smooth and sealed finished surface profile.

d. Applicator or Contractor shall provide all accessory components of the system such as infiltration control products or other compounds as recommended by the protective coating manufacturer for maximum protective lining adherence to substrate and long-term service performance.

e. Cure and prepare all cementitious materials in accordance with ACI 308R.

2.1.1 Products - Sauereisen

2.1.1.1 Cementitious Resurfacer/Underlayment

Sauereisen F-120 Underlayment or F-121 Substrate Resurfacer. Minimum thickness - 1/8 inch.

Where existing concrete has been damaged to depth of 1/2 to 2 inches, apply the cementitious resurfacer/underlayment in accordance with the manufacturer's instructions and requirements.

2.1.1.2 Protective (Corrosion Resistant) Epoxy Lining

Sauereisen SewerGard No. 210T or 210RS. Minimum applied thickness (dry film) 120 mils.

Epoxy lining shall be an aggregate-filled, trowel- or spray-applied epoxy polymer protective lining material specifically designed to protect concrete and steel surfaces of wastewater structures subjected to municipal wastewater service conditions, including associated abrasive physical attack and chemical attack mechanisms related to hydrogen sulfide and organic acids generated by microbial sources.

2.1.1.3 Epoxy Protective Lining Sealer Coat

Sealer coat - SewerGard No. 210 Glaze. Minimum applied dft 15 mils.

The unfilled epoxy sealer coat at 15 to 20 dft mils is required to enhance corrosion and abrasion resistance and reduce permeability.

2.1.2 Products - Tnemec

Use Option 1 or Option 2 depending on the condition of the concrete after abrasive blasting. The Contracting Officer will determine where each option will be installed.

2.1.2.1 Option 1

For concrete surfacing from a depth of 1/2 to 2 inches use the following:

Cementitious Resurfacer

a. Sika 123 Substrate Resurfacer, Xypex Mega-Mix II, or other as approved by Tnemec. Minimum thickness - 1/2 inch.

b. Where existing concrete has been damaged to a depth of 1/2 to 2 inches, apply and cure the cementitious resurfacer/underlayment in accordance with the manufacturer's instructions and requirements. This product can be applied to bare, abrasive-blasted rebar. Following proper curing of the resurfacer, abrasive blast to minimum ICRI CSP 5.

c. Apply one coat of Tnemec Series 1 Omnithane at 3.0 to 4.0 mils dft.

2.1.2.2 Option 2

For concrete surfacing for a depth of up to 1/2 inch use the following:

1. Cementitious Mortar Surfacer

a. Tnemec Series 218 MortarClad Mortar. Minimum thickness - 1/8

to 1/4 inch. Maximum thickness - 1/2 inch.

b. To be used directly to the existing concrete if surfacing of less than 1/2 inch is required. May also be required if the surface preparation of the Sika 123 or resurfacer used exceeds ICRI CSP 8.

2. Protective (Corrosion Resistant) Epoxy Lining

a. Tnemec Series 434 Perma-Shield. Minimum applied dft 125 mils.

b. Epoxy lining shall be an aggregate-filled, trowel- or spray-applied epoxy polymer protective lining material specifically designed to protect concrete and steel surfaces of wastewater structures subjected to municipal wastewater service conditions, including associated abrasive physical attack and chemical attack mechanisms related to hydrogen sulfide and organic acids generated by microbial sources.

3. Epoxy Protective Lining Sealer Coat

a. Tnemec Series 435 Perma-Glaze. Minimum applied dft 15 mils.

b. The unfilled epoxy sealer coat at 15 to 20 dft mils required to enhance corrosion and abrasion resistance and reduce permeability.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install the protective coating in strict accordance with the manufacturer's instructions and recommendations. Preparation of the existing concrete surfaces for the application of the protective coatings shall also meet the protective coating/lining manufacturer's requirements. Remove and properly dispose of all sand or abrasive material used in the sandblasting operation from the wet well structure. None of this material or any other coating-related material shall enter the treatment facility.

### 3.2 INSPECTION

High-pressure clean and wash as necessary the areas to be coated as required for observation by the Contracting Officer to determine the concrete area that is going to require concrete repair of a depth of 1/2 to 2 inches in depth. This observation shall also determine areas of concrete repair and/or rebar repair that will exceed 2 inches in depth. Schedule the inspection of the cleaned areas at least 7 days in advance. Provide all equipment necessary for the Contracting Officer to safely enter into the manhole/wet well during this inspection(s). Provide proper ventilation, sufficient lighting, protective gear, safety equipment, etc. as required to enter the interior of the manhole/wet well. Bypass pump or other handle the wastewater flow to allow the manhole/lift station to remain in operation during the inspections as well as during the course of the work which includes, but is not limited to the following:

a. Handle all of the lift station's flowstreams as required without spillage.

b. Provide backup pumps or generators to ensure the bypass pumping

effort is not interrupted or causes a spill.

Upon the determination of the damaged concrete areas requiring repair, locate (on the asbuilt drawings) and measure in the presence of the Contracting Officer. The agreed-to quantities shall be the basis for the Contractor's applicable unit cost payment. Repair these areas as required. Should the damaged area become more extensive than originally determined (i.e. to a depth of more than 2 inches), the Contractor and the Government shall agree to the cost for this additional work before proceeding. No additional repair work shall be paid for unless the Government agrees to the cost before the pair being started.

Do not proceed with the final two protective coatings until concrete surface preparation has been completed and unsatisfactory concrete surface conditions have been corrected in a manner acceptable to the Contracting Officer and the coating manufacturer/supplier.

Provide a National Association of Corrosion Engineers (NACE) certified coatings inspector for LS-AA and LS-4A to observe the application and testing of the protective epoxy lining coats, provide daily reports, and certify that the protective epoxy lining coats were applied in accordance with the manufacturer's recommendations. Ensure that the NACE inspector is appropriately certified in the inspection of the application and testing of coatings.

## 3.3 SURFACE PREPARATION

### 3.3.1 New Concrete Surfaces on New Structures

Cast concrete surfaces on new concrete structures (freshly poured) to receive protective coating with rough form finish. Do not rub, trowel, or otherwise finish surfaces in any manner that will obscure or cover the firm substrate surface. Complete all subsequent surface washing, abrasive blasting, grinding, patching, filling, and preparation in accordance with the protective coating manufacturer's recommendations.

Allow new concrete (freshly poured concrete) to cure for 28 days before protective lining system is installed unless otherwise recommended by the protective coating manufacturer. Ensure that concrete surfaces to be coated are free of curing compounds and form release agents, laitance and foreign particles that may inhibit bonding. Before starting protective coating systems application, vacuum blast, hydroblast, or abrasive blast surfaces to be covered as required and inspect the substrate. Start of application operations shall indicate acceptance of substrate conditions and full responsibility for the completed work. Ensure that surface preparation procedures are in accordance with ICRI 03732 or comparably approved method. Surface preparation requirement is to expose aggregate and obtain a uniform surface texture resembling an ICRI CSP 5 to ICRI CSP 6 comparators.

Level or grind all concrete substrates to protective coating manufacturer's recommended tolerances to produce a uniform surface profile, including removal of all sharp edges, ridges, or depressions.

New concrete application: Fill new concrete voids and depressions with resurfacer/underlayment material, re-establishing plan finished grades and surface profiles.

### 3.3.2 Existing Concrete Surfaces

Ensure that existing concrete structures to receive protective lining system are capable of withstanding imposed loads. Remove all oil, grease, and chemical contaminants from the surface of the concrete. Ensure that all surfaces are firm, free of damaged or contaminated concrete, laitance, form release agents, and standing water and are structurally sound as determined by the Contracting Officer. Suitable surface preparation methods include shot blasting, abrasive blasting, or hydroblasting. Surface preparation procedures shall be in accordance with ICRI 03732. Surface preparation requirements is to expose aggregate and obtain a uniform surface texture resembling an ICRI CSP 5 to ICRI CSP 6 comparators.

Open all voids and bugholes in the concrete (via abrasion, sandblasting, grinding, etc.) to the degree that coating can completely fill these voids and no off-gassing occurs after the coatings are applied and allowed to dry.

3.3.3 Metal Surfaces

Metal application: Remove all visible oils and grease in accordance with SSPC SP 1, section 2.1. Remove contaminants from surface in accordance with SSPC SP 1, section 3.2. Using CHLOR*RID INTERNATIONAL "CHLOR*TEST" test kits, or approved equivalent method, determine level of chlorides on the metal surfaces. Level of acceptable chlorides shall be no more than 3 micro-g/$cm^2$ for immersion and no more than 5 micro-g/$cm^2$ for atmospheric conditions. Surfaces with unacceptable levels must be washed with CHLOR*RID, or approved equal, in accordance with the protective coating manufacturer's recommendations and then retested.

Using SSPC VIS 1 as a guide, abrasive blast to a SSPC SP 5/NACE No. 1 for immersion and a SSPC SP 10/NACE No. 2 for other service conditions. An anchor profile range of 2.5 to 3.0 mil is preferable. Ensure that all welds are continuous, free of flux, and have a smooth rounded radius without any sharp edges or are ground flat and free of flux, fins, and spatter.

Consult protective coating manufacturer for primer recommendations on metal.

3.3.4 Removal of Surface Preparation Material(s)

Remove all surface preparation materials including, but not limited to, sand, sot, abrasive materials, degreasers, etc. as well as removed materials (concrete particulates, metal filings, damaged materials, rusted metal, etc.) from the work site and properly dispose of offsite. Do not allow any of the surface preparation material(s) or removed materials to enter the treatment plant process.

3.4 APPLICATION

Install protective coating systems when ambient air and surface temperatures are between 60 and 85 degrees F. Store coating materials within the 60 to 85 degrees F range for 48 hours before use. Application and storage temperatures outside this range will require written instruction and approval from the protective coating manufacturer. Ensure that moisture content is in accordance with manufacturer's requirements.

Application in direct sunlight and/or with rising surface temperatures is not recommended as this may result in blistering outgassing of the materials due to expansion of entrapped air or moisture (outgassing) in the concrete. In such cases, postponement will be necessary until later in the

day when the temperature of the substrate is falling. Concrete surfaces that have been in direct sunlight must be shaded for at least 24 hours before application and remain shaded until the initial set has taken place. Consult protective coating manufacturer for application schedule guidelines specific to temperature conditions and possible sealer application recommendations to reduce/eliminate outgassing.

Substrate repairs: Ensure that all substrate repairs required by the Contracting Officer or as specified in the contract documents are in accordance with the recommendations and requirements of the protective coating manufacturer. Written approval by the protective coating manufacturer is required for all substrate repairs before applying the coatings. Concrete substrate repair shall consist of removing all damaged or defective concrete to a depth of 1/8 inch into sound concrete in all directions from the damaged area(s). Ensure that no rebar, expansion joints, embedments, or other items are damaged during this process. The Contracting Officer shall agree that sound concrete has been reached. Properly repair any damaged items at no cost to the Government.

Should the repair area include an area around any existing exposed rebar, sandblast off all rust on the rebar. If the rebar has been damaged, contact the Contracting officer to determine if rebar replacement is required.

Apply and cure protective epoxy lining and epoxy protective lining sealer coat on the properly prepared surface(s) in accordance with protective coating system manufacturer's written guidelines and as specified herein. It is very important that the substrate (floors, walls, ceilings, etc.) to be coated are properly prepared with all laitance and contaminants removed and kept dry during application and cure.

Form and fill expansion and construction joints as recommended by the protective coating manufacturer.

## 3.5 FIELD QUALITY CONTROL

### 3.5.1 Inspections

Provide the resume of the NACE certified inspector who will observe the application and testing of the protective epoxy lining coats. In addition, provide a copy of the inspector's NACE certification with the resume.

### 3.5.2 High Voltage Spark Testing

Test installed protective epoxy lining in the presence of the Contracting officer and a NACE inspector for pinholes after a minimum 24-hour cure at a temperature of 70 degrees F. Before the park testing, determine and certify that the dft of the epoxy coatings is the same as recommended by the coating supplier. Accomplish pinhole testing in accordance with ASTM D 4787 using a Tinker Razor Holiday Detector, San Gabriel, CA, Model AP/W, or an approved equal device. Apply a test voltage of 100 volts/mil of coating thickness. Mark and repair all pinholes using manufacturer's approved patch kit or other approved method in accordance with written recommendations from the protective coating manufacturer. Repair other areas damaged by the spark testing as recommended by the protective coating manufacturer/supplier at no additional cost to the Government.

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FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 REQUIREMENTS

Provide design and installation in accordance with NFPA Standards. The interpretation of NFPA Standards rests with the Kennedy Space Center Fire Protection Engineer who is the Authority Having Jurisdiction (AHJ), and whose opinion is final.

This is a performance based specification with the Contractor responsible for providing engineering design, installation and testing associated with the work to be performed. As defined under Florida Statutes, Chapter 471, all design work will be performed by a "delegated engineer", who is a Professional Engineer, licensed to practice in Florida and competent in fire protection engineering.

1.2 REFERENCES

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

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISC/AISI 121 | (2004) Standard Definitions for Use in the Design of Steel Structures |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C606 | (2006) Grooved and Shouldered Joints |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME A112.18.1/CSA B125.1 | (2005; Update 2006) Plumbing Supply Fittings |
| ASME B16.34 | (2009; Supp 2010) Valves - Flanged, Threaded and Welding End |
| ASME B16.39 | (2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300 |
| ASME B16.4 | (2006) Standard for Gray Iron Threaded Fittings; Classes 125 and 250 |
| ASME B16.5 | (2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B16.9 | (2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings |

ASME B31.1 (2010) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A126 (2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM A135/A135M (2009) Standard Specification for Electric-Resistance-Welded Steel Pipe

ASTM A183 (2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts

ASTM A234/A234M (2010b) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

ASTM A307 (2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

ASTM A53/A53M (2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A563 (2007a) Standard Specification for Carbon and Alloy Steel Nuts

ASTM A795/A795M (2008) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use

ASTM C 592 (2010) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)

ASTM D 2000 (2008) Standard Classification System for Rubber Products in Automotive Applications

FM GLOBAL (FM)

FM APP GUIDE (updated on-line) Approval Guide http://www.approvalguide.com/

FM AS 4991 (2001) Approval of Firestop Contractors

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58 (2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 13 | (2010; Errata 10-1; TIA 10-1) 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 |
| NFPA 251 | (2006) Standard Methods of Tests of Fire Resistance of Building Construction and Materials |
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |
| NFPA 72 | (2010; TIA 10-4) National Fire Alarm and Signaling Code |
| NFPA 75 | (2009) Standard for the Protection of Information Technology Equipment |

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

| | |
|---|---|
| NICET 1014-7 | (2003) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-STD-101 | (1970; Rev B) Color Code for Pipelines & for Compressed Gas Cylinders |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FED-STD-595 | (Rev C, 2008) Colors Used in Government Procurement |
| CID A-A-1922 | (Rev A; Notice 2) Shield, Expansion (Caulking Anchors, Single Lead) |
| CID A-A-55614 | (Basic; Notice 2) Shield, Expansion (Non-Drilling Expansion Anchors) |
| CID A-A-55615 | (Basic; Notice 2) Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors |
| FS A-A-1923 | (Rev A; Notice 1) Standard for Shield, Expansion (Lag, Machine and Externally threaded Wedge Bolt Anchors) |
| FS A-A-1924 | (Rev A; Notice 1) Standard for Shield, Expansion; (Self Drilling Tubular Expansion Shell Bolt Anchors) |

| | |
|---|---|
| FS A-A-1925 | (Rev A; Notice 1) Standard for Shield, Expansion (Nail Anchors) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 6 | (2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel |
| UL Fire Prot Dir | (2011) Fire Protection Equipment Directory |

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meeting

No later than 15 calendar days of Contract Award, mandatory attendance is required at a pre-installation meeting. Submit the following to the Contracting Officer for review:

a. Contractor's State Certification

b. factory test data, including fully verified and dated copies of all results with a copy of the approved test procedure and any other related information.

c. Quality Assurance Plan

d. test procedures and recording forms for the preliminary tests

Provide one (1) copy of the test procedures and recording forms for the preliminary tests. For the final acceptance tests, provide ten (10) copies of the test procedures and recording forms. In each test procedure, identify each sprinkler and standpipe component to be tested, describe the initial condition, each step or function in the test, required test results, and equipment to be employed. Provide test forms with suitable spaces for recording test results on all equipment, devices, and wiring to be tested. Provide test record forms that also have identified spaces for verification signatures of official witnesses and dates of the test.

1.3.1.1 Shop Drawings

Submit shop drawings for the following items in sufficient detail and scope to verify compliance with the requirements of the contract documents:

a. Records of Existing Conditions

Submit Records of existing conditions showing the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the job site. Commencement of work constitutes acceptance of existing conditions.

b. Schematics and Fabrication Drawings

Submit Schematics and Fabrication Drawings for automatic sprinkler and standpipe systems, consisting of fabrication and assembly drawings to be performed in the shop, prior to installation and at the actual job site. Meet all requirements in NFPA 13 for fabrication drawings, stipulated for "working plans", to include a building cross-section. Provide working plans signed and sealed by a Professional Engineer, licensed to practice in the State of Florida.

Indicate on working plans all sprinkler and standpipe piping (size and length), pipe hangers, sprinkler head type and locations, valves, riser trim and associated components, etc. to comply with NFPA 13, "Working Plans."

c. Fire Service Floor Plans

Provide .DWG format computer generated floor plan layouts indicating all automatic sprinkler and standpipe systems components.

In the design, give full consideration to blind spaces, other system piping, electrical equipment, HVAC ductwork, and all other types of obstructions which could prevent the proper installation and operation of the sprinkler and standpipe systems.

Indicate in the Fire Service Floor Plans, the location of the wet-pipe and dry-pipe automatic sprinkler system, risers, standpipes, isolation valves, initiating devices, and the dry-pipe compressed air panel. Coordinate with the requirements of the Fire Alarm System Fire Service Floor Plan such that all fire alarm and suppression system devices are combined on a single fire service floor plan. Provide a symbol legend, which clearly identifies each device shown on the fire service floor plan. Install a copy of the fire service floor plan minimum size 18 by 24 inches in a painted metal frame with a Plexiglas cover. Submit the floor plan and it's location for approval to the Contracting Officer prior to installation.

d. Connection Diagrams

Submit Connection Diagrams indicating the relations and connections of the following items. Indicate on the drawings the general physical layout of all controls, and internal tubing and wiring details.

1.3.1.2 Manufacturer's Product Data

Submit Manufacturer's Catalog Data in sufficient detail and scope to verify compliance with the requirements of the contract documents.

1.3.1.3 Fire-Protection System Performance Data

Submit Fire-Protection System Performance Data consisting of information on useful life, system functional flows, safety features, and mechanical automated details. As a minimum, include the following:

a. Design Analysis and Hydraulic Calculations

Provide hydraulic calculations for the hydraulic remote area of each riser and each occupancy classification. Provide hydraulic calculations signed and sealed by a Professional Engineer, licensed to practice in Florida.

Include in the design data design density, hydraulically most remote area, occupancy classification, sprinkler head orifice size, and pipe velocities. Specify the design density in gpm per sq ft or L/m per sq m of floor area. Provide discharge from individual heads in the hydraulically most remote area to be between 100 percent and 120 percent of the specified density. Design systems such that pipe velocities do not exceed 20 feet per second.

1.4 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

Records of Existing Conditions; G

Contractor's State Certification; G

Factory Test Data; G

Quality Assurance Plan; G

Test Procedures And Recording Forms For The Preliminary Tests; G

SD-02 Shop Drawings

Connection Diagrams; G

Schematics and Fabrication Drawings; G

As-Built Drawings; G

Fire Service Floor Plans; G

SD-03 Product Data

Piping Materials; G

Supporting Elements; G

Sprinkler Riser Equipment; G

Riser Alarm Equipment; G

Fire Department Connections; G

Standpipe Equipment; G

Sprinkler Heads; G

Valves; G

Miscellaneous Materials

Identification Tags

Inspector's Test Valve; G

Fire Stopping; G

Fire-Protection System Performance Data; G

SD-05 Design Data

Design Analysis and Hydraulic Calculations; G

SD-06 Test Reports

Pressure Tests; G

Inspector's Test; G

SD-07 Certificates

Test Gauge Accuracy; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.5 QUALITY ASSURANCE PLAN

Ensure all equipment provided under this sprinkler system specification is manufactured to meet the requirements of this paragraph. Provide system(s) that is (are) the latest standard design, that is listed by Underwriters' Laboratories or approved by Factory Mutual FM APP GUIDE, and is suitable for the intended use.

Components installed under this contract cannot be more than one (1) year older than the date of installation. Submit proof that all components are Underwriter Laboratory UL Fire Prot Dir listed or Factory Mutual FM APP GUIDE and FM AS 4991 approved for their intended use and function, and are installed per manufacturer instructions.

Number all fittings and coupling that require a specific torque range and ensure the corresponding torque value is documented. Submit verification that all grooved clamp type couplings and fittings were installed in accordance with the manufacturer installation manual.

1.5.1 Services Of A Certified Automatic Sprinkler Specialist

Provide services of a Certified Specialist thoroughly experienced in automatic sprinkler system installations on site to perform or directly supervise the installation, make all necessary adjustments and perform all tests on the automatic sprinkler system at the site.

Sprinkler System Specialist is certified when the specialist holds a valid Sprinkler System Layout, Level III Certification from the National Institute for Certification in Engineering Technologies NICET 1014-7 or is licensed by the State of Florida as a Contractor Class I in accordance with Florida State Statute, Chapter 633, Section 633.521 and holds a current Certificate of Competency.

Also consider certification of other recognized agencies with equivalent requirements. Provide evidence of the Contractors State Certification and the basis of certification to the Contracting Officer and approve by the Contracting Officer prior to any work being performed at Kennedy Space Center.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide fire-protection system materials and equipment conforming to the

requirements of Underwriters Laboratories UL Fire Prot Dir or the Factory Mutual FM APP GUIDE.

2.1.1 Design Requirements

The work includes designing and providing new automatic wet pipe sprinkler systems consisting of but not limited to an easy riser type swing check valve, with all associated trim, including gauges, 2 inch main drain connection, flow switches, and sprinkler heads for the wet-pipe sprinkler system. Hydraulically design the automatic sprinkler system(s) to meet density and area of coverage requirements using a UL listed or FM approved hydraulic design program. Provide the design, equipment, materials, installation, workmanship, examination, inspection, and testing in strict accordance with the required and advisory provisions of NFPA 13, NFPA 72, NFPA 24, and NFPA 75 except as modified herein. Include in each system all materials, accessories, and equipment inside and outside the building to provide an operationally compliant system. In the system design give full consideration to blind spaces, piping, electrical equipment, ductwork, and other construction and equipment in accordance with working plans to be submitted for approval prior to installation. Locate sprinkler heads in a consistent pattern with lights, supply diffusers and return diffusers.

Provide all additional equipment, junction boxes, conduit, and labor to meet the requirements and intent of this specification.

2.2 PIPING MATERIALS

2.2.1 Type BCS - Black Carbon Steel

Pipe 1/8 through 2 inches: Schedule 40 furnace butt welded or electric-resistance welded black-carbon steel conforming to ASTM A53/A53M, ASTM A135/A135M, ASTM A795/A795M, Type F furnace butt welded.

Pipe 2-1/2 through 8 inches: Schedule 40 seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M, ASTM A135/A135M, ASTM A795/A795M, Type E (electric-resistance welded), Grade B, or Type S (seamless), Grade B.

Unions 2 inches and under: 300-pounds per square inch gage (psig) working steam pressure (wsp) female, screwed, black malleable iron, with ground joint and brass-to-iron seat conforming to ASME B16.39

Standard Pipe Couplings: Extra-heavy screwed black steel.

Fittings 2 inches and under: 175 psi working pressure, cast iron, screwed conforming to ASTM A126, Class A, and ASME B16.4.

Fittings 2-1/2 inches and larger: 175 psi working pressure, wrought steel, buttweld fittings, wall thickness to match piping system, complying with ASME B16.9 and 150 pound steel flanges complying with ASME B16.5.

Provide elbows that are of the long radius type.

Provide grooved pipe couplings 2-1/2 inch and larger: 175 psig minimum working pressure with a housing fabricated in two or more parts of black malleable-iron castings. Ensure grooved couplings do not require a specific torque setting for housing bolt installation. Provide piping that is grooved in accordance with AWWA C606, or the manufacturer's specifications, for proper installation of the grooved couplings used.

Provide couplings of the same part number for use on a single system.

Provide coupling gaskets of molded synthetic rubber conforming to requirements of ASTM D 2000. Provide coupling bolts that are oval-neck, track-head type with heavy hexagonal nuts, conforming to ASTM A183.

Grooved fittings 2-1/2 inch and larger: 175 psig working pressure fittings used with grooved couplings that are fabricated of black malleable-iron castings, and are of the same manufacture as the pipe couplings. If a manufacturer's standard-size malleable-iron fitting pattern is not available, use fabricated fittings; fabricate fittings from Grade B seamless-steel pipe and long-radius seamless welding fittings, with wall thickness to match pipe, conforming to ASTM A234/A234M and ASME B16.9.

Do not use bushings; only pre-manufactured concentric or eccentric reducing fittings or reducing tees/elbows can be used to reduce pipe size.

Pre-manufactured shaped welded outlets (weld-o-lets) can be used in lieu of "tee" fittings where the branch pipe outlet is at least one pipe diameter smaller than the main.

Do not use non-grooved products which rely in any way upon gasketing, clamps, straps, or setscrews for maintaining system integrity.

Do not use adjustable "drop nipples" which utilize an O-ring type seal arrangement.

## 2.3 SUPPORTING ELEMENTS

Provide piping system components and miscellaneous supporting elements, including, but not limited to, building-structure attachments; standpipe equipment and fire hose cabinet stations; supplementary steel; hanger rods, stanchions, and fixtures; vertical-pipe attachments; horizontal-pipe attachments; restraining anchors; and guides. Provide supporting elements suitable for stresses imposed by systems pressures and temperatures, natural, and other external forces. Include an additional 250 pound load at each anchor per NFPA 13.

Provide FM approved or UL listed supporting elements conforming to ASME B31.1, MSS SP-58, and ASME B16.34.

### 2.3.1 Building-Structure Attachments

#### 2.3.1.1 Anchor Devices, Concrete and Masonry

Conform anchor devices to CID A-A-1922, FS A-A-1923, FS A-A-1924A, FS A-A-1925, CID A-A-55614 and CID A-A-55615:

Group I: Shield, expansion (lead, bolt, and stud anchors)

Group II: Shield, expansion (bolt anchors), Type 2, Class 2, Style 1 or 2

Group III: Shield, expansion (self drilling tubular expansion shell bolt anchors

Provide adjustable positions for cast-in floor-mounted equipment-anchor devices.

Do not use powder-actuated anchoring devices to support mechanical-systems components.

2.3.1.2 Beam Clamps

Provide beam clamps that are center-loading Types 21, 28, 29, and 30, UL listed, cataloged, and load-rated commercially manufactured products.

Type 20 beam clamps can be used for pipe 2 inch and under.

Where Type 25 beam clamps are used, use two per point of pipe support.

2.3.1.3 C-Clamps

Do not use C-clamps.

2.3.1.4 Inserts, Concrete

Provide concrete inserts in accordance with the requirements of MSS SP-58 for Type 18. When applied to piping in sizes 2-inch iron pipe size (ips) and larger, and where otherwise required by imposed loads, insert and wire a 1-foot length of 1/2-inch reinforcing rod through wing slots.

2.3.2 Horizontal-Pipe Attachments

2.3.2.1 Single Pipes

Support piping in sizes up to and including 2-inch ips by Type 1, 5, 6, 7, 9, 10, 11, or 12 solid, split-ring, or band type attachments.

Support piping in sizes 2-1/2 inches and larger by Type 1, 2, 3, or 4 attachments or with Type 41 or Type 49 pipe rolls.

2.3.2.2 Parallel Fire-Protection Pipes

Use trapeze hangers fabricated from approved structural steel shapes, with U-bolts, when so specified. Provide structural-steel shapes that conform to supplementary steel requirements or provide supports that are commercially available, approved proprietary-design rolled steel.

2.3.3 Vertical-Pipe Attachments

Provide single Type 8 vertical-pipe attachments.

2.3.4 Hanger Rods and Fixtures

Use only circular solid cross section rod hangers to connect building structure attachments to pipe-support devices. Use pipe, straps, or bars of equivalent strength for hangers.

Provide turnbuckles, swing eyes, and clevises as required by support system to accommodate temperature changes, pipe accessibility, and adjustment for load and pitch.

2.3.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated

supports, design and fabricate such supplementary steel in accordance with AISC/AISI 121.

Provide supplementary steel that is hot dipped galvanized or otherwise protected from corrosion as acceptable to the Contracting Officer.

## 2.4 SPRINKLER RISER EQUIPMENT

Provide UL listed or FM approved Riser alarm equipment for fire-protection use.

### 2.4.1 Standard Check Valve

Provide check valve that is UL listed or FM approved standard swing-check type with elastomer-disc seat. Provide check valve that has a ductile iron body with flanged or grooved ends and is of the clear opening type with flanged inspection and access cover plate for sizes 4 inches and larger. Provide check valve that is able to be installed vertically or horizontally, and that is rated for 300 psi working pressure. Provide clapper that is type 304 stainless steel, Teflon-coated hot-rolled steel, ductile iron, coated ductile iron, or bronze with field replaceable EDPM or Nitrite seal, with nickel or bronze seat. Provide a valve with springs, hinge shafts and retaining rings that are stainless steel. Provide a valve that has a valve body manufacturer painted with a corrosion resistant non-lead coating.

### 2.4.2 Wet Pipe Valve

Provide wet pipe valve that is of the combination check valve/main drain type complete with standard accessories and trim, including pressure gauges, 2-inch main drain connection, flow switch tapping, and all necessary intercomponent water piping, fittings, and valves. Check valve shall have a ductile iron body with flanged ends and be of clear opening type with flanged inspection and access cover plate for sizes 4 inches and larger. Clapper shall be Type 304 stainless steel with field-replaceable EPDM or nitrile seal and nickel or bronze seat. Spring hinge shaft and retaining ring shall be stainless steel.

Wet-pipe sprinkler systems require a UL listed or FM approved OS&Y isolation valve with tamper switch and flow switch, as indicated on the contract drawings, complete with standard accessories and trim necessary to give alarm, supervisory, and trouble signals. Provide provisions for testing and draining the systems, including all necessary piping, fittings, and valves for proper operation of the systems.

## 2.5 WATER FLOW ALARM DEVICE

Provide water flow alarm devices that are UL listed for the particular type of system. Wire water flow switch to make or break a circuit on rise of water pressure. Provide water flow switch that has an integral field adjustable 0-90 second retard feature, and activates within 60 seconds, plus or minus ten (10) seconds upon opening of the inspectors test station.

Provide water flow alarm device that has a design working pressure of 300 psi, include two (2) sets of single pole, double throw contacts rated for not less than 2.0 amps at 30 VC. Provide housing that is die cast, suitable for both indoor and outdoor use and includes knockouts for conduit connections.

## 2.6 PRESSURE GAUGE

Provide pressure gauge with a minimum 3.5 inch diameter, brass or stainless steel case with chrome finish, glass or polycarbonate window, brass dial with white background, black markings, dual units (English and Metric), phosphor bronze bourdon tube, brass precision geared movement, plus or minus 3 percent accuracy, 300 psi working pressure, and three-way globe style gauge isolation valve with plugged end.

## 2.7 INSPECTOR'S TEST

Provide an inspector's test valve that is a three-position (OFF-TEST-DRAIN) combination test, drain, and pressure relief device with bronze body, bronze ball valve, one quarter turn handle, integral sight glass (on discharge side), and internal corrosion resistant orifice, sized to match the sprinkler head orifice size. Ensure pressure relief device is factory set to relieve pressure at 175 psi.

## 2.8 FIRE DEPARTMENT CONNECTIONS

Provide hose connections that have National Fire hose standard-thread form and rocker lugs in accordance with NFPA 1963. Provide hose connection sizes and threads that are compatible with the equipment used by the fire department serving the facility.

### 2.8.1 Yard Siamese

Provide unit that is cast brass or bronze with two 2-1/2inch, fire-department, swivel, female inlets; double-clapper valves; rocker-lug caps and chains; and cast-in function-identifying lettering. Provide model with Chrome-plated or polished surface finish in accordance with ASME A112.18.1/CSA B125.1. Mount unit on a Schedule 40 ASTM A53/A53M galvanized carbon-steel pipe with red-enameled finish on prime-coated surface. Protect all surfaces embedded in concrete or below grade with a 20-mil thick bituminous coating.

## 2.9 SPRINKLER HEADS

### 2.9.1 Head Types

Use standard 1/2-inch orifice sprinkler heads, except that 17/32-inch heads can be used where required by hydraulic calculation.

Provide upright type heads in unfinished areas or above suspended ceilings.

Sidewall type heads can be used where indicated on the drawings, or in locations as defined by NFPA 13.

Where needed, provide corrosion-resistant heads that are wax-coated, Nickel-Teflon coated, or manufacturer coated with an equivalent UL listed or FM approved corrosion-resistant coating.

### 2.9.2 Temperature Rating

Provide fusible links that have ordinary temperature classification, except where otherwise indicated or in locations defined in NFPA 13 as requiring intermediate or high temperature heads.

### 2.9.3 Spares

Furnish spares for each type of sprinkler head, complete with appropriate storage cabinet and wrench. Provide quantity of spare heads in accordance with NFPA 13. Mount cabinet next to riser or other location as directed by the Contracting Officer.

2.9.4 Head Protection

Protect heads with paper or plastic bags during painting operations. Immediately remove protection upon finishing painting operations.

Provide steel wire head guards wherever mechanical damage could occur. Provide head guards UL listed or FM approved for use with the sprinkler heads installed. Provide head guards with a manufacturer applied red finish, except where head guards UL listed or FM approved for use with the sprinkler heads installed do not come in a manufacturer applied red finish.

Provide water shields of cold rolled galvanized steel, and install on all heads located beneath other heads within their spray areas. Provide shields with red finish.

2.10 VALVES

2.10.1 Aboveground

Provide FM approved or UL listed gate, globe, and check valves (all sizes).

Provide FM approved ball valves, 2 inches and under, rated to 300 psi, with provisions to wire or lock handle in place where a critical alarm function is isolated.

Provide gate valves that are of the outside screw and yoke configuration with cast iron body and wedge and bronze yoke bushing, seat ring and face ring. Provide gate valves with a solid wedge, constructed of cast iron or bronze. Provide valves that have flanged or grooved ends and are rated for 175 psi non-shock cold water.

Provide angle valves (for main drain) of the screwed or union bonnet type that have bodies constructed of bronze with a bronze disk. Provide angle valves having rubber disk seats and screwed ends rated for 175 psi non-shock cold water.

Supervise all control and isolation valves using a tamper switch, except for post indicator valves and OS&Y valves on double check valve assemblies backflow prevention, unless otherwise directed by the AHJ.

2.11 MISCELLANEOUS MATERIALS

2.11.1 Bolting

Provide flange and general-purpose bolting that is hex-head and conforms to ASTM A307, Grade B. Provide heavy hex-nuts that conform to ASTM A563. Square-head bolts and nuts are not acceptable.

2.11.2 Escutcheons

Provide escutcheons manufactured from ferrous metals. Provide only chrome-plated escutcheons, except when AISI 300 series corrosion-resistant steel is provided. Provide metals and finishes conforming to

ASME A112.18.1/CSA B125.1.

Provide escutcheons that are one-piece type where mounted on chrome-plated pipe or tubing and one-piece or split-pattern type elsewhere. Provide escutcheons that have internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.11.3 Flange Gaskets

Provide gaskets that are suitable for the intended use and contain no asbestos.

2.11.4 Pipe-Thread Compounds

Use tetrafluoroethylene tape or other suitable compounds.

2.12 FIRE-PROTECTION SYSTEM IDENTIFICATION

Provide a coordinated system of piping and equipment identification which includes the following:

Framed and plastic-protected diagrammatic layout of all piping systems, identifying and locating piping, equipment, and valves. Where existing systems are being modified, bring existing layouts up to date.

Metal-tag-identified major valves, piping-system components, and equipment

Metal identification plate at controlling alarm valve identifying system and area protected

Service-labeled piping

2.12.1 Diagrams

Provide chart listing of equipment by designation number and show pertinent data. Provide diagrams that are neat, mechanical drawings mounted in extruded aluminum frames, with 1/8-inch thick acrylic plastic protection. Provide at a location directed by the Contracting Officer. Provide minimum of one mounted chart and diagram, plus one extra copy of each, for each fire-protection system.

2.12.2 Metal Tags

Install Identification tags made of brass or aluminum and indicating function of valve or similar component on each system device. Provide tags that are not less than 2 inches in diameter and that have stamped markings.

Provide equipment with metal identification tags bearing an equipment designation number matching the drawing or diagram designations.

Secure tags to valve or equipment items with 12-gage galvanized wire.

Provide risers with a stamped metal tag containing the hydraulic design data. Also identify main drain and inspectors test stations using metal nameplates with minimum 2 inch high lettering chained to the valve.

2.12.3 Service Labeling

Label piping, including that concealed in accessible spaces, to designate service. Provide labels with an arrow or arrows to indicate flow direction. Provide labels or tag designations as follows:

| SERVICE | LABEL OR TAG DESIGNATION |
|---|---|
| Main sprinkler supply | MAIN SPRINKLER SUPPLY |
| Sprinkler riser number | SPRINKLER RISER NO. |
| Sprinkler branch | SPRINKLER BRANCH |

Provide labels and arrows in accordance with the following:

Each point of entry and exit through walls

Each change in direction

In congested or hidden areas, at each point required to clarify service or indicate hazard

In long straight runs, locate labels at a distance visible to each other, but in no case can the distance between labels exceed 40 feet.

Provide label lettering to be 2 inches high. Where the size of pipes is 2-1/2-inch outside diameter and smaller, attach labels to 16-gage aluminum sheet that is attached to the pipe with 12-gage galvanized wire. Provide labels that are legible from the primary service and operating area.

Provide labels that are made of self-sticking plastic film designed for permanent installation. Provide labels that have red letters on white background.

Do not construe label and valve tag schedule above as defining or limiting the work. Label all piping systems.

## 2.13 PAINTING

Furnish equipment of the manufacturer's standard product with the manufacturer's standard finish coat.

Furnish other mechanical equipment with a shop-applied prime paint.

## 2.14 MAIN DRAINS

Provide dedicated drain piping at riser to discharge to the building exterior. Select discharge location to avoid creating a nuisance or hazardous condition and that is acceptable to the Contracting Officer. For multi-story buildings using a common drain system, increase drain size by one pipe size as required by NFPA.

Sleeve and caulk penetrations of exterior walls. Provide penetrations of exterior walls no greater than24 inches and no less than 6 inches above grade. Provide drain lines that terminate in a 45 or 90 degree elbow turned down discharging to an 18 inch concrete splash block.

# PART 3 EXECUTION

3.1 GENERAL

Install system materials and equipment in accordance with the recommendations and provisions of NFPA 13 and NFPA 24, and related Codes and Standards contained herein. Perform work in the presence of the Contracting Officer who will be notified by the Contractor 48 hours in advance of the start of work.

Provide licensed fire protection sprinkler contractors, licensed for such work in the state where the work is to be performed, to perform all installation work.

Riser locations, pipe sizes, and the number of risers shown on the drawings is approximate in nature. Coordinate final riser quantity and location with the building construction, system design, Code requirements, and water supply limitations and maintenance requirements. The number of risers shown on the documents are the minimum to be provided. Indicate on Contractor's shop drawing submittal the exact location and number of risers approved by the Contracting Officer.

For heads which could be damaged, provide wire head guards. For heads located beneath other heads where the spray from the upper head could cool the lower head, provide water shields. For locations where existing building elements could disrupt sprinkler or nozzle spray patterns, provide multiple levels of protection.

Provide return bends for systems with non-potable water sources.

3.2 ABOVEGROUND PIPING-SYSTEMS INSTALLATION

Run piping parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting can be removed between adjacent pipes and so that there is not less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Arrange hangers on different adjacent service lines running parallel to be in line with each other and parallel to the lines of the building.

Base load rating for pipe-hanger supports on all lines filled with water. Do not exceed slope gradient of pipe for deflection per span. Install schedule 40 and heavier ferrous pipe supports in accordance with the following minimum rod size and maximum allowable hanger spacing. For concentrated loads such as valves, reduce allowable span proportionately.

| PIPE SIZE (INCHES) | ROD SIZE (INCHES) | HANGER SPACING FOR STEEL PIPE (FEET) |
|---|---|---|
| 1 | 3/8 | 8 |
| 1-1/4 | 3/8 | 12 |
| 1-1/2 | 3/8 | 15 |
| 2-1/2 to 3-1/2 | 3/8 | 15 |
| 4 | 1/2 | 15 |

| PIPE SIZE (INCHES) | ROD SIZE (INCHES) | HANGER SPACING FOR STEEL PIPE (FEET) |
|---|---|---|
| 6 | 1/2 | 15 |

Support vertical risers at the base where possible and at intervals specified. Guide piping for lateral stability as necessary. Place clamps under fittings wherever possible. Support carbon-steel at each floor at not more than 15 feet intervals for pipe 2 inches and smaller, and at not more than 20 feet intervals for pipe 2-1/2 inches and larger.

Securely support piping with allowance for thrust forces and thermal expansion and contraction and do not subject to mechanical, chemical, irrational, or other damage, in conformance with ASME B31.1.

Extend riser main drain piping full size to discharge outdoors in a location approved by the Contracting Officer.

Install piping sloped back towards the riser or the auxiliary drains to allow for drainage. Where trapped piping is unavoidable, provide auxiliary drains.

Install grooved couplings in accordance with manufacturer's instructions and provide means for the government inspector to access and verify proper installation. Provide access to piping materials prior to installation for the government inspector to verify proper grooves exist on all piping with grooved ends.

Locate inspector's test valve approximately 5 feet above finished floor. Provide inspector's test valve for each sprinkler system, or portion thereof equipped with an alarm device, for testing purposes. Locate inspector's test valve at the hydraulically most remote portion of the sprinkler system. Provide inspector's test piping that discharges to the building exterior without resulting in property damage. Do not permit discharge to janitors sinks and similar locations.

Provide penetrations of exterior walls that are no greater than 24 inches and no less than 6 inches above grade, and are sleeved and caulked. Terminate inspector's test discharge in a 45 or 90 degree elbow turned down, discharging to an 18 inch concrete splash block. Size inspector's test lines to be capable of development of the design flow from one sprinkler without creating excessive back pressure.

## 3.3 FIRE STOPPING

Seal through-penetrations in fire walls, partitions, or any floors to allow passage of cables, ducts, pipes and conduits with a "fire stopping assembly" that is UL listed or FM approved, with a fire-resistance rating equal to the fire resistance rating of the walls, partitions, or floors, in accordance with NFPA 251. For sealing purposes, consider all floors to have a fire-resistance rating of 2 hours. Seal openings no longer required with a material of equal or greater fire resistance to that of the walls, partitions, or floors.

## 3.4 SLEEVES

Provide sleeves where piping passes through roofs, masonry or concrete

walls, or floors.

Provide sleeves extending through floors, or load-bearing walls, and sleeves through fire barriers that are continuous and fabricated from Schedule 40 steel pipe with welded anchor lugs. Form other sleeves by molded linear polyethylene liners or similar materials that are removable. Provide sleeves with diameters that are large enough to accommodate pipe, insulation, and jacketing without touching the sleeve, and additionally provide a minimum 3/8-inch clearance. Provide sleeve that accommodates mechanical and thermal motion of pipe to preclude transmission of vibration to walls and generation of noise.

Pack solid the space between a pipe and the inside of a pipe sleeve or a construction surface penetration with mineral fiber conforming to ASTM C 592 wherever the piping passes through firewalls, equipment-room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction-surface penetrations occur between conditioned and unconditioned spaces, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction-surface penetration with an elastomer caulk to a depth of 1/2 inch. Provide oil and grease free surfaces to be caulked.

Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

## 3.5 ESCUTCHEONS

Provide escutcheons at penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, provide escutcheons on both sides of the partition. Where suspended ceilings are installed, provide plates at the underside only of such ceilings. Provide escutcheons that are chrome plated in occupied spaces and that conceal openings in building construction. Firmly attach escutcheons.

## 3.6 PAINTING

Bring manufacturer's standard-finish equipment surfaces damaged during construction to as-new condition by touchup or repainting to the satisfaction of the Contracting Officer, or replace with new undamaged equipment at no additional cost to the Government.

Thoroughly clean and paint with one coat of primer paint pipe hangers, supports, and other iron work in concealed spaces.

Give all automatic sprinkler and standpipe system piping, valves, and appurtenances, two coats of enamel, color No. 11120 (red) in accordance with Section 09 90 00.00 98, PAINTING AND COATINGS, MIL-STD-101, and FED-STD-595.

## 3.7 ELECTRICAL WORK

Provide electrical work that is specified in DIVISION 26 ELECTRICAL for control system wiring under Section 28 31 00.00 98 FIRE DETECTION AND ALARM and this section in accordance with UL 6 and NFPA 70. Use rigid metal conduit or intermediate metal conduit, except that electrical metallic tubing can be used in dry locations not enclosed in concrete or where not subject to mechanical damage.

## 3.8 SYSTEM TESTING

Prior to acceptance of the work, test completed systems in the presence of the Contracting Officer. Upon approval, provide certificates of testing.

Provide hydrostatic Pressure tests , unless otherwise specified. Use only potable water for testing.

Full opening of the inspector's test connection has to activate the riser water flow alarm device indicator and deliver a steady stream of water at the test outlet through a calibrated orifice equivalent in diameter to a single system sprinkler head.

Government will supply testing water at a location determined by the Contracting Officer, but the Contractor is responsible for approved disposal of test water.

Prepare and maintain test records of piping-system tests. Provide records that show personnel responsibilities, dates, test-gage identification numbers, ambient and test-water temperatures, pressure ranges, rates of pressure drops, and leakage rates. Each test acceptance requires the signature of the Contracting Officer.

### 3.8.1 Test Gages

Provide test gauges that have 4-1/2-inch dials or larger with accuracy of plus or minus 1/2 of 1 percent of full-scale range and dial graduations and pointer width compatible with readability to within one-half of the accuracy extremes. Include maximum permissible scale range for a given test to be such that the pointer during a test can only have a starting position at midpoint of the dial or within the middle third of the scale range. For each test gage, include a table indicating test gauge accuracy certification and corrections made within 90 days prior to the test, the test gage number, and the project number.

### 3.8.2 Test and Acceptable Criteria

Hydrostatically test above ground systems at 200 psi or where the maximum normal working pressure exceeds 150 psi, test the system at the maximum normal working pressure plus 50 psi. Maintain the applied pressure without further addition of test media for not less than 2 hours. Maximum allowable pressure drop is 0 psi.

Test underground systems, rubber jointed ferrous-pipe water systems at 200 psi, or where the maximum normal working pressure exceeds 150 psi, test the system at the maximum normal working pressure plus 50 psi. Maintain the applied test pressure for not less than 2 hours. Maximum allowable pressure drop is 2 psi.

Test backflow prevention connected to potable-water systems and system devices for proper functioning under conditions normal to their application.

Repair dripping or weeping joints and retest until acceptable.

## 3.9 DISINFECTION

Disinfect water piping, including valves, fittings, and other devices, with a solution of chlorine and water. Solution cannot contain less than 50

parts per million (ppm) of available chlorine. Hold solution for a period of not less than 8 hours, at which time the solution has to contain a minimum residue of 2 ppm of available chlorine or the system will be re-disinfected. After successful disinfections, thoroughly flush the piping before placing into service. Water for disinfecting, and flushing will be furnished by the Government.

3.10 CLEANING AND ADJUSTING

At the completion of the work, thoroughly clean all parts of the installation. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that accumulated from the installation and testing of the system. Adjust automatic control devices for proper operation.

3.11 AS-BUILT DRAWINGS

Submit As-Built drawings for approval 21 days prior to the acceptance testing phase of the project as described in the paragraph entitled, "System Testing," of this section. Provide two (2) sets of magnetic media as-built drawings in DWG format, and hard copies of all new and revised software and drawings with the submittal. Document on as-Built drawings the final system configuration including deviations from and amendments to the drawings, and field installation changes, concealed and visible.

3.12 OPERATION AND MAINTENANCE

Submit Operation and Maintenance Manuals, grouped by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to performing acceptance tests.

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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 1 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 KSC W1 Pump Station includes three booster pumping units as specified herein and 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 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 (if applicable).

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 (if applicable).

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 (pump and motor) shall be supplied, tested, and warranted by the pump manufacturer. The variable frequency drives for use with the pumping units will be selected by the pump manufacturer and shall be suitable for the intended use.

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

Under normal water system operations, the booster pumping system shall function as the sole source of potable water supply for the KSC water system and shall function reliably over the following ranges of operation:

a. Capacity range: 500 to 2,500 gpm.
b. Discharge pressure: 70 to 75 psig.

The booster pumps shall normally operate under variable speed control to provide variable capacity and head to maintain the system discharge pressure set point.

Ensure that the pumping units provided under this section are supplied by one manufacturer. All pumping units and their appurtenance/accessories shall be identical.

All components that will come into contact with the water being pumped shall conform to NSF 61.

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 booster pumps will pump from a common suction header connected to the City of Cocoa water system.

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 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 chloramines.

Temperature: 65 to 85°F.

pH: 7.6 to 9.5.

Dissolved oxygen concentration: 0.5 to 12 mg/L.

Total Chlorine residual: 0.5 to 4.0 mg/L.

2.2 PUMP PERFORMANCES

2.2.1 Booster Pumps

| | |
|---|---|
| Number of Pumps | Three (3) |
| Pump Manufacturer | Aurora or Contracting Officer approved equal |
| Pump Model | 411 8x8x11B |
| Impeller | 10.4 |
| Primary design condition (each pump) | |
| Capacity | 1,250 gpm |
| Total head | 107 feet |
| Minimum pump efficiency | 79 percent |
| Secondary design condition No.1 | |
| Capacity | 2,680 gpm |
| Total head | 50 feet |
| Minimum pump efficiency | 69 percent |

| Secondary design condition No.2 | |
|---|---|
| Capacity | 500 gpm |
| Total head | 117 feet |
| Minimum pump efficiency | 50 percent |
| Allowable Sustained Minimum Flow | not more than 500 gpm |
| Allowable Sustained Maximum Flow | not less than 2,680 gpm |
| Shut-off Head | 119 feet |
| Motor Horsepower | 60 HP |
| Aerated Speed | 1,775 rpm |
| Pump Discharge Flange Size | 8-inch |
| Pump Suction Flange Size | 8-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.

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 50% 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 Pump Station No. 2 Booster 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 (if applicable) 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. The field testing shall also include vibration testing and field pump performance testing.

## 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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3.3 CUTTING AND PATCHING
3.4 CLEANING
3.5 PENETRATIONS
3.6 FIELD PAINTING OF MECHANICAL EQUIPMENT
3.6.1 Finish Painting
3.7 PERFORMANCE TESTS
3.8 CLEANING AND ADJUSTING
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3.9.2 Operation And Maintenance Training

-- End of Section Table of Contents --

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 A123/A123M | (2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A53/A53M | (2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A924/A924M | (2010a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM B117 | (2009) Standing Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM B766 | (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 | (2009e2) Measuring Adhesion by Tape Test |
| ASTM D 520 | (2000; R 2005) Zinc Dust Pigment |
| ASTM E 84 | (2010b) Standard Test Method for Surface Burning Characteristics of Building Materials |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (2009) 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 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; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel |
| UL Bld Mat Dir | (2011) 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 A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 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 cabling.

d. Any aerosol product or other pressurized dispenser which contains a chlorofluorocarbon, except for those listed in 40 CFR 82 Part 82.66 Subpart C.

Request a waiver if a facility requirement dictates that a prohibited material is necessary to achieve project goals. Submit the waiver request in writing to the Contracting Officer. The waiver will be evaluated and dispositioned.

1.5 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 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.

2.5 DUCT SYSTEMS

2.5.1 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.

2.5.2 Grilles

Provide factory-fabricated units of steel 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.

2.5.2.1 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.

2.6 AIR SYSTEMS EQUIPMENT

2.6.1 Air Conditioning Unit

Provide air conditioning unit as specified in 23 81 00.00 20 UNITARY AIR CONDITIONING EQUIPMENT.

2.7 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM 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 all units. 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 A53/A53M, 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 one 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.

-- End of Section --

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 34 23.00 40

HVAC POWER VENTILATORS

PART 1 GENERAL

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3.5 FINAL TEST REPORTS

-- End of Section Table of Contents --

SECTION 23 34 23.00 40

HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

Provide power roof ventilators complete with all components and accessory equipment as specified in this section.

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Section 26 60 13.00 40 LOW-VOLTAGE MOTORS applies to this section.

1.2 REFERENCES

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

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7-10 | (2010) Minimum Design Loads for Buildings and Other Structures |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B209 | (2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B37 | (2008) Standard Specification for Aluminum for Use in Iron and Steel Manufacturer |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

| | |
|---|---|
| RCBEA GUIDE | (2004) NASA Reliability Centered Building and Equipment Acceptance Guide |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 705 | (2004; Reprint Apr 2011) Standard for Power Ventilators |

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 Shop Drawings for power roof ventilator systems; G

Submit Installation Drawings for power roof ventilator systems; G

Submit Record Drawings for power roof ventilators; G

SD-03 Product Data

Submit Equipment and Performance Data; G

Submit Manufacturer's Catalog Data; G for all components including:

Housing

Fan

Motor

Bases

Dampers

Screens

SD-06 Test Reports

Tests

1.4 GENERAL REQUIREMENTS

Submit detailed shop drawings for power rood ventilator systems, and detailed record drawings upon completion of the installation.

Submit manufacturer's catalog data, including all equipment and performance data for power roof ventilator.

1.5 QUALITY ASSURANCE

Rate and label ventilators in accordance with the applicable standards of the Air Movement Control Association, and license to bear the AMCA seal for both air and sound.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

The fan and motor configuration are as specified on the drawings.

2.2 DESIGN AND FABRICATION REQUIREMENTS

Provide roof ventilators that comply with UL 705 and are furnished complete with bases, flashing flanges, dampers, and screens as indicated.

Provide ventilators that are designed for windloads in accordance with ASCE 7-10 with the installed design not less than 130 miles per hour windload. Provide structural bracing that is properly spaced to accommodate this loading and in accordance with the design requirements of the covering material. Provide ventilators that are adequately reinforced and well braced with joints properly formed. Provide edges that are wired or beaded where necessary to ensure rigidity. Prevent galvanic action

between different metals in direct contact by nonconductive separators. Make all soldering even and smooth.

Provide corrosion-resistant steel bolts, rivets, and other fastenings used in connection with protected metal.

2.3 HOUSING STYLE(S)

Provide round mushroom stylepower roof ventilator as indicated.

2.4 FAN TYPE(S)

Provide fan of the following type(s):

2.4.1 Type C-PRV Centrifugal, Direct Drive

For Type C-PRV ventilator, provide a centrifugal roof ventilator with direct drive, nonoverloading, backward-inclined wheel. Provide vibration isolated drive with elastomer. Provide drive components that are mounted in a compartment isolated from airstream.

2.5 MATERIALS

Provide manufacturers' standard materials.

2.5.1 Aluminum Alloy

Provide aluminum alloy in accordance with ASTM B209 and ASTM B37.

2.6 FAN MOTOR

Provide motors with local disconnects to provide means for fan and motor maintenance. Provide all motors with thermal overload protection. For motors located in airstreams, provide totally enclosed type.

For direct drive motors 1/2 horsepower and smaller, provide the energy efficient permanent split capacitor type, single phase, 60 hertz. Provide unit with solid-state speed control capable of varying the motor speed from 0 to 100 percent speed.

2.7 BASES

For bases provided with the ventilators, provide factory formed, of the type indicated, of the same material as the hoods, and the thickness necessary to meet the design requirement for connection to the roof. Provide bases that are suitable for raised curb mounting. Form curb flanges of the base as cap flashing extending at least 2 inches over roofing base. Where indicated or required, extend shafts of ventilators a sufficient distance through the supporting construction to permit attachment of vent ducts.

2.8 BACK-DRAFT DAMPERS

Provide gravity operated back-draft dampers with adjustable counterweight of the same material as fan housing.

2.9 SCREENS

Provide insert screens with frames of the same material as that used in the

ventilators and securely attach in a manner that permits easy removal for access and cleaning.

PART 3 EXECUTION

3.1 INSTALLATION

Install power roof ventilators in accordance with manufacturer's installation instructions. Properly coordinate installation of ventilators with other work. Coordinate anchors, attachments, and other items to be built, for installation as the work progresses. Rigidly install ventilators in a weathertight and water-tight manner free from vibration.

Submit installation drawings for power roof ventilator in accordance with referenced standards in this section.

3.2 TESTS

After installation, test each power roof ventilator to demonstrate proper operation at indicated and specified performance requirements including running, balance, noise, and proper direction of fan rotation.

Perform PT&I tests and provide submittals as required in RCBEA GUIDE.

3.3 ACCEPTANCE

Prior to final acceptance, confirm vibration levels that are not more than .075 in/sec at 1 times run speed and at fan/blade frequency, and .04 in/sec at other multiples of run speed.

3.4 LUBRICATION

Provide movable parts of dampers and related operating hardware that are lubricated in accordance with manufacturer's printed instructions and that operate smoothly and quietly without binding.

3.5 FINAL TEST REPORTS

Provide final test reports to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 81 00.00 20

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-- End of Section Table of Contents --

SECTION 23 81 00.00 20

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; G

Submit documentation for Energy Star qualifications or meeting FEMP requirements. Indicate Energy Efficiency Rating.

Thermostats; G

SD-06 Test Reports

Salt-spray tests; G

Start-up and initial operational tests; G

SD-08 Manufacturer's Instructions

Air conditioners; G

Filters

Thermostats; G

Posted Operating Instructions; G

SD-10 Operation and Maintenance Data

Air conditioners; G, 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.

1.5 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 13 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.

2.1.3 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 scroll compressors with crankcase heaters in accordance with the manufacturer's recommendations.

2.1.4 Evaporator Coils

Coils shall be constructed of seamless, 3/8-inch tubes of copper with fins of aluminum alloy 7072 mechanically bonded.

2.1.5 Condensing Coils

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 direct-driven evaporator fans with at least two speed taps.

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 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 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.

The coils shall be factory coated with Bronze-Glow, a spray applied, resin-based coating system designed to provide corrosion protection of AC coils, specifically in salt-spray environments. Deliver units with additional cans of the spray Bronze-Flow to make repairs to the coating system as necessary.

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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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 06-1; TIA 07-1; TIA 07-2; TIA 07-3; Errata 07-2; TIA 08-4; TIA 08-5; TIA 08-6; TIA 08-7; TIA 08-8; TIA 08-9; TIA 08-10; TIA 08-11; TIA 09-12; TIA 09-13; TIA 09-14; Errata 09-3; TIA 09-15; TIA 09-16; TIA 10-17) National Electrical Safety Code |
| IEEE C57.12.28 | (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity |
| IEEE C57.12.29 | (2005) Standard for 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 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

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 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.

-- End of Section --

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DIVISION 26 - ELECTRICAL

SECTION 26 05 00.00 40

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3.5 BOXES AND FITTINGS
3.6 LAMPS AND LIGHTING FIXTURES

3.7 DRY-TYPE DISTRIBUTION TRANSFORMERS
3.8 IDENTIFICATION PLATES AND WARNINGS
3.9 PAINTING
3.10 FIELD TESTING

-- End of Section Table of Contents --

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 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C57.12.28 | (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity |
| IEEE C57.12.29 | (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |

INTERNATIONAL CODE COUNCIL (ICC)

| | |
|---|---|
| ICC/ANSI A117.1 | (2003; Errata 2007) Accessible and Usable Buildings and Facilities |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

| | |
|---|---|
| RCBEA GUIDE | (2004) NASA Reliability Centered Building and Equipment Acceptance Guide |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI Z535.1 | (2006) American National Standard for Safety--Color Code |
| ANSI/NEMA FB 1 | (2007) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable |
| ANSI/NEMA OS 2 | (2008) Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports |
| NEMA KS 1 | (2001; R 2006) Enclosed and Miscellaneous |

| | |
|---|---|
| | Distribution Equipment Switches (600 V Maximum) |
| NEMA RN 1 | (2005) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit |
| NEMA TC 2 | (2003) Standard for Electrical Polyvinyl Chloride (PVC) Conduit |
| NEMA TC 3 | (2004) Standard for Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing |
| NEMA TP 1 | (2002) Guide for Determining Energy Efficiency for Distribution Transformers |
| NEMA WD 6 | (2002; R 2008) Wiring Devices Dimensions Specifications |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 489 | (2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 506 | (2008; R 2010) Specialty Transformers |
| UL 6 | (2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel |
| UL 797 | (2007) Electrical Metallic Tubing -- Steel |

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

b. 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.

1.3 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

Conduits, Raceways and Fittings; G

Wire and Cable; G

Splices and Connectors; G

Switches; G

Receptacles

Outlets, Outlet Boxes, and Pull Boxes; G

Circuit Breakers; G

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Conduits, Raceways and Fittings; G

Wire and Cable; G

Splices and Connectors

Switches

Receptacles

Outlets, Outlet Boxes, and Pull Boxes

Circuit Breakers

Lamps and Lighting Fixtures

Dry-Type Distribution Transformers

Spare Parts

Certification

Submittal for vertical assemblies will be reviewed by a licensed Mechanical, Civil or Structural Engineer to determine that the entire assembly will withstand 135 mph wind loading.

SD-06 Test Reports

Continuity Test

Phase-Rotation Tests

Insulation Resistance Test

SD-08 Manufacturer's Instructions

Submit Manufacturer's Instructions.

Dry-Type Distribution Transformers; G

1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

1.5 PREVENTION OF CORROSION

Protect metallic materials against corrosion. Provide equipment enclosures with the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action). 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.

1.6 GENERAL REQUIREMENTS

Submit manufacturer's instructions including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

Submit certification required to install equipment components and system packages.

1.7 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 be secured to prevent easy removal or peeling.

1.8 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.

1.9 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.

1.10 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including pad-mounted transformers, pad-mounted switches, 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, 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.

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.

Ensure that all hardware and accessories including, but not limited to, couplings, hubs, conduit bodies, straps, hangars and boxes, and elbows are PVC-coated in accordance with NEMA RN 1.

Ensure that all conduit, fittings, and seal-offs have an exterior PVC coating with a minimum thickness of 40 mils and an interior PVC coating with a minimum thickness of 2 mils. All hardware and accessories shall have an exterior PVC coating with a minimum thickness of 20 mils.

Fittings for rigid steel conduit shall be threaded.

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.

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.

2.2 WIRE AND CABLE

Conductors installed in conduit shall be copper 600-volt type THWN. All conductors AWG No. 8 and larger, shall be stranded. All conductors smaller than AWG No. 8 shall be stranded.

Flexible cable shall be Type SO and contain a grounding conductor with green insulation.

2.3 SPLICES AND CONNECTORS

Make all splices in AWG No. 8 and smaller with approved insulated electrical type.

Make all splices in AWG No. 6 and larger with bolted clamp-type connectors. Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

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 ANSI 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.

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 OUTLETS, OUTLET BOXES, AND PULL BOXES

Outlet boxes for use with conduit systems shall be in accordance with ANSI/NEMA FB 1 and ANSI/NEMA OS 2 and be not less than 1-1/2 inches deep. Furnish all pull and junction boxes with screw-fastened covers.

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.

2.7 CIRCUIT BREAKERS

Circuit-breaker interrupting rating shall be not less than those indicated and in no event less than 10,000 amperes root-mean-square (rms) symmetrical at 208 volts and 22,000 amperes rms symmetrical at 480 volts, respectively. Multipole circuit breakers shall be the common-trip type with a single handle. Molded case circuit breakers shall be bolt-on type conforming to UL 489.

2.8 LAMPS AND LIGHTING FIXTURES

All lighting fixtures shall be LED-type 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.

2.9 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 shall 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.

2.10 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.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

3.1.1 Rigid Steel Conduit

Follow manufacturer's recommended installation practices for installing PVC-coated rigid galvanized steel conduit. Use tools specifically designed for PVC-coated conduit during the installation process including, but not limited to, clamping, cutting, threading, bending, and assembly of conduit.

Touch up damaged coating according to manufacturer's instructions using manufacturer's approved touchup compound.

Where the conduit is field threaded, apply electrically conductive, corrosion resistance compound to the threads in accordance with NFPA 70 NEC 300.6 A.

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 or slabs for connections to free-standing equipment with a flush coupling. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

All outdoor conduits shall be PVC-coated rigid galvanized steel unless otherwise noted.

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 may be used for underground conduits where conduits do not extend into lift station wetwells.

Rigid PVC conduit shall be direct buried.

A green insulated 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 Surface Raceways and Assemblies

Surface raceways shall be mounted plumb and level, with the base and cover secured. Minimum circuit run shall be three-wire with one wire designated as ground.

3.1.5 Conduit Cleaning

Existing conduit that is to be reused 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 foreign material in the conduit.

3.2 WIRING

Feeder and branch circuit conductors shall be color coded as follows:

| CONDUCTOR | COLOR AC |
|---|---|
| Phase A | Brown |
| Phase B | Orange |
| Phase C | Yellow |
| Neutral | White |
| Equipment Grounds | Green |

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. Provide 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 5 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/ANSI A117.1 and as follows:

| LOCATION | MOUNTING HEIGHT |
|---|---|
| Receptacles in offices | 18 inches |
| Receptacles in shops and laboratories | 48 inches |
| 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, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, door bells, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Process control devices and pilot lights shall have identification plates.

Furnish identification plates for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

## 3.9 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks shall be thoroughly cleaned and painted as specified in Section 09 90 00.00 98 PAINTS AND COATINGS.

## 3.10 FIELD TESTING

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. 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 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.

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 | (1986) Electric Connectors - Sealed Underground Connector Systems Rated 600 |

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

| | |
|---|---|
| AEIC CS8 | (2007) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B 8 | (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM D 746 | (2007) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact |

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

| | |
|---|---|
| ICEA S-94-649 | (2004) Standard for Concentric Neutral Cable Rated 5 Through 46 KV |

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 | (1996; R 2003) 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 (2011; TIA 11-1; Errata 2011) National Electrical Code

1.2 DEFINITIONS

Medium voltage power cables means all cables rated above 601 to 35,000 volts.

1.3 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Pulling Plan

Submit Pulling Plan in accordance with the paragraph entitled, " Pulling Cables in Ducts and Manholes," of this section.

Splicer/Terminator Certifications

Submit Splicer Certifications in accordance with paragraph entitled "Qualifications" of this section.

SD-03 Product Data

Provide manufacturer's catalog data for the following items:

Single Conductor 15 kV Shielded Cable
Cable Supports and Fittings
Cable Tags
Fireproof Tape
Splice Kits (including splice grounding)
Terminations

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

Provide certificates for the following showing that the cable manufacturer has made factory-conducted tests on each shipping length of cable. Certified copies of test data must show conformance with the referenced standards and must be approved prior to delivery of cable.

Conductor Resistance

Accelerated Water Absorption Test
Water Immersion Test
Ionization
High-Voltage
Partial Discharge Test
Qualification Test Report

SD-08 Manufacturer's Instructions

Provide manufacturer's instructions showing the recommended sequence and method of installation for the following:

Single Conductor 15 kV Shielded Cable
Terminations
Splice Kits (including splice grounding)

1.5 QUALIFICATIONS

Personnel performing Medium Voltage (MV) splicing or terminations shall have 5 years minimum experience in cable splicing and terminations of the type used in this project. In addition, the cable splicer shall submit Splicer/Terminator Certifications issued by the cable splice and termination manufacturer who has examined and tested a test test splice or termination of each type required by this contract for each cable splicer.The certification shall identify which splices and terminations it applies to. If the contractor does not have an individual with the manufacturer's certification as described, each individual with the required 5 years medium voltage splicing and terminating who is to perform cable splicing or terminating shall be required to perform a minimum of one splice or termination of each type in the presence of the manufacturers' representative. Each splice or termination shall be submitted 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 shall not be required for load break elbows and dead break connectors.

Once a splice or termination has been started by a splicer, the same splicer shall complete that particular splice. Each termination and splice shall be started and completed in one continuous work period.

1.6 CABLE VOLTAGE RATINGS AND USE

Medium-voltage power cables must include single-conductor cables rated as follows, phase-to-phase, for grounded neutral systems:

Cables rated 15,000 volts, grounded neutral,shall be used on 13,800-volt, three-phase, 60-hertz distribution systems.

Install cables in a duct and manhole system which can be subject to continuous immersion in a coastal environment containing brackish water at depths of up to 15 feet.

1.7 FACTORY TESTING

Submit certified evidence that the cable manufacturer has made factory-conducted tests on each shipping length (reel) of cable; submit certified copies of test data in accordance with applicable provisions of the referenced standard. Tests on each length of cable must include

conductor resistance, ionization, high voltage, partial discharge test. Contracting Officer or designee must have the option of witnessing required factory testing at no additional cost. Provide a schedule of manufacturing and testing in advance to permit such witnessing, if desired.

Submit certified Qualification Test Report in accordance with AEIC CS8 made in accordance with the applicable referenced standards. Certified copies of test data must show conformance to the requirements of referenced standards and must be submitted for approval prior to shipment of the cable.

Prior to manufacturing, data regarding degradation of proposed insulating material and cable performance due to water immersion test as specified in this specification must be provided to Contracting Officer or designee. Information must indicate A.C. breakdown stress in kV/mm or V/mil versus immersion time. A complete cable description and condition under which cable was tested must accompany the test information. Also submit Accelerated water absorption test.

1.8 SHIPMENT

The shipment of cable must be made on reels in such a manner that the cable is protected from mechanical injury. Each end of each length of cable must be hermetically sealed using heat-shrinkable molded cable end caps to exclude moisture and securely attached to the reel.

The minimum diameter of the reel drum must be 14 times the overall diameter of the cable. Those reels less than 60 inches in diameter must have arbor holes sized for 2-1/2 inches spindles; those greater than 60 inches in diameter must have arbor holes sized for 3 inch spindles. Reel sizes must accommodate reel lengths specified in purchase order. Each reel must contain only one length of cable cut to order.

Each reel must have an arrow and appropriate wording stenciled in plain view on each side to indicate proper rotation of reels. Each reel must be plainly marked on each side, and on a tag attached to the cable end inside the lagging, with the following information:

a. Purchaser's order number;

b. Complete description of cable including manufacturer, cable size, voltage rating, percent insulation rating, insulating material, conductor size(s), year of manufacture;

c. Actual shipping cable (reel) length;

d. Reel number (e.g. 2 of 10);

e. Gross weight (i.e. with reel) and net weight (i.e. cable only).

Reels must be shipped in a vertical position, sufficiently blocked in the bed of shipping vehicle to preclude movement.

PART 2 PRODUCTS

2.1 CONDUCTORS

2.1.1 Material

Core (phase) conductor material must be annealed copper in accordance with

ASTM B 8.

2.1.2 Stranding

Conductors must be Class B stranded.

2.2 CABLE IDENTIFICATION

Cables must have printing on the outer jacket showing the cable type, name of the manufacturer, the year in which the cable was manufactured, sequential cable reel length markings and a unique number for identification purposes. Information must be closely grouped on the tape at 6 foot maximum intervals to permit complete identification.

2.3 15 KV CABLES

2.3.1 General; 15 kV Cable

Single conductor 15 kV shielded cable assemblies must consist of: Conductor core described above, an extruded semiconducting shield over the conductors, 220 mils of ethylene-propylene-rubber (EPR) insulation, an extruded semiconducting insulation shield, a concentric neutral, and a polyethylene (PE) jacket. The cable must be rated for minimum 90 degrees C continuous conductor temperature and 130 degrees emergency overload.

Single-conductor, ethylene-propylene-insulated, polyethylene-jacketed, shielded cable must conform to ICEA S-94-649 and AEIC CS8.

2.3.2 15 kV Cable Conductor Shielding

Conductors must have a stress control layer consisting of extruded material applied between the conductor and the insulation to form a conductor shield (strand screen). This material must have proven long-term chemical compatibility with both the conductor and overlying insulation materials. This stress control layer must meet the electrical and physical requirements of ICEA S-94-649.

2.3.3 Insulation; 15 kV Cable

Insulation material must be an ozone resistant, extruded thermosetting ethylene-propylene based polymer. Insulation must be capable of withstanding the continuous and emergency overload temperature ratings of the conductor.

2.3.4 Non-metallic Insulation Shield; 15 kV Cable

Extruded insulation shield must be an extruded thermoset material compatible with the insulation and jacket. Insulation shield must be applied directly over and bonded to the insulation, and must comply with AEIC CS8.

2.3.5 Concentric Neutral Shield; 15 kV Cable

Copper wires helically applied over the insulation shield. Minimum total cross sectional area of the shield wires is 1/3 of the core conductor for 350 Kcmil cable, and full core conductor for 4/0 cable, and no less than 20 No. 14 AWG, 13 No. 12 AWG or 9 No. 10 AWG. Minimum size of an individual shield wire is No. 14 AWG.

2.3.6 Jacket; 15 kV Cable

Polyethylene (PE) must be extruded over the concentric neutral to a minimum thickness of 80 mils.

2.4 INSULATED MEDIUM VOLTAGE CONNECTORS

IEEE Std 386. Connector must have 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.

Connections must be compatible with equipment bushings.

2.5 SPLICES

Splice kits must be 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.

2.6 TERMINATIONS

Terminations must be Class 1 per IEEE Std 48.

2.7 CABLE SUPPORTS AND FITTINGS

Cable supports, related fittings, and accessories for use in corrosive underground locations, such as manholes, shall be provided with a factory applied coating of polyvinylchloride (PVC) of at least .051 millimeter thick.

PVC coated items shall have a uniform thickness and be free of blisters, breaks, and holidays. PVC compound shall conform to ASTM D 746.

Cable racks, rack arms, cable tray supports, and related fittings shall be UL listed heavy-duty nonmetallic glass-reinforced nylon.

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.

2.8 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.

2.8.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 4500 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. Ties must have a minimum loop tensile strength of 175 pound. The cable tags must have block letters, numbers, and symbols 1 inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags orientation.

2.9 FIREPROOF TAPE

Fireproof tape must be approximately 30 mils thick by 3 inches 3 inches wide. The tape must consist of a flexible, unsupported elastomer that expands in fire to provide a thick char buildup between the flame and the cable. The tape must not give off a smoke when subjected to flames or support combustion. The tape must not deteriorate 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.

The Contractor shall notify the Contracting Officer 14 working days prior to an outage that will require testing for phasing and phase rotation of 15 KV medium voltage electrical systems. The Institutional Services Contractor shall identify and tag the phasing at equipment and shall provide to the Contractor, in writing, the results of phasing and phase rotation tests. The Contractor shall be responsible for maintaining the phasing and phase rotation tests. The Contractor shall be responsible for maintaining the phasing, and shall match the existing phase rotation and phasing when installing conductors in existing electrical systems.

Cable must be installed 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 must 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

Blowers must be provided to force fresh air into manholes or confined areas where free movement or circulation of air is obstructed. Waterproof protective coverings must be available on the work site to provide protection against moisture while a splice is being made. Pumps must be used to keep manholes dry during splicing operations. Under no conditions must a splice or termination be made 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. A standard flexible mandrel must be pulled through each duct to loosen particles of earth, sand, or foreign material in the line.

3.2.2.1 PVC Duct

Mandrel length must be not less than 12 inches long and must have a diameter 1/2 inch less than the inside diameter of the duct. A brush with stiff bristles must then be pulled through each duct to remove the loosened particles. Brush diameter must be the same or slightly larger than the diameter of the duct.

3.2.2.2 Existing Fiber (Orangeburg) Duct

Push rod through duct using accepted appropriate procedures and eqipment for this type of work and as approved by the Contracting Officer. 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. The mandrel shall not be less than 12 inches long, and shall have a diameter that is 1/2 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

The Contractor shall 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. No pull shall be performed until Government review and approval of pulling plan.

Medium-voltage cables shall be pulled 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. A sufficient number of trained personnel and equipment with two-way radio communication capability shall be employed to ensure the careful and proper installation of the cable.

Cable reel shall be set up 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. Flexible tube guide shall be

installed 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.).

Two long-radius (30 inches minimum) quadrant block cable pulling sheaves and necessary jamb skid support shall be used at the pulling end to ensure that sidewall pressures during pulling will not be excessive. A dynamometer shall be used in the pulling line to ensure that the pulling force is not exceeded. The pulling force shall not exceed the smaller of: allowable tension on pulling device, allowable tension on cable, or the tension which produces the allowable sidewall pressure. The allowable tension on the pulling device is 6500 pounds for pulling eyes and 1000 pounds for pulling grip (where allowed). The allowable tension on cable must not exceed the 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. The pulling plan submittal shall show the calculations for allowable tension and sidewall pressure as well as the anticipated tension and sidewall pressure for each pull in the project.

Cable shall be unreeled from the top of the reel. Payout shall be carefully controlled. Cable to be pulled shall be attached 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. The entire 3-1/C circuit must be pulled simultaneously.

Minimum bending radius during cable pulling operations must be 30 inches. For permanent cable bending/racking the minimum bending radius must be 12 times cable diameter.
Cables shall be liberally coated with a suitable cable-pulling lubricant as it enters the tube guide or duct. Grease and oil lubricants shall not be used. Nonmetallic sheathed cables shall be covered with wire-pulling compounds,when required, which have no deleterious effects on the cable. Rollers, sheaves or tube guides around which the cable is pulled shall conform to the 30 inches minimum bending radius of the cable during the pulling operations.

Cables shall be pulled 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 shall not be permitted. Pulling operations shall be stopped immediately with any indication of binding or obstruction and shall not be resumed until such difficulty is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

Cable splices made up in manholes shall be firmly supported on cable racks as indicated. No cable splices shall be pulled in ducts. Cable ends shall

overlap at the ends of a section to provide sufficient undamaged cable for splicing. Cables to be spliced in manholes shall overlap the centerline of the proposed joint by not less than 2 feet

Cables cut in the field must have the cut ends immediately sealed to prevent entrance of moisture with heat-shrinkable molded cable end caps.

3.2.4 Splices and Terminations

Splices shall be made in manholes or direct buried as shown on the drawings. Cable terminations shall be made at equipment specifically indicated. Splicing and terminating of cables shall be expedited to minimize exposure and cable deterioration.

The cable concentric neutral/shield wires shall be connected across one side of the splice by split bundling the splice neutral wiring and connecting each bundle set to a continuous #4 AWG solid bare copper conductor via two compression conductors. The #4 AWG conductor shall be extruded from the cable splice jacket and connected to the manholes grounding system. All connections within the splice shall be made utilizing barrel-type compression connectors and appropriate compression tools with proper size dies to ensure a satisfactory mechanical and electrical joint. Bare connections of concentric neutral/shield wires must be either contained within the splice kit or shall be sealed via an additional outer covering. This outer covering shall consist 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. The outer tubing shall conform to ANSI C119.1. The splice shall meet the requirements of IEEE Std 404 for a 15kV rating and must be rated by the manufacturer for use on 15 kV class feeder cable systems. Optionally, the splice may be of a cold shrink design that does not require any additional heat source for installation. The Cold Shrink splice body must be of a molded design made of silicone rubber. The splice jacketing shall be of a cold shrink tubing make of EPDM rubber. Extra precautions shall be taken to seal around the exit area of the bare copper jumpers with an additional mastic per the splice manufacturer's recommendations.

Cables shall be terminated 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. Terminations must be provided 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.

Terminations shall be field fabricated from termination kits supplied by, and in accordance with, the termination manufacturer's recommendations for the type, size, and electrical characteristics of the cable.

Installation shall include 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.

Cable splices shall be field fabricated 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. Cable splices in manholes shall be located midway between cable racks on walls of manholes and supported with cable arms at

approximately the same elevation as the enclosing duct.

Cable splices shall be installed on cable racks or by other approved methods which will minimize physical stress on the splice connections. Splices shall be supported at approximately the same elevation as the installed cable, except where space limitations or existing cable length limitations make this method impractical or impossible.

All universal demountable splices shall be supported in such manner so as to minimize physical stress on the splice connections. Each cable end termination shall be supported 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. Cable end termination and cable shall be secured to the supports in such a manner as to prevent movement of termination or cable at the support. Saddle type supports shall be installed 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 Splice and Termination Certification

The Contractor shall secure the services of the manufacturer of the splice/termination kits being used during the installation of this project to witness,test, and examine test splices, and to certify the competence of the technicians performing splices and terminations. The splice/termination certification shall confirm in writing that the splicer has constructed the splices/terminations in accordance with the manufacturer's approved training and/or installation instructions. Certification shall not be required for loadbreak elbow and deadbreak connectors. Certification for various types of splices and terminations that may be used on the project shall include, but not be limited to, the following:

Single conductor 15 kV EPR with concentric neutral to single conductor 15 kV EPR with concentric neutral-straight splice.

Single conductor 15 kV EPR with concentric neutral terminations.

The certification shall be for a specific time period determined by the manufacturer.

3.2.6 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.

3.2.7 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, each medium voltage cable shall be subjected to field testing in accordance with the following requirements.

The Contractor shall provide test equipment, labor, and trained technical personnel as necessary to perform the electrical acceptance tests.

The Contractor shall obtain KSC Medium Voltage Cable Test Form from the Contracting Officer prior to commencing Field Testing. All tests shall be recorded on forms provided.

Arrangements shall be made to have tests witnessed and approved by the Contracting Officer.

Each power-cable installation shall be completely isolated from extraneous electrical connections at cable terminations and joints. Safety precautions shall be observed.

Each power cable shall first be given an insulation resistance test using a megohmmeter with a voltage output of at least 2,500-volts. Test shall be applied for a long enough time to fully charge the cable (no less than one minute). Readings shall be recorded as indicated on forms provided. Minimum reading shall be 5000 megohms at an ambient temperature of 68 degrees F. Readings taken at other than 68 degrees F ambient temperatures shall be corrected accordingly.

Upon successful completion of the insulation resistance test, the cable shall be subjected to a Very Low Frequency (VLF) AC Megger test. General VLF testing measures, parameters, considerations, and results shall adhere to the following:

1) Test voltage duration shall be 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 | Acceptance (phase to ground test values) | Acceptance (phase to ground test values) |
|---|---|---|
| | (New cable) | (Existing cable spliced to new cable) |
| (rms voltage, KV) | (peak voltage, KV) | (peak voltage, KV) |

15 28 22; (EPR TO NON-EPR)

4) The sinusoidal test frequency shall be 0.1 Hertz.

5) The test shall not be performed on cable attached to equipment.

NOTE: Acceptance test values to include, but not limited to, peak voltage, frequency, and duration, with respect to the cable rating, shall be identified on the test submittal, with pass/fail results identified per cable installation. Reference IEEE Std 400.2. Notify Contracting Officer or Contracting Officer's Technical Representative 48 hours prior to test start. All testing will be witnessed by the Government.

Terminations shall be clean and dry and shall be tested per IEEE Std 48. Radiographic tests on all terminations at the discretion of the Contracting Officer to determine if voids exist in the termination. Unacceptable cable, splices or terminations shall be reworked at no additional expense to 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)

| | |
|---|---|
| ANSI C12.1 | (2008) Electric Meters Code for Electricity Metering |
| 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 | (2006) Molded Case Circuit Breakers and Their Application |
| NEMA FU 1 | (2002; R 2007) Low Voltage Cartridge Fuses |
| NEMA ICS 1 | (2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2006) Enclosures |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 489 | (2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 508 | (1999; Reprint Apr 2010) Industrial Control Equipment |

1.2 SUBMITTALS

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

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.

Motor Control
Enclosures
Circuit Breakers
Control Devices

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:

Magnetic Motor Controllers
Combination Motor Controllers
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 MOTOR CONTROL

Conform to NEMA ICS 1, NEMA ICS 2, and UL 508 for motor controllers. Provide controllers that have thermal overload protection in each phase.

2.1.1 Magnetic Motor Controllers

2.1.1.1 Full-Voltage Controllers

Provide full-voltage, full magnetic devices in accordance with NEMA ICS 1, NEMA ICS 2, and UL 508for magnetic motor controllers for the control and protection of single- and three-phase, 60-hertz, squirrel-cage induction motors.

Provide operating coil assembly that operates satisfactorily between 85 and 110 percent of rated coil voltage. Provide 120 volts, 60 hertz motor control circuits.

Provide controller with two normally open and two normally closed auxiliary contacts rated per NEMA ICS 1 and NEMA ICS 2 in addition to the sealing-in contact for control circuits.

Provide solderless pressure wire terminal connectors for line-and load-connections to controllers.

Provide solid state overload (SSOL) relays with the following features:

a. Phase loss protection; trips within 3 seconds.

b. Phase unbalance protection.

c. Ground fault trip when selected.

d. Selectable trip class 5, 10, 20, or 30.

e. Reset trip with selected Auto/Manual.

f. Dip switch selectable with the following features:
   i. Set Phase Unbalanced ON or OFF
   ii. Set Phase Loss ON or OFF
   iii. Set Reset to Manual or Automatic
   iv. Set Ground Fault ON or OFF.

g. Overload shall be self-powered with no need for external power

source.

Provide an externally operable manual-reset button to re-establish control power to the holding coil of the electromagnet. After the controller has tripped from overload, ensure that resetting the motor-overload device does not restart the motor.

2.1.2 Combination Motor Controllers

Following requirements are in addition to the requirements specified for magnetic motor controller:

Provide combination motor controllers for the control and protection of single-and three-phase 60-hertz alternating-current squirrel-cage induction motors with branch-circuit disconnecting and protective devices in accordance with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

For combination motor controllers include magnetic motor controllers and molded-case circuit breakers or MCP in metal enclosures in accordance with NEMA 250 or motor-control center draw-out assemblies with control-power transformers, selector switches, pushbuttons, and indicating lights as follows:

Provide full-voltage, full-magnetic devices as specified in this section under paragraph entitled, "Remote-Control Station Enclosures." for magnetic motor controllers and enclosures.

Provide thermal-magnetic breakers as specified in paragraph entitled, "Manual Motor Controllers."for molded-case circuit breakers. Manufacturer's standard MCP may be used in lieu of molded-case circuit breakers.

Provide control-power transformers 120-volt ac maximum, selector switches, pushbuttons, and pilot lights as required.

Identify combination motor controllers with identification plates affixed to front cover of the controller.

2.1.2.1 Nonreversing Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

For nonreversing combination motor controllers for the control and protection of single-speed squirrel-cage induction motors, include a magnetic controller with molded-case circuit breaker or MCP with selector switch or start/stop pushbutton and indicating light in the cover of the enclosure.

Provide rating of three-phase single-speed full-voltage magnetic controllers for nonplugging and nonjogging duty in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide wiring and connections for full-voltage single-speed magnetic controllers in accordance with NEMA ICS 1 and NEMA ICS 2.

2.2 ENCLOSURES

2.2.1 Equipment Enclosures

Provide enclosures for equipment in accordance with NEMA 250.

Contain equipment installed in wet locations in a NEMA Type 4 watertight, corrosion-resistant sheet-steel enclosure, constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4 enclosures.

## 2.3 CIRCUIT BREAKERS

Provide circuit breakers that conform to UL 489, NEMA AB 1, and NEMA AB 3.

### 2.3.1 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.

### 2.3.2 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 in wet locations, in NEMA Type 4, watertight corrosion-resistant sheet steel enclosures constructed to prevent entrance of water.

2.4 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.

2.5 CONTROL DEVICES

2.5.1 Magnetic Contactors

Provide magnetic contactors in accordance with NEMA ICS 1 and NEMA ICS 2 as required for the control of low-voltage, 60-hertz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the 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.

2.5.2 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.

2.5.3 Magnetic Control Relays

Provide magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices, in response to variations in the conditions of electric control devices in accordance with NEMA ICS 1, and NEMA ICS 2.

Provide core-and-coil assembly that operates satisfactorily with coil voltages between 85 and 110 percent of their voltage rating.

Provide relays that are designed to accommodate normally open and normally closed contacts.

Provide 120-volt, 60-hertz, Class AIB magnetic control relays with a continuous contact rating of 10 amperes, and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

2.5.4 Pushbuttons and Switches

2.5.4.1 Pushbuttons

For pushbuttons for low-voltage ac full-voltage magnetic controllers, provide heavy-duty oiltight NEMA 250, Type 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.

2.5.4.2 Selector Switches

Provide heavy-duty oiltight maintained-contact selector switches for low-voltage control circuits, with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Identify selector switches in remote control stations with engraved identification plates affixed to front cover in a prominent location. Carry the identification of the system being controlled on the identification plate.

2.6 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.

2.7 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 ANSI 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 A167 | (1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM D 1535 | (2008e1) Specifying Color by the Munsell System |
| ASTM D 877 | (2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes |
| ASTM D 92 | (2005a; R 2010) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester |
| ASTM D 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 APP GUIDE | (updated on-line) Approval Guide http://www.approvalguide.com/ |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 386 | (2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V |
| IEEE C2 | (2007; Errata 06-1; TIA 07-1; TIA 07-2; TIA 07-3; Errata 07-2; TIA 08-4; TIA 08-5; TIA 08-6; TIA 08-7; TIA 08-8; TIA 08-9; TIA 08-10; TIA 08-11; TIA 09-12; TIA 09-13; TIA 09-14; Errata 09-3; TIA 09-15; TIA 09-16; TIA 10-17) National Electrical Safety Code |

| | |
|---|---|
| IEEE C37.90 | (2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus |
| IEEE C57.12.00 | (2010) 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 | (2009) Standard for Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 5 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below |
| IEEE C57.12.80 | (2010) Standard Terminology for Power and Distribution Transformers |
| IEEE C57.12.90 | (2010) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEEE C57.13 | (2008) Standard Requirements for Instrument Transformers |
| IEEE C57.98 | (1993; Errata 1998; R 1999) Guide for Transformer Impulse Tests |
| IEEE C62.11 | (2005; Amd 1 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV) |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

| | |
|---|---|
| RCBEA GUIDE | (2004) NASA Reliability Centered Building and Equipment Acceptance Guide |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C12.1 | (2008) Electric Meters Code for Electricity Metering |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203 (1992) Fish Acute Toxicity Test

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-90/027F (1993) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

EPA 712-C-98-075 (1996) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) 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

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

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

SD-02 Shop Drawings

Pad-Mounted Transformer Drawings; G

SD-03 Product Data

Pad-Mounted Transformers; G

Submittal shall include manufacturer's information for each component, device, and accessory provided with the transformer.

SD-06 Test Reports

Acceptance Checks And Tests; G

SD-07 Certificates

Transformer 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 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

Transformer Test Schedule; G

Submit report of test results as specified by paragraph entitled "Field Quality Control."

## 1.5 QUALITY ASSURANCE

### 1.5.1 Pad-Mounted Transformer Drawings

Drawings shall indicate, but not be limited to the following:

a. An outline drawing, with front, top, and side views.

b. ANSI nameplate data.

c. Elementary diagrams and wiring diagrams with terminals identified of watthour meter and current transformers.

d. One-line diagram, including switch(es), current transformers, meters, and fuses.

e. Manufacturer's published time-current curves (on full size logarithmic paper) of the transformer high side fuses.

### 1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

### 1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or

brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 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.

1.5.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

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 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 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 | X | | | X | | X |

| 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 |
|---|---|---|---|---|---|---|---|
| | Line B only | | | | | | |
| 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, partial-range, current-limiting fuses. Bayonet fuse links shall sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing which closes when the fuse holder is removed and an external drip shield. Conspicuously display warning within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the open position and the tank pressure has been released.

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 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, current transformers (CTs) 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 CTs with 1.2 kV insulation, 30 kV BIL. Refer to Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES. Provide the appropriate 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.

Undervoltage, 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, 95 kV BIL.

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 transformers.

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) 300 kVA and 500 kVA 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 APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D 92 and a dielectric strength not less than 33 kV tested per ASTM D 877. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

(1) 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:

(a) Pour point: ASTM D 97, less than -15 degree C

(b) Aquatic biodegradation: EPA 712-C-98-075, 100 percent

(c) 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 A167, 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 in accordance with 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 Section 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.

## 2.5 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

ANSI 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.

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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 AERONAUTICS AND SPACE ADMINISTRATION (NASA)

| | |
|---|---|
| RCBEA GUIDE | (2004) NASA Reliability Centered Building and Equipment Acceptance Guide |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2008) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA PB 1 | (2006; Errata 2008) Panelboards |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FED-STD-595 | (Rev C, 2008) Colors Used in Government Procurement |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 489 | (2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 67 | (2009; Reprint Sep 2010) 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.

1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance

requirements is required to obtain Government approval and acceptance of the Contractor's work.

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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 UL 489. 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 OVERCURRENT 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.

-- End of Section --

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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 B187/B187M | (2011) Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar and Shapes |
| ASTM B317/B317M | (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 AERONAUTICS AND SPACE ADMINISTRATION (NASA)

| | |
|---|---|
| RCBEA GUIDE | (2004) NASA Reliability Centered Building and Equipment Acceptance Guide |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ICS 1 | (2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 4 | (2010) Terminal Blocks |
| NEMA ICS 6 | (1993; R 2006) Enclosures |
| NEMA ST 1 | (1988; R 1994; R 1997) Specialty |

Transformers (Except General Purpose Type)

| | |
|---|---|
| NEMA/ANSI C12.11 | (2007) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1063 | (2006) Machine-Tool Wires and Cables |
| UL 44 | (2010) Thermoset-Insulated Wires and Cables |
| UL 489 | (2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 845 | (2005; Reprint Aug 2006) 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 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work..

1.5 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.

1.6 MAINTENANCE

1.6.1 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.

1.6.2 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 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 B187/B187M and ASTM B317/B317M. 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 entitled, "Molded Case Circuit Breakers," of this

section.

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 VFDs (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 variable frequency drives service.

2.5.3.2 Variable Frequency Drives

Variable frequency drives shall be included in the MCC lineup as indicated in the drawings and shall conform with Section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS.

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 entitled, "Molded Case Circuit Breakers," of this section.

2.5.5 Wiring for Motor Control Centers

All wiring shall meet the requirements of paragraph entitled, "Wiring," of this section. 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/ANSI 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 entitled, "Spare Parts," of this section.

## 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 | (2011; TIA 11-1; Errata 2011) National Electrical Code |
| 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. 79K38877.

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.

-- End of Section --

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SECTION 26 28 21.00 40

AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.1 REFERENCES

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2008) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ICS 1 | (2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1008 | (2011) Transfer Switch Equipment |
| UL 508 | (1999; Reprint Apr 2010) Industrial Control Equipment |

1.2 SUBMITTALS

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

SD-02 Shop Drawings

Connection Diagrams; G

Fabrication Drawings; G

Installation Drawings; G

SD-03 Product Data

Equipment and Performance Data; G

Contacts; G

Indicating Lights; G

Terminal Board; G

Enclosures; G

Accessories; G

SD-06 Test Reports

Qualification Testing; G

Operation Tests; G

SD-07 Certificates

Listing of Product Installations; G

SD-08 Manufacturer's Instructions

Automatic Transfer Switch; G

1.3 QUALIFICATION TESTING

Provide certified independent laboratory test data for the furnished unit or an identical unit. Ensure tests meet the general use requirements of UL 508, Table 22.1. Subject the complete automatic transfer switch to a test as outlined in NEMA ICS 1, paragraph 109.5. One cycle of operation tests under the UL 508 test requirements consists of a transfer of load from the normal source to the emergency source and retransfer to the normal source. After the required number of test cycles, ensure the temperature rise of the contacts has not exceeded 149 degrees F. Test the switch operating time and the sense relay pickup and dropout times.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a complete automatic transfer switch system for use with engine-generator sets for standby power. Submit the following:

a. Connection diagrams showing the relations and connections of contacts, indicating lights, and terminal board by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another.

b. Fabrication drawings for contacts, indicating lights, terminal board enclosures, and accessories consisting of fabrication and assembly details to be performed in the factory.

c. Installation drawings for automatic transfer equipment in accordance with the paragraph entitled, "Installation," of this section.

d. Equipment and performance data for automatic transfer equipment including life, test, system functional flows, safety features, and mechanical automated details.

2.1.1 Design Requirements

Ensure control and protective devices associated with automatic transfer switches are in accordance with Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

Provide an automatic transfer switch of the two-pole type for single-phase application, and three-pole type for three-phase application. Provide an additional switched neutral pole.

2.1.2 Performance Requirements

Provide an automatic transfer switch capable of transferring the load from the normal power source to emergency power source, and from an emergency source to the normal power source. Locate switch where indicated. Provide a switch that is solenoid-operated, mechanically held, double-throw, rated for continuous duty, capable of transferring in 100 milliseconds or less, and conforming to the applicable requirements of UL 1008 and NFPA 70, Article 700, except as herein modified.

Ensure the automatic transfer switch is capable of being placed in either the normal or the emergency position.

2.2 FABRICATION

2.2.1 Short Circuit Withstand Current Rating

Provide switch with short-circuit current rating of 50,000. Ensure switch is capable of withstanding 54,000 amperes for a period of 3 cycles without damage.

2.2.2 Self-Test Capability

Provide an automatic transfer switch with a control-circuit self-test feature capable of verifying the proper operation of the switch control circuit without moving the main contactor or causing discontinuity of service to the load. Include the following characteristics in the self-test circuit:

a. A key-operated switch that disconnects the main actuator and connects in its place, an indicator light. Design the key-operated switch to prevent removal of the key while the switch is in the self-test mode.

b. A power-failure simulator switch that removes voltage from the voltage-sensing devices so that emergency power activates the test light.

2.2.3 Enclosures

Provide automatic transfer switch enclosures with solid, unventilated, code-gage 14-gage, minimum sheet metal, NEMA 250, Type 3R stainless steel, with manufacturer's standard finish.

2.3 COMPONENTS

2.3.1 Contacts

Provide main contacts with a wiping-action silver alloy that, when rated for operation at 50 amperes or greater, are protected against arcing. Ensure auxiliary contacts and control transfer relay contacts have a

minimum continuous current rating of not less than 10-amperes inductive at 120 volts ac. Provide the following auxiliary contacts:

a. Generator-control contacts, normally open, that close on undervoltage or loss of normal power as specified, remaining closed until transfer back to normal power

b. Emergency-position contacts, normally open when the switch is in the normal position, that close when the switch is in the emergency position

c. Normal position contacts, normally closed when the switch is in the normal position, that open when the switch is in the emergency position

Use two pole auxiliary contacts.

Provide a test automatic transfer switch mounted on door of enclosure with contacts rated for operation at 10 amperes.

Provide automatic transfer switch with overlapping neutral transfer contacts in addition to the two- or three-pole main bus contacts. Normal and emergency neutral are connected together only during the transfer and retransfer operation. They remain connected only until the power source contacts close/open to transfer from one source to the other. Ensure overlapping neutral transfer contacts connection time does not exceed 100 milliseconds.

2.3.2 Indicating Lights

Furnish automatic transfer switch with two indicating lamps. One light to indicate that the switch is operating on normal power, and the other light to indicate that the switch is operating on emergency power. Fuse each indicating circuit.

2.3.3 Terminal Board

Internally wire control devices, indicating lights, auxiliary contacts, and internal control devices or auxiliary switches to a common output terminal board. Wire the internal functions to facilitate remote connections or monitoring.

2.4 OPERATION

Monitor normal source voltage across phase lines by sensing devices. If the normal source voltage in phase drops to 90 percent or less for a timed period, the automatic transfer switch starts the emergency source and transfer the load to the emergency source when voltage and frequency reach rated values or, if the emergency source is on, verify voltage and frequency of the alternate source and transfer the load to the alternate source. Field adjust this time period from 1 to 30 seconds. Provide a voltage and frequency sensor relay to monitor rated values on the emergency side to prohibit transfer until the emergency source voltage and frequency reach at least 95 percent of the required rating. Provide phase failure protection, with 65 to 70 percent drop and 92 to 95 percent voltage pickup ratings.

Furnish the automatic transfer switch with a time-delay feature, field adjustable from 2 to 30 minutes, that operates to delay automatic transfer back to normal power until the normal source voltage and frequency reach at least 95 percent of the rated voltage. However, if the emergency power

fails, and the normal source is again available at 90 percent of the rated voltage, bypass the time-delay circuitry, and the load immediately transferred back to the normal source. Provide capability for manual transfer in either direction. Operate sensing relays without contact chatter or false response during voltage variations between dropout and pickup.

2.5 ACCESSORIES

Incorporate with the automatic transfer switch a 24-volt solid-state, high-and low-rate charger complete with rheostat and ammeter, to maintain the engine-generator cranking batteries in a fully charged condition.

Incorporate an engine-generator exerciser timer with the automatic transfer switch to permit weekly programming of engine-generator set test runs under load.

PART 3 EXECUTION

3.1 INSTALLATION

Install automatic transfer switch as indicated, and in accordance with the manufacturer's installation instructions. Fully align and install wall-mounted enclosures at the indicated mounting height using a minimum of six 3/8-inch bolts. Use of sheet metal screws or small machine screws is not permitted.

Submit listing of product installations for automatic transfer switches showing the manufacturer has successfully manufactured automatic transfer switches of the size specified for a minimum period of 10 years. Include on the list, purchaser, address of installation, service organization, and date of installation.

3.2 FIELD TESTING

Demonstrate the automatic transfer switch operates in accordance with the specification requirements in conjunction with the normal and emergency power sources.

-- End of Section --

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SECTION 26 29 23

VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS

PART 1 GENERAL

1.1 REFERENCES

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 519 | (1992; R 1993; Errata 2004) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems |
| IEEE C62.41.1 | (2002; R 2008) IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits |
| IEEE C62.41.2 | (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2008) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ICS 1 | (2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 3.1 | (2009) Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers |
| NEMA ICS 6 | (1993; R 2006) Enclosures |
| NEMA ICS 7 | (2006) Adjustable-Speed Drives |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-STD-461 | (2007; Rev F) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment |

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

| | |
|---|---|
| 47 CFR 15 | Radio Frequency Devices |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 489 | (2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 508C | (2002; Reprint Nov 2010) Power Conversion Equipment |

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODSapplies to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements

1.3.1.1 Electromagnetic Interference Suppression

Computing devices, as defined by 47 CFR 15, MIL-STD-461 rules and regulations, shall be certified to comply with the requirements for class A computing devices and labeled as set forth in part 15.

1.3.1.2 Electromechanical and Electrical Components

Electrical and electromechanical components of the Variable Frequency Drive (VFD) shall not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.

1.3.2 Electrical Requirements

1.3.2.1 Power Line Surge Protection

IEEE C62.41.1 and IEEE C62.41.2, IEEE 519 Control panel shall have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge arrestor shall be mounted near the incoming power source and properly wired to all three phases and ground. Fuses shall not be used for surge protection.

1.3.2.2 Sensor and Control Wiring Surge Protection

I/O functions as specified shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation;

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

SD-02 Shop Drawings

Schematic diagrams; G

Interconnecting diagrams; G

Installation drawings; G

Submit drawings for government approval prior to equipment construction or integration. Modifications to original drawings made during installation shall be immediately recorded for inclusion into the as-built drawings.

SD-03 Product Data

Variable frequency drives; G

Wires and cables

Equipment schedule

Include data indicating compatibility with motors being driven.

SD-06 Test Reports

VFD Test

Performance Verification Tests

Endurance Test

SD-08 Manufacturer's Instructions

Installation instructions

SD-09 Manufacturer's Field Reports

VFD Factory Test Plan; G

Factory test results

SD-10 Operation and Maintenance Data

Variable frequency drives, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Provide service and maintenance information including preventive maintenance, assembly, and disassembly procedures. Include electrical drawings from electrical general sections. Submit additional information necessary to provide complete operation, repair, and maintenance information, detailed to the smallest replaceable unit. Include copies of as-built submittals. Provide routine preventative maintenance instructions, and equipment required. Provide instructions on how to modify program settings, and modify the control program.

Provide instructions on drive adjustment, trouble-shooting, and configuration. Provide instructions on process tuning and system calibration.

1.5 QUALITY ASSURANCE

1.5.1 Schematic Diagrams

Show circuits and device elements for each replaceable module. Schematic diagrams of printed circuit boards are permitted to group functional assemblies as devices, provided that sufficient information is provided for government maintenance personnel to verify proper operation of the functional assemblies.

1.5.2 Interconnecting Diagrams

Show interconnections between equipment assemblies, and external interfaces, including power and signal conductors. Include for enclosures and external devices.

1.5.3 Installation Drawings

Show floor plan of each site, with V.F.D.'s and motors indicated. Indicate ventilation requirements, adequate clearances, and cable routes.

1.5.4 Equipment Schedule

Provide schedule of equipment supplied. Schedule shall provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule shall include the total quantity of each item of equipment supplied. For complete assemblies, such as VFD's, provide the serial numbers of each assembly, and a sub-schedule of components within the assembly. Provide recommended spare parts listing for each assembly or component.

1.5.5 Installation instructions

Provide installation instructions issued by the manufacturer of the equipment, including notes and recommendations, prior to shipment to the site. Provide operation instructions prior to acceptance testing.

1.5.6 Factory Test Results

Document test results and submit to government within 7 working days after completion of test.

1.5.7 Variable Frequency Drives for Booster Pump

VFDs shall meet the requirements of this section and shall be selected by the pump manufacturer in accordance with Section 22 11 23.13, PUMP STATION.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 WARRANTY

The complete system shall be warranted by the manufacturer for a period of one year, or the contracted period of any extended warrantee agreed upon by the contractor and the Government, after successful completion of the acceptance test. Any component failing to perform its function as specified and documented shall be repaired or replaced by the contractor at no additional cost to the Government. Items repaired or replaced shall be warranted for an additional period of at least one year from the date that it becomes functional again, as specified in the FAR CLAUSE 52.246-21.

1.8 MAINTENANCE

1.8.1 Spare Parts

Manufacturers provide spare parts in accordance with recommended spare parts list.

1.8.2 Maintenance Support

During the warranty period, the Contractor shall provide on-site, on-call maintenance services by Contractor's personnel on the following basis: The service shall be on a per-call basis with 36 hour response. Contractor shall support the maintenance of all hardware and software of the system. Various personnel of different expertise shall be sent on-site depending on the nature of the maintenance service required. Costs shall include travel, local transportation, living expenses, and labor rates of the service personnel while responding to the service request. The provisions of this Section are not in lieu of, nor relieve the Contractor of, warranty responsibilities covered in this specification. Should the result of the service request be the uncovering of a system defect covered under the warranty provisions, all costs for the call, including the labor necessary to identify the defect, shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES (VFD)

Provide frequency drive to control the speed of induction motor(s). The VFD shall include the following minimum functions, features and ratings.

a. Input circuit breaker per UL 489 with a minimum of 10,000 amps symmetrical interrupting capacity and door interlocked external operator.

b. A converter stage per UL 508C shall change fixed voltage, fixed frequency, ac line power to a fixed dc voltage. The converter shall utilize a full wave bridge design incorporating diode rectifiers. Silicon Controlled Rectifiers (SCR) are not acceptable. The converter shall be insensitive to three phase rotation of the ac line and shall not cause displacement power factor of less than .95 lagging under any speed and load condition.

c. An inverter stage shall change fixed dc voltage to variable frequency, variable voltage, ac for application to a standard NEMA design B squirrel cage motor. The inverter shall be switched in a manner to produce a sine coded pulse width modulated (PWM) output waveform.

d. The VFD shall be capable of supplying 120 percent of rated full load current for one minute at maximum ambient temperature.

e. The VFD shall be designed to operate from a 480 volt, plus or minus 10 percent, three phase, 60 Hz supply, and control motors with a corresponding voltage rating.

f. Acceleration and deceleration time shall be independently adjustable from one second to 60 seconds.

g. Adjustable full-time current limiting shall limit the current to a preset value which shall not exceed 120 percent of the controller rated current. The current limiting action shall maintain the V/Hz ratio constant so that variable torque can be maintained. Short time starting override shall allow starting current to reach 175 percent of controller rated current to maximum starting torque.

h. The controllers shall be capable of producing an output frequency over the range of 3 Hz to 60 Hz (20 to one speed range), without low speed cogging. Over frequency protection shall be included such that a failure in the controller electronic circuitry shall not cause frequency to exceed 110 percent of the maximum controller output frequency selected.

i. Minimum and maximum output frequency shall be adjustable over the following ranges: 1) Minimum frequency 3 Hz to 50 percent of maximum selected frequency; 2) Maximum frequency 40 Hz to 60 Hz.

j. The controller efficiency at any speed shall not be less than 96 percent.

k. The controllers shall be capable of being restarted into a motor coasting in the forward direction without tripping.

l. Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controllers to any of the following conditions shall not result in component failure or the need for fuse replacement:

1. Short circuit at controller output

2. Ground fault at controller output

3. Open circuit at controller output

4. Input undervoltage

5. Input overvoltage

6. Loss of input phase

7. AC line switching transients

8. Instantaneous overload

9. Sustained overload exceeding 115 percent of controller rated current

10. Over temperature

11. Phase reversal

m. Solid state motor overload protection shall be included such that current exceeding an adjustable threshold shall activate a 60 second timing circuit. Should current remain above the threshold continuously for the timing period, the controller will automatically shut down.

n. A slip compensation circuit shall be included which will sense changing motor load conditions and adjust output frequency to provide speed regulation of NEMA B motors to within plus or minus 0.5 percent of maximum speed without the necessity of a tachometer generator.

o. The VFD shall be factory set for manual restart after the first protective circuit trip for malfunction (overcurrent,undervoltage, overvoltage or overtemperature) or an interruption of power. The VFD shall be capable of being set for automatic restart after a selected time delay. If the drive faults again within a specified time period (adjustable 0-60 seconds), a manual restart will be required.

p. The VFD shall include external fault reset capability. All the necessary logic to accept an external fault reset contact shall be included.

q. Provide critical speed lockout circuitry to prevent operating at frequencies with critical harmonics that cause resonant vibrations. The VFD shall have a minimum of three user selectable bandwidths.

r. Provide the following operator control and monitoring devices mounted on the front panel of the VFD:

1. Manual speed potentiometer.

2. Hand-Off-Auto ( HOA ) switch.

3. Power on light.

4. Drive run power light.

5. Local display.

s. Provide properly sized NEMA rated by-pass and isolation contactors to enable operation of motor in the event of VFD failure. Mechanical and electrical interlocks shall be installed between the by-pass and isolation contactors. Provide a selector switch and transfer delay timer.

## 2.2 ENCLOSURES

Provide equipment enclosures conforming to NEMA 250, NEMA ICS 7, NEMA ICS 6.

## 2.3 WIRES AND CABLES

All wires and cables shall conform to NEMA 250, NEMA ICS 7, NFPA 70.

Conductors installed between VFDs and motors shall be shielded VFD cables for conductor sizes AWG 4/0 and below. VFD cables shall be rated for up to 1,000 V and have cross-linked polyethylene (XLPE) Type XHHW-2 insulation on current-carrying conductors. VFD cables with current-carrying conductors of size No 2 and smaller shall have an insulated grounding conductor. Larger cables may have insulated or bare grounding conductors. VFD cables shall have a braided or tape shield. The outer jacket shall be black sunlight and

oil-resistant PVC. VFD cables shall be rated for 194 degrees F in wet or dry locations and shall be suitable for direct burial. VFD cables shall be designed specifically for use in VFD applications. The Contractor shall install the VFD cables in accordance with the cable manufacturer's and the VFD manufacturer's recommendations. VFD cables shall be manufactured by Belden, or approved equal.

2.4 NAMEPLATES

Nameplates external to NEMA enclosures shall conform with the requirements of Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS. Nameplates internal to enclosures shall be manufacturer's standard, with the exception that they must be permanent.

2.5 SOURCE QUALITY CONTROL

2.5.1 VFD Factory Test Plan

To ensure quality, each VFD shall be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test plans and test reports.

PART 3 EXECUTION

3.1 INSTALLATION

Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings. A field representative of the drive manufacturer shall supervise the installation of all equipment, and wiring.

3.2 FIELD QUALITY CONTROL

Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Contractor shall conduct performance verification tests in the presence of Government representative, observing and documenting complete compliance of the system to the specifications. Contractor shall submit a signed copy of the test results, certifying proper system operation before scheduling tests.

3.2.1 VFD Test

A proposed test plan shall be submitted to the contracting officer at least 28 calendar days prior to proposed testing for approval. The tests shall conform to NEMA ICS 1, NEMA ICS 7, and all manufacturer's safety regulations. The Government reserves the right to witness all tests and review any documentation. The contractor shall inform the Government at least 14 working days prior to the dates of testing. Contractor shall provide video tapes, if available, of all training provided to the Government for subsequent use in training new personnel. All training aids, texts, and expendable support material for a self-sufficient presentation shall be provided, the amount of which to be determined by the contracting officer.

3.2.2 Performance Verification Tests

"Performance Verification Test" plan shall provide the step by step

procedure required to establish formal verification of the performance of the VFD. Compliance with the specification requirements shall be verified by inspections, review of critical data, demonstrations, and tests. The Government reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements. The contractor shall inform the Government 14 calendar days prior to the date the test is to be conducted.

3.2.3 Endurance Test

Immediately upon completion of the performance verification test, the endurance test shall commence. The system shall be operated at varying rates for not less than 192 consecutive hours, at an average effectiveness level of .9998, to demonstrate proper functioning of the complete PCS. Continue the test on a day-to-day basis until performance standard is met. During the endurance test, the contractor shall not be allowed in the building. The system shall respond as designed.

3.3 DEMONSTRATION

3.3.1 Training

Coordinate training requirements with the Contracting Officer.

3.3.1.1 Instructions to Government Personnel

Provide the services of competent instructors who will give full instruction to designated personnel in operation, maintenance, calibration, configuration, and programming of the complete control system. Orient the training specifically to the system installed. Instructors shall be thoroughly familiar with the subject matter they are to teach. The Government personnel designated to attend the training will have a high school education or equivalent. The number of training days of instruction furnished shall be as specified. A training day is defined as eight hours of instruction, including two 15-minute breaks and excluding lunch time; Monday through Friday. Provide a training manual for each student at each training phase which describes in detail the material included in each training program. Provide one additional copy for archiving. Provide equipment and materials required for classroom training. Provide a list of additional related courses, and offers, noting any courses recommended. List each training course individually by name, including duration, approximate cost per person, and location of course. Unused copies of training manuals shall be turned over to the Government at the end of last training session.

3.3.1.2 Operating Personnel Training Program

Provide one 2 hour training session at the site at a time and place mutually agreeable between the Contractor and the Government. Provide session to train 4 operation personnel in the functional operations of the system and the procedures that personnel will follow in system operation. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. Alarm formats

e. Failure recovery procedures

f. Troubleshooting

3.3.1.3 Engineering/Maintenance Personnel Training

Accomplish the training program as specified. Training shall be conducted on site at a location designated by the Government. Provide a one day training session to train 4 engineering personnel in the functional operations of the system. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. System configuration

e. Alarm formats

f. Failure recovery procedures

g. Troubleshooting and repair

h. Maintenance and calibration

i. System programming and configuration

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SINGLE OPERATION GENERATOR SETS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN PETROLEUM INSTITUTE (API)

| | |
|---|---|
| API RP 2003 | (2008) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents |
| API RP 540 | (1999; R 2004) Electrical Installations in Petroleum Processing Plants |
| API Spec 5L | (2007; Errata 2009) Specification for Line Pipe |
| API Spec 6D | (2008; Errata 2008; Errata 2008; Errata 2009; Addendum 2009; Errata 2010) Specification for Pipeline Valves |
| API Spec 6FA | (1999; R 2006; Errata 2006; Errata 2008) Specification for Fire Test for Valves |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.1 | (2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form) |
| ASME B16.1 | (2005) Gray Iron Threaded Fittings; Classes 25, 125 and 250 |
| ASME B16.11 | (2009) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.21 | (2011) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.34 | (2009; Supp 2010) Valves - Flanged, Threaded and Welding End |
| ASME B16.39 | (2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300 |
| ASME B16.5 | (2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B16.9 | (2007) Standard for Factory-Made Wrought |

| | |
|---|---|
| | Steel Buttwelding Fittings |
| ASME B18.2.1 | (2010) Square and Hex Bolts and Screws (Inch Series) |
| ASME B18.2.2 | (2010) Standard for Square and Hex Nuts |
| ASME B31.3 | (2010) Process Piping |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 105/A 105M | (2010) Standard Specification for Carbon Steel Forgings for Piping Applications |
| ASTM A 182/A 182M | (2010a) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A 216/A 216M | (2008) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service |
| ASTM A 234/A 234M | (2010) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A 307 | (2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength |
| ASTM A 312/A 312M | (2011) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A 53/A 53M | (2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 563 | (2007a) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A 733 | (2003e1; R 2009) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples |
| ASTM B 117 | (2009) Standing Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM B 687 | (1999; R 2005e1) Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples |
| ASTM D 229 | (2009b) Rigid Sheet and Plate Materials Used for Electrical Insulation |
| ASTM D 975 | (2010a) Standard Specification for Diesel Fuel Oils |

| | |
|---|---|
| ASTM F 844 | (2007a) Washers, Steel, Plain (Flat), Unhardened for General Use |

FLORIDA ADMINISTRATIVE CODE (FAC)

| | |
|---|---|
| FAC 62-762 | (2005) Aboveground Storage Tank |
| FAC 62-762.851 | (2004) Alternative Requirements and Equipment Approvals |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 115 | (2009) Guide for Test Procedures for Synchronous Machines: Part I Acceptance and Performance Testing; Part II Test Procedures and Parameter Determination for Dynamic Analysis |
| IEEE C2 | (2007; Errata 06-1; TIA 07-1; TIA 07-2; TIA 07-3; Errata 07-2; TIA 08-4; TIA 08-5; TIA 08-6; TIA 08-7; TIA 08-8; TIA 08-9; TIA 08-10; TIA 08-11; TIA 09-12; TIA 09-13; TIA 09-14; Errata 09-3; TIA 09-15; TIA 09-16; TIA 10-17) National Electrical Safety Code |
| IEEE C50.12 | (2005) Standard for Salient Pole 50 HZ and 60 Hz Synchronous Generators and Generation/Motors for Hydraulic Turbine Applications Rated 5 MVA and above |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 3046 | (1986; Am. 1) Reciprocating Internal Combustion Engines - Performance |
| ISO 8528 | (1993; R 2005) Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA C50.10 | (1990) Rotating Electrical Machinery - Synchronous Machines |
| NEMA ICS 6 | (1993; R 2006) Enclosures |
| NEMA MG 1 | (2009) Motors and Generators |
| NEMA PB 1 | (2006; Errata 2008) Panelboards |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 30 | (2008; Errata 08-1) Flammable and Combustible Liquids Code |
| NFPA 37 | (2010; TIA 10-1) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines |
| NFPA 407 | (2007; Errata 2007; AMD 1 2007; AMD 2 2008) Standard for Aircraft Fuel Servicing |
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |
| NFPA 704 | (2006) Identification of the Hazards of Materials for Emergency Response |
| NFPA 77 | (2006) Recommended Practice on Static Electricity |
| NFPA 780 | (2007) Standard for the Installation of Lightning Protection Systems |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS W-C-375 | (Rev D) Circuit Breakers, Molded Case, Branch Circuit and Service |
| FS W-P-115C | (2001) Panel, Power Distribution |

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

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

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1236 | (2006; R 2009; R 2010) Standard for Battery Chargers for Charging Engine-Starter Batteries |
| UL 142 | (2006; Rev thru Dec 2007) Steel Aboveground Tanks for Flammable and Combustible Liquids |
| UL 2085 | (2006; R 2010) Protected Aboveground Tanks for Flammable and Combustible Liquids |
| UL 429 | (2009; Rev 2010) Electrically Operated Valves |
| UL 467 | (2007) Grounding and Bonding Equipment |
| UL 489 | (2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 67 | (2009; Reprint Sep 2010) Standard for Panelboards |

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to this section except as modified herein.

1.3 SYSTEM DESCRIPTION

1.3.1 Engine-Generator Set Data

Submit data pertaining to the diesel engine-generator set and to the auxiliary equipment including but not limited to the following:

a. Make of engine.

b. Type or model of engine.

c. Gross bhp rating of engine shall be the total rated power output before deducting power requirements of electric motor-driven equipment or engine driven radiator fan.

d. Net brake power rating of engine shall include deductions for the total power requirements of electric motor-driven or engine-driven accessories as defined in ISO 3046. Net ratings shall include a deduction in power output for cooling media system power requirements including radiator fans and any other power consuming devices required to provide cooling as specified.

e. Strokes per cycle.

f. Number of cylinders.

g. Bore and stroke, inches.

h. Engine speed, rpm.

i. Piston speed, fpm.

j. kW power rating of engine-generator set as defined in the paragraph entitled "Engine-Generator Set Ratings and Performance."

k. Induction method (naturally aspirated, turbocharged).

l. Intercooler type (air-to-air or jacket water).

m. Governor type, make, and model.

n. Make and model of turbochargers.

1.3.2 Engine-Generator Set Efficiencies

Submit data pertaining to the diesel engine-generator set including but not limited to the following: Loads shall be calculated on basis of rated engine-generator set power.

a. Fuel consumption at 0.80 power factor, gallons per hr.

1. 1/2 load

2. 3/4 load

3. Full load

b. Generator efficiency at 0.80 power factor (percent).

1. 1/2 load

2. 3/4 load

3. Full load

c. Radiator capacity at design conditions.

1. Coolant shall be antifreeze mixture as specified under paragraph entitled "Cooling System."

2. gpm of coolant

3. cfm of air through radiator

4. Btu per hr of heat exchange based on optimum coolant temperature to and from engine.

1.3.3 Diesel Engine Data

Submit data certified by the engine manufacturer including but not limited to the following: Loads shall be calculated on basis of rated engine-generator set power.

a. Approximate exhaust temperature degrees F at full load

b. Weight of exhaust gas at full load lb per hr

c. Weight of intake air at full load lb per hr

d. Total heat rejected at full load Btu per hr

1. To jacket coolant system

2. To fuel oil cooling system

e. Emissions (Lbs/hr)(kg/hr) at full load

1. Total Suspended Particulate

2. Particulate matter with an average aerodynamic diameter of 10 microns (PM-10)

3. Sulfur dioxides

4. Nitrogen Oxides (as N02)

5. Carbon Monoxide

6. Volatile Organic Compounds

f. Visible Emissions (percent opacity) at full load

1.3.4 Generator and Exciter Data

Submit data certified by the generator manufacturer including but not limited to the following:

a. Make and model number of generator

b. kW rating of generator

c. Generator reactances

1. Synchronous reactance, Xd

2. Transient reactance, X'd

3. Subtransient reactance, X"d

4. Negative sequence reactance, X2

5. Zero sequence reactance, Xo

1.3.5 Capacity Calculations for Engine-Generator Set

Calculations shall verify that the engine-generator set power rating is adequate for the load described in the paragraph entitled "Load Profile."

1.3.6 Calculations for Brake Mean Effective Pressure (BMEP)

Calculation shall verify that the diesel engine meets the specified maximum BMEP as follows:

a. kW: Minimum power rating of engine-generator set as defined in the paragraph entitled "Engine-Generator Set Ratings and Performance."

b. rpm: Engine revolutions per minute.

c. cu. in.: Total engine piston displacement in cubic inches.

d. GEN.EFF.: Generator efficiency.

e. x: Multiplication sign.

f. bhp': Brake horsepower required from diesel engine by generator loaded to full power rating.

g. bhp': kW/(GEN.EFF. x 0.746).

h. bhp": Brake horsepower required by diesel engine driven fan for cooling radiator or motor driven fan for cooling radiator.

i. bhp: bhp' + bhp".

j. BMEP psi: (792,000 x bhp)/(rpm x cu. in.).

1.3.7 Torsional Vibration Stress Analysis Computations

Torsional vibrational stresses in the crankshaft and generator shaft of assembled diesel engine and driven generator shall not exceed 5000 psi when engine is driving generator at rated speed while assembled unit is loaded

to rated engine-generator set power. Computations shall be based on a mathematical model of the assembled generator set provided or based on calculations using measured values from tests on a unit identical to the one provided. Calculations based on models of, or measured data from, the unassembled engine and generator will not be acceptable. Calculations shall include:

a. A description of the system relating information pertinent to analysis such as operating speed range and identification plate data.

b. A mass elastic assembly drawing, showing the arrangement of the units in the generator set and dimensions of shafting, including minimum diameters (or section moduli) of shafting in the system.

c. A labeled line diagram of the mass elastic system indicating values of masses, stiffness, equivalent lengths, and equivalent diameters including basic assumptions and definition of terms.

d. Sample computations showing procedures used to obtain resulting stress values.

e. Computations indicating assembled engine-generator speed of 1800 rpm with assembly loaded to rated generator power and the resulting computed critical torsional stress values in the assembled engine crankshaft and generator shaft.

1.3.8 Capacity Calculations for Batteries

Calculation shall verify that the engine starting battery capacity exceeds dc power requirements.

1.3.9 Turbocharger Load Calculations

When the proposed exhaust system layout is different from that shown on the contract drawings, submit calculations showing that the external loads from the exhaust system such as weight and thermal expansion do not exceed the engine manufacturer's maximum allowed forces and moments on the turbocharger.

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

Engine-Generator set and auxiliary equipment

Generator control panel

Auxiliary systems

SD-03 Product Data

Engine-generator set data

Engine-generator set efficiencies

Diesel engine data

Generator and exciter data

Diesel engine-generator set

Auxiliary systems and equipment

Remote alarm annunciator

Generator control panel

Carbon steel pipe

Ball valve

Pressure relief valve

SD-05 Design Data

Capacity calculations for engine-generator set

Calculations for brake mean effective pressure

Torsional vibration stress analysis computations

Capacity calculations for batteries

Turbocharger load calculations

SD-06 Test Reports

Acceptance checks and tests

Functional acceptance tests

Functional acceptance test procedure

SD-07 Certificates

Vibration isolation system certification

Fuel system certification

Start-up engineer qualification resume

Instructor's qualification resume

SD-09 Manufacturer's Field Reports

Engine tests

Generator tests

Assembled engine-generator set tests

SD-10 Operation and Maintenance Data

Diesel engine-generator set, Data Package 4

Auxiliary systems and equipment, Data Package 4

Preliminary assembled operation and maintenance manuals

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and the paragraph entitled "Assembled Operation and Maintenance Manuals."

SD-11 Closeout Submittals

Posted operating instructions

Training plan

1.5 QUALITY ASSURANCE

1.5.1 Drawing Requirements

1.5.1.1 Engine-Generator Set and Auxiliary Equipment

Submit drawings pertaining to the engine-generator set and auxiliary equipment, including but not limited to the following:

a. Certified outline, general arrangement (setting plan), and anchor bolt details. Show total weight and center of gravity of assembled equipment on the steel subbase.

b. Detailed elementary, schematic wiring, and interconnection diagrams of the engine starting system, jacket coolant heating system, engine protective devices, engine alarm devices, engine speed governor system, generator and excitation system, and other integral devices.

c. Detailed elementary, schematic wiring; and interconnection diagrams of the diesel fuel system, starting battery system, engine-generator control panel, generator circuit breaker, interior lighting, and remote alarm annunciator.

d. Dimensional drawings or catalog cuts of exhaust silencers, radiator, diesel fuel day tanks, fuel oil cooler, valves and pumps, intake filters, vibration isolators, interior lighting, and other auxiliary equipment not integral with the engine-generator set.

1.5.1.2 Auxiliary Systems

Submit drawings showing floor plan arrangement of weatherproof enclosure, exhaust, air intake, fuel oil cooler, and jacket coolant water systems including arrangement of piping and pipe sizes.

1.5.2 Vibration Isolation System Certification

Submit certification from the manufacturer that the vibration isolation system will reduce the vibration to the limits specified in the paragraph entitled "Vibration Isolation System."

1.5.3 Fuel System Certification

When the diesel fuel system requires a fuel oil cooler as described in the

paragraph entitled "Fuel Oil Cooler," submit certification from the engine manufacturer that the fuel system design is satisfactory.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver equipment on pallets or blocking wrapped in heavy-duty plastic, sealed to protect parts and assemblies from moisture and dirt. Plug piping, conduit, exhaust, and air intake openings. Protect and prepare batteries for shipment as recommended by the battery manufacturer. Store auxiliary equipment at the site in covered enclosures, protected from atmospheric moisture, dirt, and ground water.

1.7 SITE CONDITIONS

Protect the components of the engine-generator set, including cooling system components, pumps, fans, and similar auxiliaries when not operating and provide components capable of the specified outputs in the following environment:

a. Site Location: Kennedy Space Center (KSC), Florida

b. Site Elevation: 10 feet above mean sea level

c. Ambient Temperatures:

1. Maximum 104 degrees F.

2. Minimum 0 degrees F.

d. Design Wind Velocity: 140 mph.

1.8 MAINTENANCE

1.8.1 Extra Materials

1.8.1.1 Paint

Furnish one gallon of identical paint used on engine-generator set in manufacturer's sealed container with each engine-generator set.

1.8.1.2 Filters

Furnish four spare replacement elements in their original containers for each filter with each unit.

1.8.2 Posted Operating Instructions

Provide proposed operating instructions for the engine-generator set and auxiliary equipment laminated between matte-surface thermoplastic sheets and suitable for placement adjacent to corresponding equipment. After approval, install operating instructions where directed.

PART 2 PRODUCTS

2.1 DIESEL ENGINE-GENERATOR SET

Provide diesel engine-generator sets consisting of a water cooled diesel engine direct connected to an ac generator with a brushless excitation system and accessories. Equipment and materials shall be the

manufacturer's standard products offered in catalogs for commercial or industrial use.

2.1.1 Engine-Generator Set Ratings and Performance

ISO 8528. Each engine-generator set shall have a power rating of not less than 250 kW at 0.8 power factor and supply 480Y/277-volt, three-phase, 60 -Hz ac output. Coordinate the engine-generator set to ensure an installed rating in the environment described in paragraph entitled "Site Conditions." The power of the engine-generator set is defined as the power output available at the generator terminals excluding the electrical power absorbed by the essential independent auxiliaries. Essential independent auxiliaries are items of equipment which are essential for the continued or repeated operation of the engine which uses power supplied from a source other than the engine.

2.1.1.1 Diesel Engine Capacity

The diesel engine shall meet the specified maximum BMEP requirements at rated speed as calculated in accordance with the paragraph entitled "Calculations for BMEP." The engine capacity shall be based on the following:

a. Engine burning diesel fuel conforming to ASTM D 975, Grade 2-D, at an ambient temperature of 85 degrees F.

b. Engine cooled by a radiator fan mechanically driven by the diesel engine or remote with a motor driven fan.

c. Engine cooled by coolant mixture of water and ethylene glycol, 50 percent by volume of each.

Engine speed, rpm: 1800

2.1.1.2 Performance Class

The voltage and frequency behavior of the generator set shall be in accordance with ISO 8528 operating limit values for performance Class G3.

2.1.1.3 Load Profile

The diesel engine-generator set shall be of adequate capacity necessary for the following load profile:

a. Lighting 40 kW

b. Variable frequency drives (VFD) 206 kVA, 6 pulse

c. Motor starting sequence

| Starting Order | Size (hp) | Locked Rotor NEMA Code | Starting Method | Maximum Voltage Dip |
|---|---|---|---|---|
| 1 | 60 | F | VFD | 10 Percent |
| 2 | 60 | F | VFD | 10 Percent |

f. Other load: 75 kW at 0.8 p.f.

2.1.2 Diesel Engines and Accessories

ISO 3046. Diesel engines shall be four-cycle naturally aspirated, or turbocharged, or turbocharged and intercooled; vertical in-line or vertical Vee type; designed for stationary service. Engines shall be capable of immediate acceleration from rest to normal speed without intermediate idle/warm up period or prelubrication to provide essential electrical power. Two-cycle engines are not acceptable.

2.1.2.1 Subbase Mounting

Mount each engine-generator set on a structural steel subbase sized to support the engine, generator, and necessary accessories, auxiliaries and control equipment to produce a complete self-contained unit as standard with the manufacturer. Design the structural subbase to properly support the equipment and maintain proper alignment of the engine-generator set in the specified seismic zone. In addition, provide subbase with both lifting rings and jacking pads properly located to facilitate shipping and installation of the unit. Factory align engine and generator on the subbase and securely bolt into place in accordance with the manufacturer's standard practice. Crankshaft shall have rigid coupling for connection to the generator.

2.1.2.2 Assembly

Completely shop assemble each engine-generator set on its structural steel subbase. Paint entire unit with manufacturer's standard paints and colors. After factory tests and before shipping, thoroughly clean and retouch painting as necessary to provide complete protection.

2.1.2.3 Turbocharger

If required by the manufacturer to meet the engine-generator set rating, provide turbine type driven by exhaust gas from engine cylinders, and direct connected to the blower supplying air to the engine intake manifold.

2.1.2.4 Intercooler

Provide manufacturer's standard intercooler for engine size specified.

2.1.2.5 Crankcase Protection

Provide manufacturer's standard method of preventing crankcase explosions and standard method of crankcase ventilation.

2.1.2.6 Engine Lubricating Oil System

Provide each engine with the manufacturer's standard full pressure lubricating oil system arranged to cool the pistons and to distribute oil to moving parts of the engine. Provide oil type and oil filters as recommended by the engine manufacturer.

2.1.2.7 Engine Cooling System

Provide each engine with the manufacturer's standard jacket water pump. Provide a thermostatic control valve in the jacket coolant system for each engine-generator set to maintain a constant jacket coolant temperature to the engine.

2.1.2.8 Engine Fuel System

Provide each engine with the manufacturer's standard fuel system integral with the engine, complete with necessary piping, fittings, and valves for connecting items of equipment which are a part of the system. Provide engine manufacturer's standard hand priming pump. Provide manufacturer's standard simplex filter for each engine, of the throwaway filter element type, consisting of shell filter elements, drains, and necessary connections and fittings.

2.1.2.9 Engine Intake Filter

Provide intake filter assemblies for each engine of the oil bath or dry type, as standard with the manufacturer. Filters shall be capable of removing a minimum of 92 percent of dirt and abrasive 3 microns and larger from intake air. Size filters to suit engine requirements at 100 percent of rated full load. Design unit for field access for maintenance purposes.

2.1.2.10 Engine Starting System

Starting shall be accomplished using an adequately sized dc starter system with a positive shift solenoid to engage the starter motor and to crank the engine continuously for 60 seconds without overheating.

2.1.2.11 Jacket Coolant Heating System

Provide a factory-installed, 120 volts ac, jacket coolant heating system to ensure rapid starting. Thermostatically control heater at the temperature recommended by engine manufacturer. Include necessary equipment, piping, controls, wiring, and accessories.

2.1.2.12 Engine Protective (Shutdown) Devices

Equip each engine with devices to shut down the engine by shutting off the fuel supply to the engine via a fuel shutoff solenoid. Auxiliary contacts shall be suitable for activating a remote alarm system. Shutdown shall open the associated generator circuit breaker. Provide the following shutdown devices:

a. Overspeed device which operates when engine speed exceeds normal synchronous speed by 18 percent or as recommended by manufacturer. Device shall require manual reset.

b. Pressure switch which operates when lubricating oil pressure to engine drops below a preset value.

c. Temperature switch which operates when jacket coolant temperature exceeds a preset value.

d. Device which operates when the coolant level in the radiator drops below a preset level.

e. Other shutdown devices as recommended by the engine manufacturer.

2.1.2.13 Engine Alarm Devices

Equip each engine with alarm devices. Auxiliary contacts shall be suitable for activating a remote alarm system. Alarm devices shall have factory-fixed set points. Provide the following alarm contact devices:

a. Pressure switch which operates when lubricating oil pressure drops below a preset value.

b. Temperature switch which operates when jacket coolant temperature exceeds a preset value.

c. Temperature switch which operates when jacket coolant temperature is too low.

d. Other alarm devices as recommended by the engine manufacturer.

2.1.2.14 Miscellaneous Engine Accessories

Provide the following engine accessories where the manufacturer's standard design permits:

a. Piping on engine to inlet and outlet connections, including nonstandard companion flanges.

b. Structural steel subbase and vibration isolators, foundation bolts, nuts, and pipe sleeves.

c. Level jack screws or shims, as required.

d. Rails, chocks, and shims for installation of subbase on the foundation.

e. Removable guard, around fan. Support guard, on engine subbase, to suit manufacturer's standard.

2.1.2.15 Engine Speed Governor System

Provide a forward acting type engine speed governor system. Steady-state frequency band and frequency regulation (droop) shall be in accordance with the operating limit values of the performance class specified in the paragraph entitled "Performance Class."

2.1.3 Generator and Excitation System

2.1.3.1 Generator

Provide salient-pole type, ac, brushless-excited, revolving field, air-cooled, self-ventilated, coupled type, synchronous generator conforming to NEMA MG 1, Part 16, NEMA C50.10, and IEEE C50.12. Generator shall be rated for standby duty at 100 percent of the power rating of the engine-generator set as specified in paragraph entitled "Engine-Generator Set Ratings and Performance." Temperature rise of each of the various parts of the generator shall not exceed 130 degrees C as measured by resistance, based on a maximum ambient temperature of 40 degrees C. Winding insulation shall be Class H.

a. Stator: Stator windings shall be 10-12 lead reconnectable coils.

b. Rotor: The rotor shall have connected amortisser windings.

c. Generator Space Heater: Provide 120 volt ac heaters. Heater capacity shall be as recommended by the generator manufacturer to aid in keeping the generator insulation dry.

d. Grounding: Provide non-corrosive steel grounding pads located at two opposite mounting legs.

e. Filters: Provide manufacturer's standard generator cooling air filter assembly.

2.1.3.2 Excitation System

Provide a brushless excitation system consisting of an exciter and rotating rectifier assembly integral with the generator and a voltage regulator. Insulation class for parts integral with the generator shall be as specified in paragraph entitled "Generator." System shall provide a minimum short circuit of 300 percent rated engine-generator set current for at least 10 seconds. Steady state voltage regulation shall be in accordance with the operating limit values of the performance class specified in the paragraph entitled "Performance Class."

a. Exciter and Rotating Rectifier Assembly: Rectifiers shall be provided with surge voltage protection.

b. Voltage Regulator: Voltage regulator shall be solid state or digital, automatic, three-phase sensing, volts per hertz type regulator. Voltage variation for any 40 degree C change over the operating temperature range shall be less than plus or minus 1.0 percent. Operating temperature shall be minus 40 degree C to plus 70 degree C. Voltage adjust range shall be plus to minus 5.0 percent of nominal. Inherent regulator features shall include overexcitation shutdown.

2.2 ENGINE-GENERATOR SET AUXILIARY SYSTEMS AND EQUIPMENT

Provide auxiliary systems and equipment designed for continuous duty at 100 percent of the power rating of the engine-generator set as specified in the paragraph entitled "Engine-Generator Set Ratings and Performance."

2.2.1 Vibration Isolation System

Install the subbase on vibration isolators that are secured to a suitable concrete foundation. Provide isolators as recommended by the engine-generator set and isolator manufacturers and provide integral or external lateral support to limit lateral movement and overturning moments. The isolation system shall reduce the vibration transmitted to the adjacent floor slab to a maximum of 0.0015 inch total amplitude throughout the frequency range down to 65 Hz.

2.2.2 Exhaust System

Provide exhaust systems for each engine.

2.2.2.1 Exhaust Silencers

a. The Contractor shall furnish and install, according to the manufacturer's recommendations, silencers, wall thimbles, stainless steel flexible corrugated exhaust connections, flanges, hangers and supports, pipe and fittings, and insulation as specified in this section or as indicated on the drawings to provide a complete and operable exhaust system.

b. Silencers shall be residential grade, Maxim M-41 or equal, and shall have bolted flange connections. The silencer shall be mounted so that

the engine does not support its weight nor will thermal expansion be imposed on the engine. The silencer shall be mounted outside the generator enclosure.

2.2.3 Cooling System

Provide the specified cooling water system. Properly size equipment to handle the flow rate and pressure losses of the coolant mixture specified in the paragraph entitled "Diesel Engine Capacity," and at the site elevation specified in the paragraph entitled "Site Conditions."

2.2.3.1 Radiators

Provide for each engine-generator set, as standard with the manufacturer.

a. Design Conditions: Each radiator unit shall have ample capacity to remove not less than the total Btu per hour of heat rejected by its respective engine at 100 percent full-rated load to the jacket water, fuel oil, and lubricating oil system, and intercooler. Radiator capacity shall be rated at optimum temperature of coolant leaving the engine and intercooler as recommended by the engine manufacturer with an ambient dry bulb air temperature outside the enclosure of 104 degrees F maximum, and 0 degrees F minimum at the site elevation specified in the paragraph entitled "Site Conditions," and with the coolant mixture specified in the paragraph entitled "Diesel Engine Capacity." Pressure drop through the radiator shall not exceed 6 psi when circulating the maximum required coolant flow. Radiator air velocity shall be a maximum of 1500 feet per minute.

b. Engine Mounted Radiator Construction: Radiator fan shall direct airflow from the engine outward through the radiator. Fan shall be V-belt driven directly from the engine crankshaft. Fan static capacity shall be adjusted to suit the ductwork furnished. Cooling section shall have a tube and fin-type core consisting of copper or copper base alloy tubes with nonferrous fins. Select engine-driven fans for quiet vibration-free operation. Make provision for coolant expansion either by self-contained expansion tanks or separately mounted expansion tanks, as standard with the manufacturer. Provide suitable guards for each fan and drive.

c. Coolant solution shall be a mixture of clean water and ethylene glycol, 50 percent by volume each. Provide an anti-freeze solution tester suitable for the mixture.

2.2.4 Diesel Fuel System

NFPA 30 and NFPA 37 and the requirements herein.

2.2.4.1 Diesel Fuel Piping System

Factory installed piping shall conform to the engine manufacturer's standard. Provide flange connections in accordance with ASME B16.1 Class 125 flanges.

2.2.4.2 Flanged End Connections

2.2.4.2.1 Flanges

Provide flanged end connections on equipment, fittings, piping, piping

components, adapters, couplers,and valves that conform to ASME B16.5, Class 150.

a. Carbon Steel

Carbon steel flanges shall conform to ASTM A 105/A 105M.

2.2.4.2.2 Flange Gaskets, Non-Isolating

Provide flange gaskets that are 1/8 inch thick and that conform to ASME B16.21, raised-face type unless otherwise indicated. Gaskets shall be constructed of Buna-N.

2.2.4.2.3 Flange Gaskets, Electrically Isolating

Flange gaskets shall conform to ASTM D 229 and shall provide an electrical insulating material of 1000 ohms minimum resistance. Provide gasket material that is chemically compatible with the fuel to be handled. Provide gaskets that are the full face type. Provide flanges that have a full surface 0.03 inch thick, spiral-wound mylar insulating sleeves between the bolts and the holes in the flanges. Bolts may have reduced shanks of a diameter not less than the diameter at the root of the threads. Provide high-strength 1/8 inch thick phenolic insulating washers next to the flanges with flat circular stainless steel washers over the insulating washers and under bolt heads and nuts. Provide bolts long enough to compensate for the insulating gaskets and stainless steel washers.

2.2.4.2.4 Flange Bolts, Nuts, and Washers

Bolts and nuts for pipe flanges, flanged fittings, valves and accessories shall conform to ASME B18.2.1 and ASME B18.2.2, except as otherwise specified. Bolts shall be regular hexagonal type. Bolts shall be threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes 1 inch and smaller and Eight-Pitch Thread Series for sizes larger than 1 inch. Nuts shall be the hexagonal, heavy series type. Nuts shall be threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes 1 inch and smaller and Eight-Pitch Thread Series for sizes larger than 1 inch. Bolts shall be of sufficient length to obtain full bearing on the nuts and shall project no more than two full threads beyond the nuts with the bolts tightened to the required torque.

a. Carbon Steel Materials

Bolts shall conform to ASTM A 307, Grade B, hot-dipped galvanized. Nuts shall conform to ASTM A 563, Grade A, hex style, hot-dipped galvanized. Washers shall conform to ASTM F 844, hot-dipped galvanized.

2.2.4.3 Pipe

Pipe shall meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein.

2.2.4.3.1 Carbon Steel Pipe

Provide carbon steel pipe that complies with one of the following:

a. Pipe shall conform to ASTM A 53/A 53M, Type E or S, Grade B, seamless or electric welded. Pipe smaller than 2-1/2 inches shall be Schedule 80. Pipe 2-1/2 inches and larger shall be Schedule 40.

b. Pipe shall conform to API Spec 5L, Product Specification Level (PSL) 1, Grade B, seamless or electric welded.

End connections for pipe or fittings smaller than 2-1/2 inches shall be forged, socket weld type conforming to ASTM A 182/A 182M and ASME B16.11, unless indicated otherwise. End connections for pipe or fittings 2-1/2 inches and larger shall be buttweld type conforming to ASTM A 234/A 234M, Grade WPB and ASME B16.9 of the same wall thickness as the adjoining pipe.

2.2.4.3.2 Fittings 2 Inches and Smaller

Socket welded type fittings, unless indicated otherwise, shall conform to ASME B16.11. Fitting materials shall be stainless steel that conforms to ASTM A 182/A 182M, Type F304L.

2.2.4.3.3 Welded Nipples

Nipples shall conform to ASTM A 733 or ASTM B 687 and be constructed of the same material as the connecting pipe.

2.2.4.3.4 Steel Couplings

Coupling shall conform to API Spec 5L, seamless, extra heavy, wrought steel with recessed ends.

2.2.4.3.5 Threaded Unions

Unions shall conform to ASME B16.39, Class 150. Union materials shall conform to ASTM A 312/A 312M, Grade 304 or 316. Dielectric unions shall conform to dimensional, strength, and pressure requirements of ASME B16.39, Class 150. Steel parts shall be galvanized or plated. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, union shall be able to withstand a 600-volt breakdown test.

2.2.4.3.6 Threaded End Connections

Provide threaded end connections only on piping 2 inches in nominal size or smaller and only where indicated on the drawings. Provide threaded connections with thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is tightened.

2.2.4.3.7 Joint Compound

Joint compounds shall be resistant to water and be suitable for use with fuel containing 40 percent aromatics. Threading compound shall be Locktite 5, 6, 7, Gasoila PLS2 or approved equivalent. PTFE tape should not be used.

2.2.4.4 Piping Components

Provide piping components that meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein. Pressure design class for piping components shall be Class 150 as defined in ASME B16.5.

2.2.4.4.1 Flexible Pipe Connector

Connector shall be the flexible, close pitch, metal hose type that is constructed with exterior annular corrugations and provided with a single

layer of braided wire sheath covering. Connectors shall be constructed entirely of stainless steel and be rated for the system working pressure and temperature. Provide threaded end connections for connectors smaller than 2-1/2 inches. Provide flanged end connections for connectors 2-1/2 inches and larger.

2.2.4.4.2 Strainer

Strainer shall be the in-line, cleanable, simplex basket type configured in either an "S" or "T" pattern. Strainer type shall be RACOR™ 75/900 series fuel filter/water separator or approved equivalent. Strainer shall be installed within generator enclosure adjacent to the daytank in accordance with the manufacturer instructions.

2.2.4.4.3 Vent Cap

Provide atmospheric, updraft type cap. Cap shall be constructed of aluminum or carbon steel. Cap shall have an internal brass or bronze insect screen, minimum 40-mesh. Cap shall prevent rain, snow, or ice from entering the vent piping.

2.2.4.5 General Valves

Provide valves that meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein. Valves shall have flanged end connections and conform to ASME B16.34, Class 150 except as modified herein. Provide stainless steel stem and trim for each valve. Valves shall have a weatherproof housing. Seats, body seals, and stem seals shall be Viton or Buna-N.

a. Carbon Steel Piping. Provide valves with bodies, bonnets, and covers constructed of cast steel conforming to ASTM A 216/A 216M.

2.2.4.5.1 Ball Valve

Valve shall be the non-lubricated, double seated, ball type that conforms to API Spec 6D. Valve shall meet the fire test requirements of API Spec 6FA. Valve shall operate from fully open to fully closed with 90 degree rotation of the ball. Valve shall be capable of 2-way shutoff. For valves 2 inches and larger, provide full bore type. Valves smaller than 2 inches shall have one piece bodies and shall have a minimum bore not less than 55 percent of the internal cross sectional area of a pipe of the same nominal diameter.

2.2.4.5.2 Pressure Relief Valve

Valve shall be the fully enclosed, spring loaded, angle pattern, ball seated type with lift lever. Valve shall have corrosion-resistant valve seats. Valve stem shall be fully guided between the fully opened and fully closed positions. Valve shall be factory set to open at the indicated pressure (plus or minus ten percent deviation). Valve setpoint shall be field adjustable within a minimum range of plus or minus 20 percent of the indicated setpoint.

2.2.4.6 Finishes

Ship, store, and handle coating materials as well as apply and cure coatings in accordance with SSPC PA 1.

2.2.4.6.1 Exterior Coating, Aboveground Piping

Coat the exterior of aboveground steel piping, flanges, fittings, nuts, bolts, washers, valves, and piping components, as defined in this specification.

2.2.4.6.2 New Equipment and Components

a. Factory Coating

Unless otherwise specified, provide equipment and components fabricated from ferrous metal with the manufacturer's standard factory finish. Each factory finish shall withstand 125 hours exposure to the salt spray test specified in ASTM B 117. For test acceptance, the test specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark immediately after completion of the test. For equipment and component surfaces subject to temperatures above 120 degrees F, the factory coating shall be appropriately designed for the temperature service.

b. Field Painting

Do not paint stainless steel and aluminum surfaces. Do not coat equipment or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

2.2.4.7 Pipe Hangers and Supports

Provide and install pipe hangers and support in accordance with Section 33 11 00.

2.2.4.7.1 Pipe Tightness Testing

2.2.4.7.1.1 Preliminary Pneumatic Piping System Test

Apply a 25 psig pneumatic test to product piping. Maintain the pressure while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). If leaks are discovered, repair the leaks accordingly and retest.

2.2.4.7.1.2 Final Pneumatic Piping System Test

Following the preliminary pneumatic test, apply a 50 psig pneumatic test to all product piping and hold for a period of not less than 2 hours. During the test period, there shall be no drop in pressure in the pipe greater than that allowed for thermal expanse and contraction. Disconnect the pressure source during the final test period. If leaks are discovered, repair the leaks accordingly and retest. Documentation of successful tightness test shall be provided to the Contracting Officer in accordance with the submittal schedule.

2.2.5 Diesel Fuel System

NFPA 30 and NFPA 37 and the requirements herein.

2.2.5.1 Diesel Fuel Piping System

Factory installed piping shall conform to the engine manufacturer's standard. provide flange connections in accordance with ASME B16.1 Class 125 flanges.

2.2.5.2 Diesel Fuel Day Tank System

Provide 120 volt ac diesel fuel day tank system. Include necessary equipment, piping, controls, wiring, and accessories.

Day Tanks: UL 142. Provide free standing double-wall (110 percent containment) diesel fuel day tanks with a 75- to 100-gallon capacity. Epoxy coat day tanks inside and prime and paint outside. Tanks shall be doubled-walled anti-siphon. Construct tanks of not less than 3/16-inch steel plate with welded joints and necessary stiffeners on exterior of tank. Provide overflow return. Provide a brace structural steel framework support. Weld tank top tight and provide an access opening with dustproof, removable 24-inch cover. Provide 4-1/2-inch square inspection port. Provide proper venting of both inner and outer containment.

Float Switches: Provide tank-top mounted or external float cage, single-pole, single-throw type designed for use on fuel oil tanks. Arrange high level float switches to close on rise of liquid level, and low level float switches to close on fall of liquid level. Mount float cage units with isolating and drain valves. Contacts shall be suitable for the station battery voltage.

1. Critical low level float switch which shall activate at 5 percent of normal liquid level shall shut engine off.

2. Low-level float switch which shall activate alarm at 30 percent of normal liquid level.

3. Low level float switch which shall open the fuel oil solenoid valve and start that remote fuel transfer pump at 75 percent of normal liquid level.

4. High level float switch which shall close the fuel oil solenoid valve and stop the remote fuel transfer pump at 90 percent of normal liquid level.

5. Critical high level float switch which shall activate alarm at 95 percent of normal liquid level.

c. Leak Detector Switch: Actuates when fuel is detected in containment basin, stops fuel transfer pump and closes the fuel oil solenoid valve.

d. Control Panel: Provide NEMA ICS 6, Type 3R, enclosed control panel for each day tank. Control panel shall include the following accessories:

1. Power available LED (green).
2. Critical low fuel alarm contacts for shut down of engine.
3. Low-low level fuel alarm LED.
4. Low-low level fuel alarm contacts for remote annunciator.
5. Critical high level fuel alarm LED.
6. Leak detecting alarm LED.

7. Alarm horn.

e. Tank Gauges: Provide buoyant force type gauges for diesel fuel day tanks with dial indicator not less than 4 inches in size and arranged for top mounting. Calibrate each reading dial or scale for its specific tank to read from empty to full with intermediate points of 1/4, 1/2, and 3/4.

2.2.5.3 Fuel Transfer Pump

Fuel transfer pumps may be day tank or base mounted. Pumps shall be duplex, horizontal, positive displacement. Direct-connect pump to motor through a flexible coupling. Equip each pump with a bypass relief valve, if not provided with an internal relief valve. Provide motor and controller in accordance with paragraph entitled "Electrical Support Equipment."

2.2.5.4 Fuel Oil Solenoid Valve

UL 429. Provide electric solenoid type control valve for each day tank. Solenoid shall be rated for starting battery voltage. Valve body shall have a minimum working pressure rating of 150 psig at 200 degrees F. Valve shall be capable of passing 0 to 10 gpm of fuel oil. Valves shall be two-way, direct acting, normally closed (open when energized, closed when de-energized), with brass body and resilient seat material. Solenoid enclosures shall be NEMA ICS 6, Type 1. Body connections shall be same size as connecting piping. Valve shall be in line before the fuel pump.

2.2.6 Remote Fuel Storage

The remote fuel storage shall be an aboveground tank having a capacity of 1500 gallons with integral secondary containment. Where applicable, storage tank components shall be approved for use in the State of Florida in accordance with Florida Administrative Code FAC 62-762.851.

The aboveground storage tank shall be horizontal, rectangular, consisting of a steel primary tank, a secondary containment, and concrete encasement.

a. The primary tank shall be fabricated and tested to UL 142 standards. The tank shall be constructed of 1/4-inch-thick (minimum) carbon steel and shall have continuous welds on all sides, inside and outside, conforming to the AWS standard for continuous weld. All exposed steel shall be powder-coated to inhibit corrosion. The tank shall be warranted for 30 years.

b. The secondary containment shall consist of an impervious barrier of 30-mil high-density polyethylene to contain leaks from the primary tank. A leak-detection tube shall be provided between the primary tank and the secondary containment. The design shall permit leaked fluid to flow freely to the detection tube. The tube shall allow manual or automatic monitoring. The tube shall be provided with a special cap with 2-inch female NPT fitting for connection of the automatic sensor.

c. The concrete encasement shall be 6 inches thick with a minimum design strength of 3,000 psi and shall be steel reinforced. The encasement shall comply with UL 2085 and be listed. The Contractor shall provide an aluminum hand rail and access ladder around the concrete-vaulted encasement. The encasement shall be of a continuous monolithic pour on top, bottom, and sides and contain no cold joints or heat transfer

points on bottom and sides. The encasement shall have concrete support legs of unitized monolithic construction to provide visual inspection capability. Thermal insulation shall be incorporated to protect against temperature extremes and corrosion. No steel or insulating spacers shall come into direct contact with the concrete.

d. A leak-detection system shall be provided and shall be a microprocessor-based detector with a remote sensor designed to fit the detection tube. The detector shall be equipped with lights to indicate normal operation (green), oil (red), and water (amber) and shall include a test button and a reset button. The sensor shall be the capacitance type which will differentiate between air, water, and hydrocarbons in the environment. The detector shall be NEMA 4, wall-mounted in the generator room, and suitable for operation on a 120-volt 60-hertz single-phase power supply and shall provide a dry contact for remote annunciation. The leak-detection system shall be Pneumercator or approved equal.

e. Tank nipples shall be provided on top of the tank as follows:

| Size | Type | Comments |
|---|---|---|
| 4-inch | Threaded | Fill (lockable) |
| 4-inch | Threaded | Spare |
| 6-inch | Threaded | Emergency Vent |
| 2-inch | Threaded | Normal Vent |
| 2-inch | Threaded | Outlet (suction) |
| 2-inch | Threaded | Level Gauge |
| 1-1/2-inch-by-1-1/2-inch | ----- | Lead-Detection Tube |

f. Provide a 7-gallon overfill/spill containment surrounding the fill pipe with a normally closed valve to release spilled fuel into the primary tank.

g. Provide a 5-gallon minimum overfill/spill containment surrounding the fill pipe fueling connection. The fill port containment shall be mounted on the tank side as a remote fill box and have a 3-inch-by-2-inch reducing bushing with a cam lock style debris cap.

h. The fuel fill line drop tube shall be equipped with an internal overfill protection device capable of automatic shut-off at the 90 percent full level.

i. All nipples shall be capped during shipping. Caps shall remain on nozzles which do not receive fittings.

j. The aboveground tank shall be designed and tested to provide a 2-hour fire protection for the primary tank. The aboveground tank shall have epoxy-coated concrete exterior to resist weathering, reflect sunlight,

and inhibit corrosion and shall be UL labeled. Tank shall be Con Vault or approved equal.

k. The concrete vault encasement shall be equipped with factory installed, OSHA approved ladder and a handrail system around the entire tank top to allow for physical inspection of system and appurtenances.

l. Remote fuel tank and daytank shall each be grounded in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, and API RP 2003. Provide jumpers on piping and components to overcome insulating effects of gaskets paints or non-metallic components.

2.2.6.1 Labeling

Provide labeling to tank exterior to include NO SMOKING signage, product stored, tank storage capacity, and an NFPA fire diamond placecard. NFPA numbering and classification information are found on the material safety data sheet for the commodity stored. Labeling and marking shall be done in accordance with requirements in NFPA 704.

2.2.6.2 Tank Manufacturer's Tests

Manufacturer's tank tightness tests certification is required by UL 142 and FAC 62-762. Documentation of test and repair of leaks discovered during the tests in accordance with manufacturer's instructions shall be provided. Provide manufacturer tightness test result to the Contracting Officer before start-up and final regulatory inspection.

2.2.7 Starting Battery System

Provide a 24-volt dc starting battery installation for starting of each engine-generator set utilizing an electric cranking system.

2.2.7.1 Engine Starting Battery

Provide maintenance free, sealed, lead-acid, SAE Type D diesel engine starting batteries. Batteries shall have sufficient capacity to provide 60 seconds of continuous cranking of the engine in an ambient temperature of 0 degrees F.

2.2.7.2 Starting Battery Charger

UL 1236. Provide 120 volt ac, enclosed, automatic equalizing, dual-rate, solid-state, constant voltage type battery charger with automatic ac line compensation. Dc output shall be voltage regulated and current limited. Charger shall have two ranges, float and equalize, and shall provide continuous taper charging. The charger shall have a continuous output rating of not less than 10 amperes and shall be sized to recharge the engine starting batteries in a minimum of 8 hours while providing the control power needs of the engine-generator set. Enclosure shall be NEMA ICS 6, Type 3R. The following accessories shall be included:

a. Dc ammeter

b. Dc voltmeter

c. Equalize light

d. Ac on light

e. Low voltage light

f. High voltage light

g. Equalize test button/switch

h. Ac circuit breaker

i. Low dc voltage alarm relay

j. High dc voltage alarm relay

k. Current failure relay

l. Ac power failure relay

2.2.8 Engine-Generator Control Panel

Provide NEMA ICS 6, Type 3R, enclosed control panel mounted on the engine-generator set with vibration isolators. Provide external serial communication using mod-bus. Provide the following control panel mounted devices and control features.

2.2.8.1 Control Panel Mounted Devices

a. Engine Control Switch (ECS): Provide a three position control switch with "MANUAL START" - "OFF/RESET" - "AUTO START" positions.

b. Emergency Stop Push Button (ESPB): Provide a red, mushroom head, twist-to-reset, maintained contact type push button.

c. Generator Metering: Provide ac metering package that displays ac voltage, current, and frequency of one phase of the generator output simultaneously. Metering package shall include a voltmeter/ammeter phase selector switch to allow viewing of each phase.

d. Generator Voltage Adjust Potentiometer (VAP): Provide a potentiometer, locking screwdriver type, to adjust generator voltage.

e. Engine Instrumentation: Provide instrumentation package that displays the following engine information:

1. Engine oil pressure

2. Engine coolant temperature

3. Engine speed (rpm)

4. Engine running hours

f. Indicating Lamps: Provide LED type indicating lamps and a lamp test switch. Lamps shall indicate the following alarm and shutdown conditions:

1. Low engine lubricating oil pressure alarm

2. Low engine lubricating oil pressure shutdown

3. High engine coolant temperature alarm

4. High engine coolant temperature shutdown

5. Engine overcrank shutdown

6. Engine overspeed shutdown

7. Emergency stop shutdown

8. Starting battery system trouble alarm

9. Day tank low fuel shutdown

10. Low engine coolant temperature alarm

11. Low coolant level shutdown

g. Alarm Horn: Provide an alarm horn and a horn silence switch.

h. Panel Lamp: Provide a panel lamp and lamp "ON-OFF" switch.

2.2.8.2 Crank Cycle/Terminate Relay

Provide crank cycle/terminate relay with adjustable crank/rest periods of 1 to 60 seconds (initially set for 15 seconds) and adjustable total crank time of 30 seconds to 10 minutes (initially set for 75 seconds).

2.2.8.3 Engine Cooldown Relay

Provide cooldown relay with adjustable cool down time of 0 to 30 minutes (initially set at engine manufacturer's recommended time).

2.2.9 Remote Alarm Annunciator

Provide NEMA ICS 6, Type 3R, enclosed remote alarm annunciator powered by the engine starting battery system. The annunciator shall have a lamp test switch and LED type indicating lamps. The annunciator shall give visual and audible warnings for the following operating and alarm conditions:

a. Provide lamps for the following operating conditions:

1. Operating power source, normal or emergency

2. Starting battery system trouble

b. Provide lamps and an audible signal for the following alarm conditions:

1. Low engine lubricating oil pressure

2. Low engine coolant temperature

3. High engine coolant temperature

4. Low fuel

5. Engine overcrank shutdown

6. Engine overspeed shutdown

2.2.9.1 Storage Battery

Provide storage batteries of suitable rating and capacity to supply and maintain power for the remote alarm annunciator for a period of 90 minutes minimum without the voltage applied falling below 87.5 percent of normal. Provide a 120 volt ac automatic battery charger.

2.2.10 Generator Circuit Breaker

UL 489, molded case, adjustable thermal magnetic trip type circuit breaker. The circuit breaker continuous current rating shall be adequate for the power rating of the engine-generator set and the circuit breaker shall be rated to withstand the short circuit current provided by the generator set. Provide circuit breaker in a NEMA ICS 6, Type 3R enclosure mounted on the engine-generator set.

2.2.11 Electrical Support Equipment

Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects shall conform to Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL. Provide electrical connections under Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL. Provide controllers and contactors with maximum of 120-volt control circuits, and auxiliary contacts for use with controls furnished. When motors and equipment furnished are larger than size indicated, the cost of providing additional electrical service and related work shall be included under this section.

2.2.12 Sound Attenuated Weatherproof Enclosure

Standby generator set located outdoors shall be enclosed in a modular, weatherproof, corrosion-resistant, walk-in enclosure. The enclosure shall be constructed with removable side and end panels. Louver-access doors and top panels shall be made out of 14-gauge steel with 12-gauge steel corner and side supports (10-gauge for generator sets above 175 kW), and 16-gauge steel solid access doors minimum. The enclosure shall have continuous hinged doors on each side and at the control end and shall be equipped with key locks for ease of engine maintenance and a three-point latch system. There shall be expanded metal grating or radiator core guard in front for the radiator grill and fixed punched louvered air intake ports on the enclosure sides and rear for proper air circulation within the housing. Provide sleeves for wall penetrations of enclosure with enough annulus space to visually inspect the piping. The complete generator set and housing shall be prime painted and have two finish coats of protective enamel paint. Provide lifting eyes and spreader bar reinforcement for crane unloading.

The enclosure shall be sized to house the generator breaker, generator control panel, annunciator, load center, rack-mounted batteries, battery charger, and accessories. Control wire connection between starting and safety circuits shall be preconnected before the standby generator set is delivered. A thermostatically controlled exhaust fan shall be provided. Space heater(s) shall be provided as recommended by the generator set manufacturer. A 120/208-VAC load center shall be provided to supply power to the jacket water heaters, battery charger, exhaust fan, space heaters, etc. Enclosures for electrical equipment shall be NEMA 3R. The load center shall be Type 1, Class 2 circuit-breaker type, conforming to FS W-P-115C. Load center shall be dead-front safety type equipped with main and branch circuit breakers. Main breaker and bus shall be rated a

minimum of 125 percent of the connected load plus 25 percent spare capacity. All current-carrying parts of the bus assembly shall be plated copper. The load center shall be enclosed in a steel cabinet for surface mounting. Wiring gutters and steel gauge shall be in accordance with NEMA PB 1 and UL 67 for electric panelboards. The enclosure shall be fabricated from galvanized steel or equivalent rust-resistant steel and shall be coated with a rust-inhibiting primer and baked-enamel finish. The load center shall be equipped with a neutral bus bar and separate equipment grounding bar. The circuit breakers shall be quick-make, quick-break thermal magnetic-molded case type with trip indicated by handle taking a position between ON and OFF when tripped. Circuit breakers shall comply with FS W-C-375B/GEN(1). The load center shall have an integrated equipment fault current interrupting rating equal to the available fault with a minimum rating of 10,000 A/C. The load center shall be listed by UL and bear the UL label. Load center shall be as manufactured by Square D, General Electric, Cutler-Hammer/Westinghouse, or approved equal.

Engine oil and radiator drain lines shall be brought to the outside of the enclosure. A globe-type shut-off valve shall be installed in each drain line inside the enclosure for security.

An exhaust silencer shall be mounted on top of the unit. Silencers shall be critical grade and shall have bolted flange connections. The silencer shall be mounted so that the engine shall not be supporting its weight nor will thermal expansion be imposed on the engine. A top-mount unit shall be secured in position at no fewer than four points. The silencer shall be supported by an angle-iron cradle welded to the silencer and bolted to the angle-iron roof support members mounted inside the roof of the enclosure. The silencer shall be of the side-inlet type. The exhaust side of the silencer shall have a length of black iron pipe extending beyond the radiator end of the enclosure by minimum of 10 inches and cut back on a 45-degree angle. The intake of the silencer shall connect to a flexible exhaust connection. Route exhaust pipe to penetrate the enclosure roof through a metal thimble. The flash penetration area is to be weatherproof. Size as required by the engine manufacturer. The flexible exhaust connection as specified shall mount directly on the exhaust manifold and shall be mounted so that no weight is exerted on the manifold at any time. Provide sleeves in the side of the generator enclosure for fuel line piping. Provide enough annular space to enable visual inspection of the fuel line piping.

## 2.3 SPECIAL WRENCHES AND TOOLS

Wrenches and tools specifically designed and required to work on the new equipment, which are not commercially available as standard mechanic's tools, shall be furnished to the Contracting Officer.

## 2.4 IDENTIFICATION OF EQUIPMENT

Provide plates and tags sized so that inscription is readily legible to operating or maintenance personnel and securely mounted to or attached in proximity of their identified controls or equipment. Lettering shall be normal block lettering, a minimum of 0.25 inch high.

### 2.4.1 Materials

Construct ID plates and tags of 16 gage minimum thickness bronze or stainless steel sheet metal engraved or stamped with inscription. Construct plates and tags not exposed to the weather or high operational

temperature of the diesel engine of laminated plastic, 0.125 inch thick, matte white finish with black center core, with lettering accurately aligned and engraved into the core.

2.4.2 Control Devices and Operation Indicators

Provide ID plates or tags for control devices and operation indicators, including valves, off-on switches, visual alarm annunciators, gages and thermometers, that are required for operation and maintenance of provided mechanical systems. Plates or tags shall be minimum of 0.5 inch high and 2 inches long and shall indicate component system and component function.

2.4.3 Equipment

Provide ID plates of a minimum size of 3 inches high and 5 inches long on provided equipment indicating the following information:

a. Manufacturer's name, address, type and model number, and serial number;

b. Contract number and accepted date;

c. Capacity or size;

d. System in which installed; and

e. System which it controls.

2.5 ASSEMBLED OPERATION AND MAINTENANCE MANUALS

The contents of the assembled operation and maintenance manuals shall include the manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data" and the manufacturer's O&M information specified in Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS.

a. Manuals shall be in separate books or volumes, assembled and bound securely in durable, hard covered, water resistant binder, and indexed by major assembly and components in sequential order.

b. A table of contents (index) shall be made part of the assembled O&M. The manual shall be assembled in the order noted in table of contents.

c. The cover sheet or binder on each volume of the manuals shall be identified and marked with the words, "Operation and Maintenance Manual."

2.6 SOURCE QUALITY CONTROL

Perform and report on factory tests and inspections prior to shipment. Provide certified copies of manufacturer's test data and results. Test procedures shall conform to ASME, IEEE, and ANSI standards, and to ISO requirements on testing, as appropriate and applicable. The manufacturer performing the tests shall provide equipment, labor, and consumables necessary for tests and measuring and indicating devices shall be certified to be within calibration. Tests shall indicate satisfactory operation and attainment of specified performance. If satisfactory, equipment tested will be given a tentative approval. Equipment shall not be shipped before approval of the factory test reports for the following tests.

2.6.1 Engine Tests

Perform customary commercial factory tests in accordance with ISO 3046 on each engine and associated engine protective device, including, but not limited to the following:

a. Perform dynamometer test at rated power. Record horsepower at rated speed and nominal characteristics such as lubricating oil pressure, jacket water temperature, and ambient temperature.

b. Test and record the values that the low oil pressure alarm and protective shutdown devices actuate prior to assembly on the engine.

c. Test and record values that the high jacket water temperature alarm and protective shutdown devices actuate prior to assembly on the engine.

2.6.2 Generator Tests

Tests shall be performed on the complete factory assembled generator prior to shipment. Conduct tests in accordance with IEEE 115, NEMA C50.10 and NEMA MG 1.

2.6.2.1 Routine Tests

Perform the following routine tests on the generators and their exciters:

a. Resistance of armature and field windings

b. Mechanical balance

c. Phases sequence

d. Open circuit saturation curve and phase (voltage) balance test

e. Insulation resistance of armature and field windings

f. Megger test

2.6.2.2 Design Tests

Submit the following design tests made on prototype machines that are physically and electrically identical to the generators specified.

a. Temperature rise test

b. Short circuit saturation curve and current balance test

2.6.3 Assembled Engine-Generator Set Tests

Submit the following tests made on prototype machines that are physically and electrically identical to the engine-generator set specified.

2.6.3.1 Initial Stabilization Readings

Operate the engine-generator set and allow the set to stabilize at rated kW at rated power factor, rated voltage, and rated frequency. During this period record instrument readings for output power (kW), terminal voltage, line current, power factor, frequency (rpm) generator (exciter) field voltage and current, lubricating oil pressure, jacket water temperature,

and ambient temperature at minimum intervals of 15 minutes. Adjust the load, voltage, and frequency to maintain rated load at rated voltage and frequency. Adjustments to load, voltage, or frequency controls shall be recorded on the data sheet at the time of adjustment. Stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

2.6.3.2 Regulator Range Test

Remove load and record instrument readings (after transients have subsided). Adjust voltage to the maximum attainable value or to a value just prior to actuation of the overvoltage protection device. Apply rated load and adjust voltage to the minimum attainable value or a value just prior to activation of the undervoltage protection device. The data sheets shall indicate the voltage regulation as a percent of rated voltage and the maximum and minimum voltages attainable. Voltage regulation shall be defined as follows:

$$\text{Percent Regulation} = \frac{((\text{No-Load Voltage}) - (\text{Rated-Load Voltage})) \times 100}{(\text{Rated-Load Voltage})}$$

2.6.3.3 Frequency Range Test

Adjust the engine-generator set frequency for the maximum attainable frequency at rated load. Record instrument readings. Adjust the engine-generator set frequency for the specified minimum attainable frequency at rated load. Record instrument readings. Reduce the load to zero and adjust the engine-generator set frequency for the maximum attainable frequency. Record instrument readings. Adjust the engine-generator set frequency for the minimum attainable frequency. Record instrument readings. The data sheet shall show the maximum and minimum frequencies attained at rated load, and at no load.

2.6.3.4 Transient Response Test

Drop the load to no load and re-apply rated load three times to ensure that the no load and rated load voltage and frequency values are repeatable and that the frequency and voltage regulation is within the limits specified. Record generator terminal voltage and frequency using a high speed strip chart recorder. The data sheet shall show the following results:

a. Frequency

1. Stability bandwidth or deviation in percent of rated frequency.

2. Recovery time.

3. Overshoot and undershoot.

b. Voltage

1. Stability bandwidth or deviation in percent of rated voltage.

2. Recovery time.

3. Overshoot and undershoot.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall conform to the applicable requirements of IEEE C2 NFPA 30, NFPA 37, and NFPA 70.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounding systems shall have a resistance to solid earth ground not exceeding 10 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL. 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 Engine-Generator Set Grounding

Provide separate copper grounding conductors and connect them to the ground system 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 by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 START-UP ENGINEER

Provide the services of a qualified factory trained start-up engineer, regularly employed by the engine-generator set manufacturer. The start-up services shall include conducting preliminary operations and functional acceptance tests. The start-up engineer shall be present at the engine generator set installation site, full-time, while preliminary operations and functional acceptance tests are being conducted.

3.4 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the engine-generator set and auxiliary equipment.

3.4.1 Testing

The Contractor shall operate the standby generator(s) under full-load conditions for a continuous period of 4 hours with loading provided by a Contractor-furnished load bank.

a. Load bank testing shall be done in the presence of the Contracting

Officer's appointed representative after the unit is permanently installed in accordance with the drawings and specifications.

b. Before acceptance any defects which become evident during this test shall be corrected at no expense to the Government.

c. The Contractor will provide fuel for load bank testing.

The services of a factory-trained service engineer who is specifically trained on the type of equipment specified in this Section shall be provided to fully inspect the installation, calibrate the equipment, and supervise testing.

Upon completion of testing, the services of the service engineer shall be provided for instruction of the Government's operating and maintenance personnel. The instructions shall include operating and maintenance procedures specifically written for the equipment installed and not generally written to cover all options available.

The transfer switch shall be operationally tested as part of the complete system to verify satisfactory operation under the worst-case conditions to be provided by the electrical system.

After testing is complete, the Contractor shall fill all fuel storage tanks to full capacity with #2 diesel fuel. The cost for filling the storage tanks with fuel shall be included in the Contract bid amount.

3.4.1.1 Generator Sets

Complete as specified in the paragraph entitled "Acceptance Checks and Tests."

3.4.1.2 Automatic Transfer Switches

Complete acceptance checks and tests as specified in Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS.

3.4.2 Preliminary Operations

The start-up engineer shall conduct manufacturer recommended start-up procedures and tests to verify that the engine-generator set and auxiliary equipment are ready for functional acceptance tests. Give the Contracting Officer 15 days' advance notice that preliminary operations will be conducted. After preliminary operation has been successfully conducted, the start-up engineer will notify the Contracting Officer in writing stating the engine-generator set and auxiliary equipment are ready for functional acceptance tests.

3.4.3 Preliminary Assembled Operation and Maintenance Manuals

Preliminary assembled operation and maintenance manuals shall have been submitted to and approved by the Contracting Officer. Manuals shall be prepared as specified in the paragraph entitled "Assembled Operation and Maintenance Manuals."

3.4.4 Functional Acceptance Test Procedure

Test procedure shall be prepared by the start-up engineer specifically for the engine-generator set and auxiliary equipment. The test agenda shall

cover the requirements specified in the paragraph entitled "Functional Acceptance Tests." The test procedure shall indicate in detail how tests are to be conducted. A statement of the tests that are to be performed without indicating how the tests are to be performed is not acceptable. Indicate what work is planned on each workday and identify the calendar dates of the planned workdays. Specify what additional technical support personnel is needed such as factory representatives for major equipment. Specify on which testing workday each technical support personnel is needed. Data recording forms to be used to document test results are to be submitted with the proposed test procedure. A list of test equipment and instruments shall also be included in the test procedure.

3.4.5 Test Equipment

Test equipment and instruments shall be on hand prior to scheduling field tests or, subject to Contracting Officer approval, evidence shall be provided to show that arrangements have been made to have the necessary equipment and instruments on site prior to field testing.

3.5 FIELD QUALITY CONTROL

Give Contracting Officer 30 days notice of dates and times scheduled for tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The Contractor shall be responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The Contractor shall provide labor, equipment, diesel fuel, test load, and consumables required for the specified tests. The test load shall be a cataloged product. Calibration of measuring devices and indicating devices shall be certified. Refer to Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, for requirements for a cataloged product. Perform the following field tests.

3.5.1 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.

3.5.1.1 Circuit Breakers - Low Voltage Insulated Case/Molded Case

a. Visual and mechanical inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect circuit breaker for correct mounting.

3. Operate circuit breaker to ensure smooth operation.

4. Inspect case for cracks or other defects.

5. Verify tightness of accessible bolted connections and cable connections by calibrated torque-wrench method. Thermographic survey is not required.

6. Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

1. Perform contact-resistance tests.

2. Perform insulation-resistance tests.

3. Adjust Breaker(s) for final settings in accordance with engine-generator set manufacturer's requirements.

3.5.1.2 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. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is not required.

6. Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

1. Perform insulation-resistance tests.

2. Perform polarity tests.

3. Perform ratio-verification tests.

3.5.1.3 Metering and Instrumentation

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. Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

2. Calibrate watthour meters according to manufacturer's published data.

3. Verify all instrument multipliers.

4. Electrically confirm that current transformer secondary circuits are intact.

3.5.1.4 Battery Systems

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 accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is not required.

4. Measure electrolyte specific gravity and temperature and visually check fill level.

5. Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical tests

1. Set charger float and equalizing voltage levels.

2. Verify all charger functions and alarms.

3. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.

4. Perform a capacity load test.

3.5.1.5 Engine-Generator Set

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Inspect for correct anchorage and grounding.

b. Electrical and mechanical tests

1. Perform an insulation-resistance test on generator winding with respect to ground. Calculate polarization index.

2. Perform phase rotation test to determine compatibility with load requirements.

3.5.1.6 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. 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.

3.5.2 Functional Acceptance Tests

The tests shall be performed by the start-up engineer. Upon successful test completion, the start-up engineer shall provide the Contracting Officer with a written test report within 15 calendar days showing the tests performed and the results of each test. The report shall include the completed approved test data forms and certification from the start-up engineer that the test results fall within the manufacturer's recommended limits and meet the specified requirements performance. The report shall be dated and signed by the start-up engineer, and submitted for approval by the Contracting Officer. The Contracting Officer will witness final acceptance tests. Testing shall include but not be limited to:

a. Verify proper functioning of each engine protective shutdown device and pre-shutdown alarm device. Testing of the devices shall be accomplished by simulating device actuation and observing proper alarm and engine shutdown operation.

b. Verify proper functioning of the engine overspeed trip device. Testing of the overspeed trip device shall be accomplished by raising the speed of the engine-generator set until an overspeed trip is experienced.

c. Verify proper functioning of the crank cycle/terminate relay. Testing of the relay shall be accomplished by engaging the starter motor with the engine being prevented from running. Observe the complete crank/rest cycle as described in the paragraph entitled "Crank Cycle/Terminate Relay."

d. Verify proper functioning of the following automatic and manual operations. Testing shall include but not be limited to:

1. Loss of Utility: Initiate a normal power failure with connected test load of rated kW at 1.0 power factor. Record time delay on start, cranking time until engine starts and runs, time to come up to operating speed, voltage and frequency overshoot, and time to achieve steady state conditions with all switches transferred to emergency position.

2. Return of Utility: Return normal power and record time delay on retransfer for each automatic transfer switch, and time delay on engine cooldown and shutdown.

3. Manual starting

4. Emergency stop

e. Operate the engine-generator set at rated current (amperes) until the jacket water temperature stabilizes. Stabilization will be considered to have occurred when three consecutive temperature readings remain unchanged. Continue to operate the generator set for an additional 2 hours. Record instrument readings for terminal voltage, line current, frequency (Hz), engine speed rpm, lubricating oil pressure, jacket water temperature, and ambient temperature at 5 minute intervals for first 15 minutes and at 15 minute intervals thereafter.

## 3.6 DEMONSTRATION

Upon completion of the work and at a time approved by the Contracting Officer, the Contractor shall provide instructions by a qualified instructor to the Government personnel in the proper operation and maintenance of the equipment. Six Government personnel shall receive training comparable to the equipment manufacturer's factory training. The duration of instruction shall be for not less than one 8 hour working day for instruction of operating personnel and not less than one 8 hour working day for instruction of maintenance personnel.

### 3.6.1 Instructor's Qualification Resume

Instructors shall be regular employees of the engine-generator set manufacturer. The instruction personnel provided to satisfy the requirements above shall be factory certified by the related equipment manufacturer to provide instruction services. Submit the name and qualification resume of instructor to the Contracting Officer for approval.

### 3.6.2 Training Plan

Submit training plan 30 calendar days prior to training sessions. Training plan shall include scheduling, content, outline, and training material (handouts). Content shall include but not limited to the following:

#### 3.6.2.1 Operating Personnel Training

This instruction includes operating the engine-generator set, auxiliary equipment including automatic transfer switches in all modes, and the use of all functions and features specified.

#### 3.6.2.2 Maintenance Personnel Training

Shall include mechanical, hydraulic, electrical, and electronic instructions for the engine-generator set and auxiliary equipment including automatic transfer switches.

a. Mechanical Training: Shall include at least the following:

1. A review of mechanical diagrams and drawings.

2. Component location and functions.

3. Troubleshooting procedures and techniques.

4. Repair procedures.

5. Assembly/disassembly procedures.

6. Adjustments (how, when, and where).

7. Preventive maintenance procedures.

8. Review of flow diagram.

9. Valve locations and function.

10. Valve and hydraulic equipment adjustment and maintenance procedures.

11. Hydraulic system maintenance and servicing.

12. Lubrication points, type, and recommended procedures and frequency.

b. Electrical and Electronic Maintenance Training: Shall include at least the following:

1. A review of electrical and electronic systems including wiring diagrams and drawings.

2. Troubleshooting procedures for the machine and control systems.

3. Electrical and electronic equipment servicing and care.

4. Use of diagnostics to locate the causes of malfunction.

5. Procedures for adjustments (locating components, adjustments to be made, values to be measured, and equipment required for making adjustments).

6. Maintenance and troubleshooting procedures for microprocessor or minicomputer where applicable.

7. Circuit board repair procedures where applicable (with schematics provided).

8. Use of diagnostic tapes.

9. Recommended maintenance servicing and repair for motors, switches, relays, solenoids, and other auxiliary equipment and devices.

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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 | (2011; TIA 11-1; Errata 2011) National Electrical Code |
| 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) 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.

-- End of Section --

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SURGE PROTECTIVE DEVICE (SPD)

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SECTION 26 43 00.00 99

SURGE PROTECTIVE DEVICE (SPD)

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C62.41 | (1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1449 | (2006; Rev thru Sep 2009) Surge Protective Devices |

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

The following shall be submitted in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's Catalog Data shall be submitted for the following items:

Surge Protective Device (SPD) Components; G
UL Documentation

PART 2 PRODUCTS

2.1 SURGE PROTECTIVE DEVICE (SPD) COMPONENTS

All SPDs shall be manufactured by a company engaged in the design, development, and manufacture of such devices for electrical and electronics systems equipment. The said firm shall offer a five-year warranty.

The surge protective manufacturer shall offer technical assistance through support by a factory representative and local stocking distributor or local direct factory distribution warehouse and coordinate with the panelboard manufacturer for installation into the panelboards.

Suppressors shall be listed in accordance with UL 1449. Protective modes shall be as follows: Wye = L-N, L-G, N-G; Delta = L-G, L-L.

Suppressors shall be tested with Category C3 high exposure waveform (20KV, 10 KA, 9/200 usec. waveform) per IEEE C62.41.

Surge protective devices shall be installed in all new panelboards installed flush in walls and surface-mounted in shop and mechanical spaces in accordance with requirements of all National Fire Protection Association (NFPA) codes.

Provide Level One, Level Two or Level Three SPDs where indicated. SPD shall have seven(7) mode protection for 3-phase, wye configuration and four (4) mode protection for 3-phase delta configurations. SPD shall be an integral part of the panel and mounted directly to the bus. SPD provided for new switchgear shall be an integral part of the switchgear and mounted in the auxiliary compartment, dead-front design and front accessible.

SPD shall be installed internal to the new equipment being protected. The mounting position of the SPD shall permit a straight and short lead length connection between the SPD and the point of connection to the equipment. The interconnecting leads between the SPD and the point of connection to the bus should be kept as short as possible, 0.5 m (20 in) or less, and should be twisted to minimize lead reactances. Bends should be avoided if possible. Provide overcurrent protection as recommended by the SPD manufacturer.

All SPD units shall be equipped with an audible alarm which shall actuate when any one of the surge current modules has failed. An alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm. Both switches and audible alarm shall be located on the front cover of the panelboard.

2.1.1 REQUIRED SUPPRESSOR LOCATIONS

In service entrance panelboards.

In distribution and branch circuit panels as indicated on the drawings.

2.1.2 LEVEL "I"

SPD shall meet or exceed the following criteria.

1) Maximum single impulse current rating: 100,000 amperes per mode(8X20 usec current waveform).

2) Pulse life rating (IEEE C62.41-1991, Table 4, Category C3 transient): 1000 occurrences min./mode, based on the highest voltage mode of the device. (20KV/10KA - 8X20usec/1.2X50usec waveform)

Suppression Voltage Ratings (SVR): The maximum UL 1449, Second Edition SVR for the device should not exceed the following:

| Nominal Voltage | Configuration | L-N | N-G | L-G | L-L |
|---|---|---|---|---|---|
| 120/240 | Grd. Neutral | 400 | 400 | 400 | 700 |
| 120/208 | Grd. Wye | 400 | 400 | 400 | 700 |
| 277/480 | Grd. Wye | 800 | 800 | 800 | 1500 |
| 240 | Delta | | | 700 | 700 |
| 480 | Delta | | | 1500 | 1500 |

2.1.3 LEVEL "II"

SPD shall meet or exceed the following criteria.

1) Maximum single impulse current rating: 50,000 amperes per mode (8x20 usec current waveform).

2) Pulse life rating (IEEE C62.41-1991, Table 4, Category C3 transient): 1000 occurrences minimum per mode, based on the highest voltage mode of the device. (6KV/3KA - 8X20usec/1.2X50usec waveform)

Suppression Voltage Ratings (SVR): The maximum UL 1449, Second Edition SVR for the device should not exceed the following:

| Nominal Voltage | Configuration | L-N | N-G | L-G | L-L |
|---|---|---|---|---|---|
| 120/240 | Grd. Neutral | 400 | 400 | 400 | 700 |
| 120/208 | Grd. Wye | 400 | 400 | 400 | 700 |
| 277/480 | Grd. Wye | 800 | 800 | 800 | 1500 |
| 240 | Delta | | | 700 | 700 |
| 480 | Delta | | | 1500 | 1500 |

2.1.4 LEVEL "III"

Suppressors shall be listed in accordance with UL 1449.

For 3 phase, 4-wire configurations, suppressors shall provide suppression elements between each phase conductor and the system neutral, between each phase conductor and the system ground, and between the neutral conductor and ground, for a total of seven suppression modes.

Visible indication of proper suppressor connection and operation shall be provided.

Suppressors shall be designed for a straight and short lead length connection between the suppressor and the point of connection to the panelboard. Other suppressor connections will not be acceptable.

Suppressors shall meet or exceed the following criteria:

1. Maximum single impulse current rating: 80,000 amperes per phase (8/20 usec. waveform).

Note: If the suppressor utilizes internal fuses, the maximum single impulse current cannot exceed the rating of the fuse.

2. Pulse life rating: Category C (8/20 usec. waveform): 2,000 occurrences, with no clamping drift.

3. UL Clamping voltage shall not exceed the following:

| Voltage | L-N | N-G | L-G |
|---|---|---|---|
| 120/208 | 400 | 400 | 400 |

Suppressors shall have turn-on and turn-off times of less than one nanosecond.

Suppressors shall be of the solid-state componentry and shall operate

bidirectionally.

2.2 DOCUMENTATION

Submit UL Documentation verifying listing for UL 1449 sections 34, 35,36, 37, 38, 39, 40.

PART 3 EXECUTION

3.1 INSTALLATION

Arresters and SPD units shall be installed and connected in accordance with the manufacturer's installation instructions.

Ground connection shall be made to a driven ground rod, counterpoise, or station grounding system.

Lightning arresters shall be connected as close as practicable to the apparatus being protected.

3.2 SPDs

Install the proper "level" of suppressor at each switchboard/panelboard as indicated on the power one-line diagram and panelboard schedules.

Suppressor shall be installed in the equipment to be protected, per the manufacturer's installation instructions.

Conductors between suppressor and point of attachment to the panelboard shall be kept as short and straight as possible.

Suppressor's ground shall be bonded to the service entrance ground or point of ground for the respective panelboard.

Include the costs for the manufacturer's certified representative to inspect and approve the installation upon completion of the project.

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LOW-VOLTAGE MOTORS

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SECTION 26 60 13.00 40

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) Load Ratings and Fatigue Life for Roller Bearings |
| ABMA 9 | (1990; R 2008) Load Ratings and Fatigue Life for Ball Bearings |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 112 | (2004) Standard Test Procedure for Polyphase Induction Motors and Generators |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |
| NETA MAINT | (2011) Standard for Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 1940-1 | (2003; 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 | (2009) 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 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 for variable-speed applications shall be designed for operation at the rated maximum speed and at reduced speed throughout the variable-speed range without overloading. Motors for variable-speed operation shall be inverter duty rated and compatible with the associated variable-speed control equipment and operating conditions, including the effects of harmonic current and voltage distortion. Motors for variable-speed operation shall be equipped with a normally closed automatic reset winding thermostat in addition to all accessory equipment recommended by the

variable-speed equipment manufacturer. Thermostat leads shall be brought to the motor connection box.

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 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 |
| 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 ATS and NETA MAINT 7.15.1 for rotating machinery, AC motors.

Calculate the polarization index of each phase by dividing the 10 minute reading by the 1 minute reading. The polarization index shall be greater than 1.25. Any values lower shall be rejected and the motor returned to the factory.

-- End of Section --

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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 06-1; TIA 07-1; TIA 07-2; TIA 07-3; Errata 07-2; TIA 08-4; TIA 08-5; TIA 08-6; TIA 08-7; TIA 08-8; TIA 08-9; TIA 08-10; TIA 08-11; TIA 09-12; TIA 09-13; TIA 09-14; Errata 09-3; TIA 09-15; TIA 09-16; TIA 10-17) 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 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

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-455-177-B | (2003) FOTP-177 IEC-60793-1-43 Optical Fibres - Part 1-43: Measurement Methods and Test Procedures - Numerical Aperture |
| 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-526-14A | (1998) Optical Power Loss Measurements of Installed Multimode Fiber Cable |

| | |
|---|---|
| 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 and Multi-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 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 Multi-Mode Fiber Media

Provide FO 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. FO media shall have an all glass, graded index material with a nominal core diameter of 62.5 microns. Provide a cladding material for the fiber which is compatible with the core. Media transmission window shall be centered at 850 and 1300 nanometer wavelengths, attenuation at 1300 nanometers shall be less than 2.0 dB per kilometer. Minimum bandwidth shall be 500 mHz-Km.

2.1.1.2 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

The cable may contain one of two types of optical fibers, single-mode fiber and multi-mode fiber, as specified. The optical fibers 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."

Multi-Mode (MM) fiber shall be the graded index optical glass. Core diameter of the fiber shall be 62.5 plus or minus 3 micrometer. Cladding diameter shall be 125 plus or minus 3 micrometer. Core-cladding offset shall be less than 3 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 Single-Mode and Multi-Mode 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

Unless otherwise indicated on the drawings, all cable shall contain 12-count of multi-mode fiber.

12-count cable shall be comprised of one loose buffer tube containing twelve fibers. The fibers shall be color coded using the standard Munsell color code, Blue, Orange, Green, Brown, Slate, White, Red, Black, Yellow, Violet, Rose, and Aqua.

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 dielectric 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 or multi-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. Single-mode fibers shall be spliced last in the splice tray.

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.

Multi-mode fiber optic cable assembly shall be comprised of a single fiber connector, terminated on three (3) meter length of single fiber, multi-mode cable. Single fiber cable shall contain a buffered optical fiber and be the same as that provided in the multi-fiber cable.

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 Multi-Mode Fibers in the Cable

Optical attenuation of each optical fiber in the cable (reeled) shall be no greater than 1.0 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.

Bandwidth at minus 3 dB optical power of each optical fiber in the cable

(reeled) shall be a bandwidth length product, gamma equals 1, greater than 1 GHz-Km at 1300 plus or minus 50 nm optical spectrum window.

Numerical aperture of each optical fiber shall be 0.2 plus or minus 0.015 at 1300 nm optical spectrum window. Method of numerical aperture measurement shall be in accordance with TIA-455-177-B, at central wavelength 1300 nm nominal. When this requirement is not met, apply the fusion splice compatibility test.

2.6.1.2 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 ST 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, attach a permanent identification tag as indicated 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 and Multi-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. [6] 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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SECTION 28 05 26.00 40

GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

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 A5.8/A5.8M | (2004) Specification for Filler Metals for Brazing and Braze Welding |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B3 | (2001; R 2007) Standard Specification for Soft or Annealed Copper Wire |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 81 | (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-STD-889 | (1988; Rev B; Notice 2 1988; Notice 3 1993) Dissimilar Metals |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 467 | (2007) Grounding and Bonding Equipment |

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-01 Preconstruction Submittals

Submit material, equipment, and fixture lists for Grounding Systems including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

SD-02 Shop Drawings

Submit Record Drawings in accordance with paragraph entitled, "Drawings," of this section.

SD-03 Product Data

Submit equipment and performance data for the following items including life, test, system functional flows, safety features, and mechanical automated details.

Submit Manufacturer's catalog data for the following items:

Ground Rods

Ground Wires

Connectors and Fasteners

Bonding

SD-06 Test Reports

Submit Test Reports for the following tests on grounding systems in accordance with the paragraph entitled, "Field Tests," of this section. Within the report include certified record of ground-resistance tests on each driven ground rod, ground rod assembly, and other grounding electrodes. Include within the record the number of rods driven and their depth at each location to meet the required resistance-to-ground measurements specified. Include a statement describing the condition of the soil at the time of measurement.

Bond Resistance Test

Ground Resistance Tests

Ground Isolation Test

Continuity Isolation Test

SD-08 Manufacturer's Instructions

Submit Manufacturer's instructions for the Grounding Systems including special provisions required to install equipment components and system packages. Within special notices, detail impedances, hazards and safety precautions.

1.4 DRAWINGS

Record Drawings must indicate the location of ground rods, mats, grids, building ground bus, supplementary grounding electrodes, steel building columns, and other metal structures connected to the grounding system.

Identify the location of each ground rod and ground-rod assembly and other grounding electrodes by letter in alphabetical order and keyed to the record of ground-resistance tests.

PART 2 PRODUCTS

2.1 GROUND RODS

Ground rods must conform to the requirements of NFPA 70.

Ground rods must be copper-clad steel rods not less than 3/4 inch in diameter and not less than 10-feet long per section. Ground rods must be clean and smooth and have a cone-shaped point on the first section and be die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in feet.

2.2 GROUND WIRES

Ground wires must be in accordance with Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

Ground and bond wires for substations, main panels and distribution points, and ground rod connections must be annealed bare copper conforming to ASTM B3, stranded, with 98 percent conductivity. Wire size must be in accordance with the grounding requirements of NFPA 70.

Ground wires for equipment receptacles for noncurrent carrying hardware, installed in conduit must be soft drawn copper, in accordance with ASTM B3, stranded, with green insulation. Note wire size.

2.3 CONNECTORS AND FASTENERS

Grounding and bonding fasteners and connectors must conform to the requirements of UL 467, and Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

Grounding and bonding fasteners must be copper.

Bonding straps and jumpers must be copper and have a cross-sectional area of not less than No. 6 AWG.

PART 3 EXECUTION

3.1 BONDING AND GROUNDING

Bonding and grounding requirements must be in accordance with NFPA 70.

3.2 GROUNDING ELECTRODES

Grounding electrodes must include ground rods installed expressly for grounding systems.

Minimum ground rod section must be 10 feet. Thread sections together and exothermically fusion weld.

Install ground rods so that the top of the rod is not less than 18 inches below finished grade.

3.3 GROUND GRIDS

Ground grids must consist of a series of ground rods installed with interconnecting grounding conductors between ground rods. Space ground rods as noted.

Do not bury ground grid less than 18 inches below the finish grade. Grounding conductors must not be less than No. 4/0 AWG and must be exothermically fusion welded together at crossover points and to ground rods.

3.4 BUILDING GROUNDS

Steel framework of the building must be grounded with a driven ground rod at the base of every corner column and intermediate exterior columns at distances not greater than 60-feet apart. Electrically connect grounding conductor to each ground rod and to each steel column and extend around the perimeter of the building. Grounding-conductor loop around the perimeter of the building must not be less than No. 4/0 AWG. Tap connections from the ground loop to the building steel must not be less than No. 4/0 AWG.

Bury building ground no less than 18 inches below grade and 2 feet from the building foundation. Interconnecting grounding conductor between ground grid and building grounds must not be less than No. 4/0 AWG.

3.5 EQUIPMENT GROUNDING

Metallic raceway systems must have electrical continuity with equipment individually and be directly connected to the building ground, independent of the raceway system.

Individually and directly connect enclosures for panelboards to the building ground. Grounding conductor must not be less than No. 2 AWG and be connected from the building ground to a copper ground-bus terminal strip located in each panelboard.

Polarized receptacles, lighting fixtures, and equipment enclosures must be grounded with an identified (green color) insulated conductor, not smaller than No. 12 AWG, connected to the branch circuit ground-bus terminal strip. Ground-bus terminal strip in each panelboard enclosure must be isolated and independent of the system neutral terminal strip.

Indoor transformers, motors, motor control centers, air compressors, air handlers, and generators must be individually and directly connected to the building ground. Current-carrying capacity of the grounding conductor must be the same as the current-carrying capacity of the power conductors for circuits utilizing power lines size No. 2 AWG and smaller. For circuits with power wiring larger than No. 2 AWG, the grounding conductor must be in accordance with NFPA 70, except that the grounding conductor must not be smaller than No. 2 AWG.

Noncurrent carrying metallic parts of electrical equipment, including metallic cable sheaths, conduit, raceways, and electrical structural members, must be bonded together and connected to the ground grid or ground connection rods.

Install secure ground systems for power and instrumentation. Independently connect each system to the building counterpoise as shown.

Secure ground systems must consist of unspliced ground wires in individual

welded or epoxied conduit runs from the secure area to the building counterpoise. Welding and epoxying must conform to Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

## 3.6 GROUNDING CONNECTIONS

Ground connections must be bonded connections in accordance with paragraph entitled, "Bonding," of this section.

Weld ground connections that are buried or in inaccessible locations.

Bolt connections in accessible locations. Connections to steel building columns in accessible locations must be cast-copper-alloy clamp lugs exothermically fusion-welded to the structure.

Clean, grease, and remove foreign matter from ground connection surfaces. Do not penetrate clad material in the cleaning process. Make connection between like metals where possible. Where dissimilar metals are welded, brazed, or clamped, follow the weld kit manufacturer's instructions. Connections between dissimilar metals must not produce galvanic action in accordance with MIL-STD-889.

## 3.7 BONDING

### 3.7.1 Type of Bonds

Accomplish bonding of metal surfaces by welding.

#### 3.7.1.1 Brazing

Brazing solder must conform to AWS A5.8/A5.8M.

#### 3.7.1.2 Welding

Welding must be by the exothermic process. Within the welding procedure, include the proper mold and powder charge and conform to the manufacturer's recommendations.

Welding processes must be of the exothermic fusion type that will make a connection without corroding or loosening. Process must join all strands and not cause the parts to be damaged or weakened. Completed connection or joint must be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor. Paint buried ground connections with a bitumastic paint.

#### 3.7.1.3 Clamping

In external locations, use clamping only where a disconnect type of connection is required. Connection device may utilize threaded fasteners. Construct device such that positive contact pressure is maintained at all times. Use machine bolts with tooth-type lockwashers.

#### 3.7.1.4 Structural Joining Methods

Consider joints made with high-strength structural bolts, and clean unpainted faying surfaces sufficiently bonded. Install a jumper across the joint in the form of a No. 4 AWG bare copper wire exothermically welded at each end to the surfaces involved spanning the connection wire jumpers used across joints employing miscellaneous machine bolts.

3.7.2 Cleaning of Bonding Surfaces

Thoroughly clean surfaces that comprise the bond before joining. Apply an appropriate abrasive with gentle and uniform pressure to ensure a smooth and uniform surface. Do not remove excessive metal from the surface. Clean clad metals in such a manner that the cladding material is not penetrated by the cleaning process. Then clean bare metal with an appropriate solvent to remove any grease, oil, dirt, corrosion preventives, and other contaminants. Bond to the cleaned area must be made within one hour after cleaning. Seal joint and refinish the exposed surfaces within two hours of exposure to prevent oxidation. When additional time is required, apply a corrosion preventive compound until the area can be refinished.

3.7.3 Bonding Straps and Jumpers

Install jumpers such that the vibration by the shock-mounted device will not change its electrical characteristics.

Weld bonds for outdoor locations unless a disconnect type of connection is required. When a disconnect is required, use clamping with bolts. Insert a tooth-type lockwasher between the strap and metallic member for each bolt.

Bond straps directly to the basic structure and do not penetrate any adjacent parts. Install straps in an area that is accessible for maintenance.

Use single straps for the bonds and install such that they will not restrict movement of structural members. Do not connect two or more straps in series.

Install straps such that they will not weaken structural members to which they are attached.

3.7.4 Equipment and Enclosure Bonding

Each metallic enclosure and all electrical equipment must be bonded to ground. At least one copper connection must be made from the system ground point to one or more enclosures in the area such that all enclosures and equipment provide a low-impedance path to ground when properly bonded together.

3.7.5 Bonding of Conduit and Raceway Systems

Bond all metal conduit, fittings, junction boxes, outlet boxes, armored and metal sheathed cable, and other raceways. Take care to ensure adequate electrical contact at the joints and terminations.

3.7.5.1 Rigid Metal Conduit and Terminations

Threaded connections must be wrench-tight and there must be no exposed threads. Ream all ends of the conduit to remove burrs and rough edges. Conduits entering boxes and enclosures must be bonded to the box with locknuts and grounding-type bushings. Locknuts that gouge into the metal box when tightened are not acceptable.

Conduit systems that are interrupted by PVC dielectric links must be bonded separately on either side of the link. Dielectric link must not be

jumpered.

3.7.5.2 Flexible Metal Conduit

Flexible conduit must have an integral grounding conductor.

3.7.6 Cable Tray Bonding

Bond cable tray sections together. Cable tray sections in tandem assembly must be considered as having electrical continuity when these sections are bonded with the appropriate bolts. Install bond straps across expansion joints. Bond cable trays to the building ground system.

3.7.7 Protection of Finished Bonds

Protect finished bonds by painting to match the original finish after the bond is made.

3.8 FIELD TESTS

Perform the following tests in the presence of the Contracting Officer.

3.8.1 Bond Resistance Test

Resistance of any bond connection must not exceed 0.5 milliohm. Rework bonds that exceed this resistance at no additional cost to the Government.

3.8.2 Ground Resistance Tests

Test Grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise must not exceed 50 milliohms.

Ground resistance and counterpoise tests must be made during dry weather, and no sooner than 48 hours after rainfall. Conduct tests using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE 81.

Indicating instrument must be self-contained and include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Calibrate direct-reading ohmmeter for ranges of 0 to 20 ohms and 0 to 200 ohms.

Place auxiliary grounding electrodes in accordance with instrument manufacturer's recommendations but not less than 50 feet apart, in accordance with IEEE 81.

3.8.3 Ground Isolation Test

Test ground systems for isolation from other ground systems.

3.8.4 Continuity Isolation Test

Perform continuity test on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

-- End of Section --

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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 | (2012; Amd 09-1 & 09-2) Life Safety Code |
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |
| NFPA 72 | (2010; TIA 10-4) National Fire Alarm and Signaling Code |
| NFPA 75 | (2009) Standard for the Protection of Information Technology Equipment |
| NFPA 90A | (2012) Standard for the Installation of Air Conditioning and Ventilating Systems |

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

| | |
|---|---|
| NICET 1016-2 | (2007) Program Detail Manual Fire Alarm Systems, 8th Edition |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FED-STD-595 | (Rev C, 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 | (2011) 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.

## 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 sends a silence signal. 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. 11120 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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SECTION 31 00 00

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SECTION 31 00 00

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 | (2009) Standard Method of Test for 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 | (2010) 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 | (2008a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| Index 600 Series | Traffic Control Thru Work Zones |

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 presented in ASTM D 1557, 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 | |

| MATERIAL | REQUIREMENT | TEST METHOD | NUMBER OF TESTS |
|---|---|---|---|
| | Amount of material passing No. 200 sieve | ASTM C 117 | |
| | Moisture content of subbase material | ASTM D 2216 | |
| Soil materials prior to compaction | Moisture-density relations of soil | ASTM D 1557 | One of each type of subgrade soil 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 DRAWINGS

As-Built Drawings shall be submitted in accordance with Section 01 78 00 CLOSE-OUT SUBMITTALS.

1.7 SUBMITTALS

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

SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shoring; G

Dewatering Work Plan; G

Submit 15 days prior to starting work.

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.

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 All Piping Including Horizontal Directional Drilling

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.

The Contractor shall maintain traffic in accordance with FDOT Standard Index 600 Series and the technical specifications. One traffic lane must be maintained at all times with use of flagger. All traffic lanes must be open for traffic at the close of workdays. All signing, barricades, lighting, flaggers, and other necessary materials shall be included in the lump-sum cost. For roadways with more than two lanes, the Contractor shall maintain one traffic lane in each direction.

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 NASA KSC policy.

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 and in paragraph entitled "Location" in Section 33 11 00 WATER DISTRIBUTION.

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 3 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 and in paragraph entitled "Location" in Section 33 11 00 WATER DISTRIBUTION.

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 TRACER 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 Tracer Wire

Install tracer wire on all piping in accordance with the Typical Trench Detail. Install tracer wire for horizontal directional drilling in accordance with the installer's recommendations.

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 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. 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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SECTION 32 01 16.17

COLD MILLING OF BITUMINOUS PAVEMENTS

PART 1 GENERAL

1.1 UNIT PRICES

1.1.1 Measurement

The quantity of milled pavement will be the number of square yards completed and accepted as determined by the Contracting Officer. Determine the number of square yards of milled pavement by measuring the length and width of the milled surface within the specified work area. Measurement to determine the area shall be to the closest inch for width and the closest foot for length.

1.1.2 Payment

Payment will be to the nearest square yard. No payment will be made for milling outside the specified area of work.

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.

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

Section 327 (2010) Milling of Existing Asphalt Pavement

1.3 SYSTEM DESCRIPTION

Maintain in a satisfactory working condition equipment, tools, and machines used in the performance of the work.

1.3.1 Cold-Milling Machine

Provide a cold-milling machine which is self-propelled, capable of milling the pavement to a specified depth and smoothness and of establishing grade control; with means of controlling transverse slope and dust produced during the pavement milling operation. The machine shall have the ability to remove the millings or cuttings from the pavement and load them into a truck. The milling machine shall not cause damage to any part of the pavement structure that is not to be removed.

1.3.2 Cleaning Equipment

Provide cleaning equipment suitable for removing and cleaning loose material from the pavement surface.

1.3.3 Straightedge

Furnish and maintain at the site, in good condition, one 12 foot

straightedge or other suitable device for each milling machine, for testing the finished surface. Make straightedge available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal, with blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on the pavement.

1.4 QUALITY ASSURANCE

1.4.1 Grade

Conform the finished milled surfaces to the lines, grades, and cross sections indicated. The finished milled-pavement surfaces shall vary not more than 0 inch from the established plan grade line and elevation. Finished surfaces at a juncture with other pavements shall coincide with the finished surfaces of the abutting pavements. The deviations from the plan grade line and elevation will not be permitted in areas of pavements where closer conformance with planned grade and elevation is required for the proper functioning of appurtenant structures involved.

1.4.2 Surface Smoothness

Finished surfaces shall not deviate from the testing edge of a straightedge more than 1/4 inch in the transverse or longitudinal direction.

1.4.3 Traffic Control

Provide all necessary traffic controls during milling operations.

1.5 ENVIRONMENTAL REQUIREMENTS

Milling shall not be performed when there is accumulation of snow or ice on the pavement surface.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Clean the pavement surface of excessive dirt, clay, or other foreign material immediately prior to milling the pavement.

3.2 MILLING OPERATION

A minimum of seven days notice is required, prior to start work, for the Contracting Officer to coordinate the milling operation with other activities at the site. Make sufficient passes so that the designated area is milled to the grades and cross sections indicated. The milling shall proceed with care and in depth increments that will not damage the pavement below the designated finished grade and in accordance with FDOT Section 327. Repair or replace, as directed, items damaged during milling such as manholes, valve boxes, utility lines, pavement that is torn, cracked, gouged, broken, or undercut. The milled material shall be removed from the pavement and loaded into trucks.

3.3 GRADE AND SURFACE-SMOOTHNESS TESTING

3.3.1 Grade-Conformance Tests

Test the finished milled surface of the pavement for conformance with the plan-grade requirements and for acceptance by the Contracting Officer by running lines of levels at intervals of 25 feet longitudinally and 25 feet transversely to determine the elevation of the completed pavement. Correct variations from the designated grade line and elevation in excess of the plan-grade requirements as directed. Skin patching for correcting low areas will not be permitted. Remove and replace the deficient low area. Remove sufficient material to allow at least 1 inch of asphalt concrete to be placed.

3.3.2 Surface-Smoothness Tests

After completion of the final milling, the finished milled surface will be tested by the Government with a straightedge. Other approved devices may be used, provided that when satisfactorily and properly operated, such devices reveal all surface irregularities exceeding the tolerances specified. Correct surface irregularities that depart from the testing edge by more than 1/4 inch. Skin patching for correcting low areas will not be permitted. Remove and replace the deficient low area. Remove sufficient material to allow at least 1 inch of asphalt concrete to be placed.

3.4 REMOVAL OF MILLED MATERIAL

Material that is removed shall become the property of the Contractor and removed from the site.

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SECTION 32 10 00

BITUMINOUS CONCRETE PAVEMENT

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO T 166 | (2007) Standard Method of Test for Bulk Specific Gravity of Compacted Hot-Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens |
| AASHTO T 176 | (2008) Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test |
| AASHTO T 180 | (2009) Standard Method of Test for 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 30 | (2008) Mechanical Analysis of Extracted Aggregate |
| AASHTO T 37 | (2007) Standard Method of Test for Sieve Analysis of Mineral Filler for Hot-Mix Asphalt (ASTM D 546) |

ASPHALT INSTITUTE (AI)

| | |
|---|---|
| AI MS-02 | (6th Edition; 1997) Mix Design Methods for Asphalt |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C 127 | (2007) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate |
| ASTM C 128 | (2007a) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate |
| ASTM C 131 | (2006)Standard Test Method for Resistance to Degradation of Small-Size Coarse |

| | |
|---|---|
| | Aggregate by Abrasion and Impact in the Los Angeles Machine |
| ASTM C 136 | (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C 88 | (2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate |
| ASTM D 1073 | (2007) Fine Aggregate for Bituminous Paving Mixtures |
| ASTM D 113 | (2007) Standard Test Method for Ductility of Bituminous Materials |
| ASTM D 1556 | (2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 1754 | (1997; R 2002) Standard Test Method for Effects of Heat and Air on Asphaltic Materials (Thin-Film Oven Test) |
| ASTM D 1856 | (1995a; R 2003) Recovery of Asphalt from Solution by Abson Method |
| ASTM D 2041 | (2003a) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures |
| ASTM D 2170 | (2007) Kinematic Viscosity of Asphalts (Bitumens) |
| ASTM D 2172 | (2005) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures |
| ASTM D 2216 | (2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass |
| ASTM D 242 | (2004) Mineral Filler for Bituminous Paving Mixtures |
| ASTM D 2922 | (2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 3176 | (1989; R 2002) Standard Practice for Ultimate Analysis of Coal and Coke |
| ASTM D 3180 | (2007) Standard Practice for Calculating Coal and Coke Analyses from As-Determined to Different Bases |
| ASTM D 3282 | (1993; R 2004) Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes |
| ASTM D 4 | (1986; R 2004) Bitumen Content |
| ASTM D 5 | (2006e1) Penetration of Bituminous |

| | |
|---|---|
| | Materials |
| ASTM D 5581 | (2007a) Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus |
| ASTM D 692 | (2000; R 2004) Coarse Aggregate for Bituminous Paving Mixtures |
| ASTM D 70 | (2008) Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method) |
| ASTM D 854 | (2006e1) Specific Gravity of Soil Solids by Water Pycnometer |
| ASTM D 92 | (2005a; R 2010) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester |
| ASTM D 979 | (2001; R 2006e1) Sampling Bituminous Paving Mixtures |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| Section 300 | (2010) Prime and Tack Coats for Base Courses |
| Section 300-1 | (2010) Prime and Tack Coats for Base Courses - Description |
| Section 300-2 | (2010) Prime and Tack Coats for Base Courses - Materials |
| Section 330 | (2010) Hot Bituminous Mixtures - General Construction Requirements |
| Section 330-13 | (2010) Hot Bituminous Mixtures - General Construction Requirements - Protection of Finished Surface |
| Section 334 | (2010) Superpave Asphalt Concrete |
| Section 916-1 | (2010) Bituminous Materials - Superpave PG Asphalt Binder |
| Index 600 | (2010) Maintenance of Traffic Through Work Zones |

1.2 SUBMITTALS

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

SD-03 Product Data

Manufacturer's catalog data for bituminous concrete shall be

submitted showing description, mixing, and application instructions for the following items:

Bituminous Concrete; G
Asphalt Cement; G
Bituminous Prime Coat; G
Bituminous Tack Coat; G

SD-05 Design Data

A Job-Mix Formula (G) for bituminous concrete shall be submitted in accordance with paragraph entitled, "Job-Mix Formulas," of this section.

SD-06 Test Reports

Test Reports shall be submitted in accordance with the paragraph entitled, "Quality Control Testing During Construction" of this section.

## 1.3 PROTECTION OF PERSONS AND PROPERTY

Paving operations shall be conducted in a manner that will ensure the safety of persons and property.

## 1.4 MAINTAINING TRAFFIC

Vehicular and pedestrian traffic shall be maintained in accordance with FDOT Index 600, during the construction of the work by keeping open vehicular traffic lanes.

Traffic lanes posted with warning signs for safety and directing traffic. Warning lights shall be provided during hours of darkness, in accordance with FDOT.

## 1.5 SAMPLING AND TESTING

### 1.5.1 Testing and Inspection

A bituminous-concrete testing and inspection service shall be provided by the Contractor. Testing service shall be approved and shall include sampling and testing bituminous-concrete materials proposed for use in the work, tests and calculations for bituminous concrete mixture, and field-testing facilities for quality control during construction of bituminous-concrete courses.

### 1.5.2 Tests for Bituminous Concrete Materials

Bituminous-concrete materials proposed for use in the work shall be sampled and tested as follows:

| MATERIAL | REQUIREMENT | TEST METHOD | NUMBER OF TESTS |
|---|---|---|---|
| Coarse and fine aggregates | Sampling | AASHTO T 2 | One for each material |
| | Sieve analysis | ASTM C 136 | |
| | Magnesium Sulfate Sound- | ASTM C 88 | |

| MATERIAL | REQUIREMENT | TEST METHOD | NUMBER OF TESTS |
|---|---|---|---|
| | ness Test | | |
| | Sand Equivalent Test of fine aggregate | AASHTO T 176 | |
| | Resistance to abrasion of small size coarse aggregate | ASTM C 131 | |
| Mineral Filler | Sieve analysis | AASHTO T 37 | One for each source of material |
| Asphalt cement | Penetration | ASTM D 5 | One for each specified penetration grade |
| | Flash point | ASTM D 2170<br>ASTM D 92 | |
| | Ductility | ASTM D 113 | |
| | Loss on heating | ASTM D 1754 | |
| | Solubility | ASTM D 4, Procedure No. 1 | |
| | Ash | ASTM D 3176<br>ASTM D 3180 | |

1.5.3 Test for Bituminous Concrete Mixture

| MATERIAL | REQUIREMENT | TEST METHOD | NUMBER OF TESTS |
|---|---|---|---|
| Compacted bituminous-concrete mix | Bulk density | AASHTO T 166 | Four for each bituminous-concrete mixture |
| | Marshall Stability Test | ASTM D 5581 | |
| Aggregate and asphalt cement | Specific gravity of coarse aggregate | ASTM C 127 | One for each material |
| | Specific gravity of fine aggregate | ASTM C 128 | |
| | Apparent specific gravity of mineral filler | ASTM D 854 | |
| | Apparent specific gravity of asphalt cement | ASTM D 70 | |
| Uncompacted bituminous- | Maximum theoretical specific | ASTM D 2041 | Two for each bituminous-con- |

| MATERIAL | REQUIREMENT | TEST METHOD | NUMBER OF TESTS |
|---|---|---|---|
| concrete mix | gravity | | crete mixture |

A density and voids analysis shall be calculated for each series of bituminous-concrete mixture test specimens in conformance with AI MS-02 and shall include the quantity of absorbed asphalt cement in pounds of dry aggregate, percent of air voids, and percent of voids in mineral aggregate.

Report of each job-mix formula shall be submitted on the form entitled, "Hot-Mix Design Data by the Marshall Method" as shown in AI MS-02.

1.5.4 Quality Control Testing During Construction

Soil and base materials shall be tested during construction as follows:

| MATERIAL | REQUIREMENT | TEST METHOD | NUMBER OF TESTS |
|---|---|---|---|
| Subbase or base course | Soil classification | ASTM D 3282 | One for each soil material |
| | Moisture content of subbase or base material (Just prior to compaction) | ASTM D 2216 | |
| Soil materials prior to compaction | Moisture-density relations of soil | AASHTO T 180, Method Bor D | One for each type of soil material |
| Soil material-in-place after compaction | Unit Weight of soil-in-place | ASTM D 1556, Sand Cone Method, or ASTM D 2922, Nuclear Method | At least three daily for each soil material and for each layer; additional test whenever there is any change in moisture conditions |

Bituminous-concrete mixtures shall be sampled and tested for quality control during construction of the bituminous-concrete courses as follows:

| MATERIAL | REQUIREMENT | TEST METHOD | NUMBER OF TESTS |
|---|---|---|---|
| Uncompacted bituminous-concrete mix | Sampling | ASTM D 979 | One for each mixture or day of operation |
| | Asphalt cement content | ASTM D 2172 | |
| | Mechanical analysis extracted aggregates | AASHTO T 30 | |
| | Recovery of | ASTM D 1856 | |

| MATERIAL | REQUIREMENT | TEST METHOD | NUMBER OF TESTS |
|---|---|---|---|
| | asphalt cement by Abson Method | | |
| | Penetration of recovered asphalt cement | ASTM D 5 | |
| | Ductility of recovered asphalt cement | ASTM D 113 | |
| Compacted bituminous-concrete Marshall samples | Bulk density | AASHTO T 166 | Same as specified for uncompacted mix |
| | Marshall Stability and Flow Tests | ASTM D 5581 | |
| In-place pavement | Density and thickness | As specified | One specimen for each 500 square yards of completed bituminous-concrete course |

Test reports results shall be reported in writing on the same day that tests are made.

A bituminous-concrete mixture that does not meet the requirements specified shall not be used in the specified work.

1.5.5 Field Testing Facilities at the Mixing Plant

Field-testing facilities for testing bituminous-concrete materials and mixes at the bituminous mixing plant shall be provided by the testing service.

1.6 CONSTRUCTION EQUIPMENT LIST

Construction equipment list for all major equipment used for transporting, spreading and finishing shall be submitted to the Contracting Officer prior to construction.

1.7 ENVIRONMENTAL REQUIREMENTS

Do not produce or place bituminous concrete when the weather is rainy or foggy, when the base course is frozen or has excess moisture, or when the ambient temperature is less than 40 degrees F in the shade away from artificial heat.

PART 2 PRODUCTS

2.1 BITUMINOUS CONCRETE

2.1.1 Aggregate for Bituminous-Concrete

Coarse aggregate shall conform to ASTM D 692.

Fine aggregate shall conform to ASTM D 1073. Sand equivalent value shall be not less than 30.

2.1.2 Mineral Filler

Mineral filler for bituminous paving mixtures shall conform to ASTM D 242.

2.2 ASPHALT CEMENT

Cement shall conform to Section 916-1 of the FDOT Standards Specifications.

2.3 BITUMINOUS PRIME COAT

Bituminous prime coat shall be emulsified asphalt conforming to the requirements of FDOT Standard Specification Section 300-2.

2.4 BITUMINOUS TACK COAT

Bituminous tack coat shall be emulsified asphalt conforming to the requirements of FDOT Standard Specification Section 300-2.

2.5 JOB-MIX FORMULAS

A job-mix formula for each bituminous-concrete mixture proposed for use in the work shall be submitted for approval prior to start of work.

Job-mix formula shall be in accordance with FDOT Standard Specification Section 334.

2.6 PERFORMANCE REQUIREMENTS

Bituminous concrete mixtures shall meet the performance requirements of FDOT Standard Specification Section 334 for Type SP-9.5 Superpave Asphalt Concrete when sampled and tested, except the Contractor is to meet FDOT's requirements for a 1.00 pay factor. Sampling, test methods, and frequency shall be in conformance with FDOT Standard Specification Section 334.

2.7 PRECAST CAR STOPS

Provide car stops to the profile and size indicated. Manufacture with air entrained concrete having a minimum compressive strength of 3,000 psi at 28 days, with two No. 4 reinforcing rods located at mid-point of its cross section and with two galvanized sleeves for anchoring.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Excavation and Filling

Excavation and filling to establish elevation of subgrade is specified in Section 31 00 00 EARTHWORK.

3.2 SUBBASE OR BASE COURSE

3.2.1 Preparation of Subgrade or Subbase

Prior to constructing the subbase or base course, the previously constructed subgrade or subbase course shall be cleaned of foreign

substances. At the time of construction of the base course, the subgrade or subbase course shall contain no frozen material.

Ruts or soft, yielding spots that may appear in the subgrade or subbase course, areas having inadequate compaction and deviations of the surface from the requirements in the applicable section shall be corrected. Correction shall be performed by loosening the affected areas, removing unsatisfactory material, adding approved material and reshaping and recompacting to line and grade to the specified density requirements.

3.2.2 Placing and Compacting

Material shall be leveled to a uniform thickness so that the layer, after compaction, will not exceed 6 inches. Water shall be added by sprinkling and mixing or reduced by aeration as necessary. Mixing and aeration shall be accomplished until the water content is at optimum. Layer shall be compacted through the full depth to the specified density. In places inaccessible to rolling equipment, compaction shall be with approved mechanical compactors. Successive layers shall be constructed in a similar manner, scarifying between layers to ensure adequate bonding. Materials found unsatisfactory shall be replaced with satisfactory material or reworked to produce an acceptable standard.

3.2.3 Smoothness

Surface of each layer shall show no deviations in excess of 1/2 inch when tested with a 10-foot straightedge applied parallel with, and at right angles to, centerline of area to be paved.

3.2.4 Thickness Control

Completed thickness of the subbase or base course shall be within 1/2 inch of plan. Thicknesses shall be measured at intervals providing at least one depth measurement for each 500 square yards. Depth measurement shall be made by test holes 3 inches minimum in diameter. Where the measured thickness is more than 1/2-inch deficient, the areas shall be corrected by scarifying, adding mixture of proper gradation, reblading, and recompacting. Average job thickness shall be the average of job measurements within 1/4 inch of plan.

3.3 ASPHALT CONCRETE SURFACE COURSE

3.3.1 Weather Limitations

Weather limitations are stated in FDOT Standard Specifications Section 330 and as modified herein.

Bituminous prime and tack coats shall be applied only when the ambient temperature in the shade is above 50 degrees F or when the temperature has not been below 35 degrees F for 12 hours immediately prior to application. Application may commence when the aggregate base course is dry or contains moisture not in excess of the amount that will permit uniform distribution and the required penetration.

Bituminous-concrete courses shall be constructed only when the ambient temperature is above 40 degrees F and the underlying base course is dry.

3.3.2 Transportation of Mixtures

Bituminous-concrete mixtures shall be transported from the mixing plant to the project site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of a concentrated solution of hydrated lime and water to prevent adhesion of the mixture to the truck beds.

Each load of mixture shall be covered with canvas or similar material of sufficient size and weight to retard heat loss and to protect the mixture from the weather.

In cool weather or for long hauls, the entire contact area of each truck bed shall be insulated. Covers shall be securely fastened.

Deliveries of the mixture shall be so scheduled that the placing and compaction can be completed during daylight unless satisfactory artificial light is provided.

Mixture shall be delivered in a such manner that the temperature of the mixture at the time of dumping into the paver will be not less than 230 degrees F.

Trucks shall not travel on the mixture until compaction is complete and the bituminous-concrete pavement surface will support traffic without measurable deformation.

## 3.4 PREPARATION OF AREA TO BE PAVED

### 3.4.1 Surface Preparation

Preparation shall be in accordance with Section 300 of the FDOT Standard Specifications.

### 3.4.2 Priming the Base Course Surface

Priming the base course surface shall be in accordance with Section 300 of the FDOT Standard Specifications.

### 3.4.3 Priming Other Contact Surfaces

Contact surfaces of curbs, gutters, manholes, and other structures projecting into or abutting the concrete pavement shall be coated with a thin, uniform coating of bituminous tack-coat material prior to the bituminous-concrete mixture being placed against such structures.

Application shall conform to FDOT Standard Specifications Section 300-1.

Excess tack-coat material shall be squeegeed from the surface.

## 3.5 PLACING BITUMINOUS-CONCRETE COURSES

Placement shall be in accordance with FDOT Standard Specification Section 330 and Section 334, except at modified herein.

### 3.5.1 General

Bituminous-concrete mixture shall be placed on the prepared surface, uniformly spread and struck off. Bituminous-concrete courses shall be placed in layers of approximately equal thickness except that no layer shall be more than 2-inches thick after compaction. Courses shall be so placed that, when compacted, they will conform to the indicated grade,

cross-section, and thickness.

3.5.2 Pavement Placing

Each paver shall be adjusted and the speed regulated so that the surface of the bituminous-concrete mixture will be smooth and, when compacted, will conform to the depths, cross sections, grades, and contours indicated.

Placing shall begin along the centerline of areas to be paved on a crowned section, at the high side of a section with a one-way slope and in the direction of the traffic flow. The mixture for each course shall be placed in strips not less than 10-feet wide. Progressive strip placement shall commence after rolling of the first strip. Rolling shall be extended to overlap the preceding strips. Placing the bituminous-concrete mixture shall be continuous.

Experienced shovelers and rakers shall follow each paver, adding hot bituminous-concrete mixture and raking the mixture as required to produce a course that, when completed, will conform to requirements specified.

3.5.3 Hand Placing

In areas where the use of machine spreading is not practicable, the mixture shall be spread and finished by the use of heated hand tools.

Mixture shall be dumped on approved dump boards and distributed into place from the dump boards in a uniformly loose layer of a thickness that will, when compacted, conform to required grade and thickness. Mixture shall be dumped no faster than it can be handled properly by the shovelers and rakers.

3.5.4 Joints

Joints shall have the same texture, density, and smoothness as other sections of the course. Joints between old and new pavements, or between successive days' work, shall be made to ensure a continuous bond between the old and new sections of the pavement.

Transverse joints in succeeding courses shall be offset at least 24 inches. The edge of the previously placed course shall be cut back to expose an even vertical surface over the full thickness of the course.

Longitudinal joints in succeeding courses shall be offset at least 6 inches. When the edges of longitudinal joints are irregular or do not conform to the specifications, the edge shall be cut back to expose an even vertical surface over the full thickness of the course.

3.6 COMPACTION

3.6.1 General

Compaction shall commence as soon after placing as the bituminous-concrete mixture will bear the weight of the roller without undue displacement.

Delays in compacting the freshly spread mixture will not be permitted.

During rolling, the wheels shall be kept moist with the minimum amount of water required to avoid picking up the bituminous-concrete mixture.

In places not accessible to the rollers, the mixture shall be compacted with hot hand tampers.

3.6.2 Rolling Procedure

Rolling shall commence longitudinally at the extreme sides of lanes and proceed toward the center of the pavement, except on superelevated curves. Rolling on superelevated curves shall commence on the low side and progress to the high side, overlapping on successive trips by at least one-half the width of the rear wheel of the roller.

Alternate trips of the roller shall be of slightly different lengths.

Rollers shall move at a slow but uniform speed with the drive roll or wheel nearest the paver. Speed of the rollers shall not exceed 3 miles per hour for steel-wheeled rollers or 5 miles per hour for pneumatic-tired rollers.

Rollers shall not be parked on the pavement.

3.6.3 Initial Rolling

The initial rolling shall immediately follow the rolling of the longitudinal joint and edges. Rollers shall be operated as close to the paver as possible without causing undue displacement.

Preliminary tests of crown, grade and smoothness shall be made immediately after the initial rolling.

Before the rolling is continued, deficiencies shall be corrected by adding or removing material so that the finished course will conform to the specified requirements for grade and smoothness.

3.6.4 Second Rolling

Second rolling shall follow the initial rolling as closely as possible, while the mixture is hot and in condition suitable for proper compaction.

Rolling shall be continuous (at least 3 complete coverages) after the initial rolling until the mixture has been compacted.

Causing undue displacement will not be permitted.

3.6.5 Finish Rolling

Finish rolling shall be done while the mixture is warm enough for the removal of roller marks. Rolling shall continue until all roller marks are eliminated and the course has the specified density.

3.6.6 Patching Deficient Areas

Bituminous-concrete mixtures that become mixed with foreign material or that are defective, such as low areas or "bird-baths," shall be removed, replaced with fresh bituminous-concrete mixture to obtain the required grade and smoothness for the finished surface, and compacted to the specified density.

Pavement in deficient areas shall be removed to the full thickness of the bituminous-concrete course and so cut that the sides are perpendicular and parallel to the direction of traffic and the edges are vertical. Edges

shall be sprayed with bituminous tack-coat material.

Skin patching an area that has been rolled will not be permitted.

3.6.7 Protection of Pavement

After final rolling, vehicular traffic shall not be permitted on the pavement until the pavement has cooled and hardened and in no case sooner than 6 hours.

3.7 ACCEPTANCE PROVISIONS

3.7.1 General

Density, surface smoothness, and thickness of completed bituminous-concrete base and surface courses shall be tested to verify compliance with the specified requirements.

3.7.2 Density and Thickness Requirements

Pavement specimens of each completed bituminous-concrete course shall be taken on the basis specified. Diameter of pavement core specimens shall be not less than 3 inches, and shall be through the entire base course and surface course. Locations for the removal of pavement specimens shall be directed by the Contract Officer. Test holes shall be repaired.

Perform testing in conformance with Section 334 of FDOT Standard Specifications.

Thickness shall not vary from the indicated thickness by more than 1/2 inch for the base course and 1/4 inch for the surface course.

3.7.3 Surface Requirements

Surface requirements shall be as provided in FDOT Standard Specifications Section 330-13, except as modified herein.

The finished surface of each bituminous-concrete course shall be tested for smoothness with a 10-foot straightedge applied parallel with, and at right angles to, the centerline of the paved area. The entire paved area shall be checked from one side to the other. Advancement along the pavement shall be in successive stages of not more than half the length of the straightedge.

Final surface shall have a uniform texture and shall conform to the required grade and cross section. Low or defective areas shall be immediately corrected by cutting out the faulty areas and replacing them.

3.8 WASTE MANAGEMENT

Protect excess material from contamination and return to manufacturer, or reuse on-site for walkways, patching, ditch beds, speed bumps, or curbs.

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AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE

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AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO T 180 | (2009) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop |
| AASHTO T 224 | (2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C 117 | (2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C 136 | (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 1556 | (2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 1557 | (2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D 2167 | (2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method |
| ASTM D 4318 | (2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D 6938 | (2008a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |
| ASTM E 11 | (2009) Wire Cloth and Sieves for Testing Purposes |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

Section 160 (2010) Stabilizing

Section 285 (2010) Optional Base Course

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Graded-Crushed Aggregate Base Course

Graded-crushed aggregate (GCA) base course is well graded, crushed, durable aggregate uniformly moistened and mechanically stabilized by compaction. GCA is similar to ABC, but it has more stringent requirements and it produces a base course with higher strength and stability.

1.2.3 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve are expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

1.3 SYSTEM DESCRIPTION

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. Provide adequate equipment having the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth 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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills and Delivery Tickets

Copies of waybills and delivery tickets during the progress of the work.

SD-06 Test Reports

Sampling and Testing; G

Field Density Tests; G

1.5 QUALITY ASSURANCE

1.5.1 Tests

Provide waybills and delivery tickets, and perform sampling and testing in conformance with the applicable standards listed.

1.5.1.1 Sieve Analysis

Make sieve analysis in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11.

1.5.1.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D 4318.

1.5.1.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with AASHTO T 180, Method D and corrected with AASHTO T 224.

1.5.1.4 Field Density Tests

Measure field density in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 6938.

1.5.2 Testing Frequency

1.5.2.1 Initial Tests

Perform one of each of the following tests, on the proposed material prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

1.5.2.2 In Place Tests

Perform each of the following tests on samples taken from the placed and compacted ABC and GCA. Samples shall be taken and tested at the rates indicated. Perform sampling and testing of recycled concrete aggregate at twice the specified frequency until the material uniformity is established.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 500 square yards, or portion thereof, of completed area.

b. Perform sieve analysis on every lift of material placed and at a frequency of one sieve analysis for every 500 square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the total thickness of the base course at intervals, in such a manner as to ensure one measurement for each 500 square yards of base course. Measurements shall be made in 3 inch diameter test holes penetrating the base course.

1.6 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

PART 2 PRODUCTS

As specified in FDOT Section 160 and Section 285 and all reference sections within. Allowable material shall be limited to limerock only.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

As specified in FDOT Section 160 and Section 285 and all referenced sections within.

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PAVEMENT MARKINGS

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 247 | (2009) Standard Specification for Glass Beads Used in Pavement Markings |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D 4280 | (2008) Extended Life Type, Nonplowable, Raised, Retroreflective Pavement Markers |
| ASTM D 4505 | (2005) Preformed Retroflective Pavement Marking Tape for Extended Service Life |
| ASTM D 792 | (2008) Density and Specific Gravity (Relative Density) of Plastics by Displacement |
| ASTM E 28 | (1999; R 2009) Softening Point of Resins Derived from Naval Stores by Ring and Ball Apparatus |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS TT-B-1325 | (Rev D) Beads (Glass Spheres) Retro-Reflective (Metric) |
| FS TT-P-1952 | (Rev E) Paint, Traffic and Airfield Markings, Waterborne |

1.2 SYSTEM DESCRIPTION

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Submit lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

1.2.1 Paint Application Equipment

1.2.1.1 Self-Propelled or Mobile-Drawn Pneumatic Spraying Machines

The equipment to apply paint to pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. The machine shall have a speed during application not less than 5 mph, and shall be capable of applying the stripe widths indicated, at the paint coverage rate specified in paragraph APPLICATION, and of even uniform thickness with clear-cut edges. Equipment used for marking streets and highways shall be capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines or a combination of solid and intermittent lines using a maximum of two different colors of paint as specified. The paint applicator shall have paint reservoirs or tanks of sufficient capacity and suitable gauges to apply paint in accordance with requirements specified. Tanks shall be equipped with suitable air-driven mechanical agitators. The spray mechanism shall be equipped with quick-action valves conveniently located, and shall include necessary pressure regulators and gauges in full view and reach of the operator. Paint strainers shall be installed in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Pneumatic spray guns shall be provided for hand application of paint in areas where the mobile paint applicator cannot be used.

1.2.1.2 Hand-Operated, Push-Type Machines

All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Hand-operated push-type machines of a type commonly used for application of paint to pavement surfaces will be acceptable for marking small streets and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

1.2.2 Thermoplastic Application Equipment

1.2.2.1 Thermoplastic Material

Thermoplastic material shall be applied to the primed pavement surface by spray techniques or by the extrusion method, wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material. By either method, the markings shall be applied with equipment that is capable of providing continuous uniformity in the dimensions of the stripe.

1.2.2.2 Application Equipment

a. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the

material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. The application equipment shall be constructed to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skiplines". The equipment shall be capable of applying varying widths of traffic markings.

c. The applicator shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser shall be automatically operated and shall begin flow prior to the flow of composition to assure that the strip is fully reflectorized.

1.2.2.3 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. The equipment used for the placement of thermoplastic pavement markings shall be of two general types: mobile applicator and portable applicator.

a. Mobile Application Equipment: The mobile applicator shall be defined as a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method. The unit shall be equipped to apply the thermoplastic marking material at temperatures exceeding 375 degrees F, at widths varying from 3 to 12 inches and in thicknesses varying from 0.020 to 0.190 inch and shall have an automatic drop-on bead system. The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.

(1) The mobile unit shall be equipped with a melting kettle which holds a minimum of 6000 pounds of molten thermoplastic material. The kettle shall be capable of heating the thermoplastic composition to temperatures of 375 to 425 degrees F. A thermostatically controlled heat transfer liquid shall be used. Heating of the composition by direct flame will not be allowed. Oil and material temperature gauges shall be visible at both ends of the kettle. The mobile unit shall be equipped with a minimum of two extrusion shoes located one on each side of the truck, and shall be capable of marking simultaneous edgeline and centerline stripes. Each extrusion shoe shall be a closed, oil-jacketed unit; shall hold the molten thermoplastic at a temperature of 375 to 425 degrees F; and shall be capable of extruding a line of 3 to 8 inches in width; and at a thickness of not less than 0.125 inch nor more than 0.190 inch, and of generally uniform cross section.

(2) The mobile unit shall be equipped with an electronic programmable line pattern control system. The control system shall be capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, the mobile unit shall be equipped with an automatic counting mechanism capable of recording the number of lineal feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

b. Portable Application Equipment: The portable applicator shall be

defined as hand-operated equipment, specifically designed for placing special markings such as crosswalks, stopbars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be capable of applying thermoplastic pavement markings by the extrusion method. The portable applicator shall be loaded with hot thermoplastic composition from the melting kettles on the mobile applicator. The portable applicator shall be equipped with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature of 375 to 425 degrees F, of extruding a line of 3 to 12 inches in width, and in thicknesses of not less than 0.125 inch nor more than 0.190 inch and of generally uniform cross section.

1.2.3 Reflective Media Dispenser

The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION, at all operating speeds of the applicator to which it is attached.

1.2.4 Preformed Tape Application Equipment

Mechanical application equipment shall be used for the placement of preformed marking tape. Mechanical application equipment shall be defined as a mobile pavement marking machine specifically designed for use in applying precoated, pressure-sensitive pavement marking tape of varying widths, up to 12 inches. The applicator shall be equipped with rollers, or other suitable compactive device, to provide initial adhesion of the preformed, pressure-sensitive marking tape with the pavement surface. Additional hand-operated rollers shall be used as required to properly seat the thermoplastic tape.

1.2.5 Surface Preparation Equipment

1.2.5.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.2.5.2 Waterblast Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

1.2.6 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be

equipped with traps to maintain the air free of oil and water.

1.2.6.1 Shotblasting Equipment

Shotblasting equipment shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

1.2.6.2 Chemical Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface, and shall leave only non-toxic biodegradable residue.

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

Equipment; G
Composition Requirements; G
Qualifications; G

SD-06 Test Reports

Sampling and Testing; G

SD-07 Certificates

Volatile Organic Compound (VOC); G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of chemicals.

1.4.2 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

1.4.3 Maintenance of Traffic

1.4.3.1 Roads, Streets, and Parking Areas

When traffic must be rerouted or controlled to accomplish the work, the necessary warning signs, flagpersons, and related equipment for the safe

passage of vehicles shall be provided.

1.5 DELIVERY, STORAGE, AND HANDLING

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

1.6 ENVIRONMENTAL REQUIREMENTS

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

PART 2 PRODUCTS

2.1 PAINT

The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paints for roads, parking areas, and streets shall conform to FS TT-P-1952, color as indicated. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

2.2 THERMOPLASTIC COMPOUNDS

The thermoplastic reflectorized pavement marking compound shall be extruded or sprayed in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking shall be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.

2.2.1 Composition Requirements

Submit Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use. The binder component shall be formulated as a hydrocarbon resin. The pigment, beads and filler shall be uniformly dispersed in the binder resin. The thermoplastic composition shall be free from all skins, dirt, and foreign objects and shall comply with the following requirements:

| Component | Percent by Weight | |
|---|---|---|
| | White | Yellow |
| Binder | 17 min. | 17 min. |
| Titanium dioxide | 10 min. | - |

| Component | Percent by Weight | |
|---|---|---|
| | White | Yellow |
| Glass beads | 20 min. | 20 min. |
| Calcium carbonate and inert fillers | 49 max. | * |
| Yellow pigments | - | * |
| *Amount and type of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing the other composition requirements of this specification are met. | | |

2.2.2 Physical Properties

2.2.2.1 Color

The color shall be as indicated.

2.2.2.2 Drying Time

When installed at 70 degrees F and in thicknesses between 1/8 and 3/16 inch, after curing 15 minutes.

2.2.2.3 Softening Point

The composition shall have a softening point of not less than 194 degrees F when tested in accordance with ASTM E 28.

2.2.2.4 Specific Gravity

The specific gravity of the composition shall be between 1.9 and 2.2 as determined in accordance with ASTM D 792.

2.2.3 Asphalt Concrete Primer

The primer for asphalt concrete pavements shall be a thermosetting adhesive with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved and/or dispersed in a volatile organic compound (VOC). Submit certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Solids content shall not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch plus or minus 0.001 inch, shall dry to a tack-free condition in less than 5 minutes.

2.2.4 Portland Cement Concrete Primer

The primer for Portland cement concrete pavements shall be an epoxy resin primer. The primer shall be of the type recommended by the manufacturer of the thermoplastic composition. Epoxy primers recommended by the manufacturer shall be approved by the Contracting Officer prior to use. Requests for approval shall be accompanied with technical data, instructions for use, and a 1 quart sample of the primer material.

2.3 PREFORMED TAPE

The preformed tape shall be an adherent reflectorized strip in accordance with ASTM D 4505 Type I or IV, Class optional.

2.4 RAISED REFLECTIVE MARKERS

Either metallic or nonmetallic markers of the button or prismatic reflector type may be used. Markers shall be of permanent colors, as specified for pavement marking, and shall retain the color and brightness under the action of traffic. Button markers shall have a diameter of not less than 4 inches, and shall be spaced not more than 40 feet apart on solid longitudinal lines. Markers shall have rounded surfaces presenting a smooth contour to traffic and shall not project more than 3/4 inch above level of pavement. Pavement markers and adhesive epoxy shall conform to ASTM D 4280.

2.5 REFLECTIVE MEDIA

Reflective media for roads and streets shall conform to FS TT-B-1325, Type I, Gradation A or AASHTO M 247, Type I.

2.6 SAMPLING AND TESTING

Materials proposed for use shall be stored on the project site in sealed and labeled containers, or segregated at source of supply, sufficiently in advance of needs to allow 60 days for testing. Submit certified copies of the test reports, prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory. Upon notification by the Contractor that the material is at the site or source of supply, a sample shall be taken by random selection from sealed containers in the presence of the Contracting Officer. Samples shall be clearly identified by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quantity involved. Testing shall be performed in an approved independent laboratory. If materials are approved based on reports furnished by the Contractor, samples will be retained by the Government for possible future testing should the material appear defective during or after application.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Thoroughly clean surfaces to be marked before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Areas of old pavement affected with oil or grease shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be recleaned, when work has been stopped due to rain.

3.1.1 Pretreatment for Early Painting

Where early painting is required on rigid pavements, apply a pretreatment with an aqueous solution, containing 3 percent phosphoric acid and 2 percent zinc chloride, to prepared pavement areas prior to painting.

3.1.2 Cleaning Existing Pavement Markings

In general, markings shall not be placed over existing pavement marking patterns. Remove existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns. Deteriorated or obscured markings that are not misleading or confusing or interfere with the adhesion of the new marking material do not require removal. New preformed and thermoplastic pavement markings shall not be applied over existing preformed or thermoplastic markings. Whenever grinding, scraping, sandblasting or other operations are performed the work must be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

3.1.3 Cleaning Concrete Curing Compounds

On new portland cement concrete pavements, cleaning operations shall not begin until a minimum of 30 days after the placement of concrete. All new concrete pavements shall be cleaned by either sandblasting or water blasting. When water blasting is performed, thermoplastic and preformed markings shall be applied no sooner than 24 hours after the blasting has been completed. The extent of the blasting work shall be to clean and prepare the concrete surface as follows:

a. There is no visible evidence of curing compound on the peaks of the textured concrete surface.

b. There are no heavy puddled deposits of curing compound in the valleys of the textured concrete surface.

c. All remaining curing compound is intact; all loose and flaking material is removed.

d. The peaks of the textured pavement surface are rounded in profile and free of sharp edges and irregularities.

e. The surface to be marked is dry.

3.2 APPLICATION

All pavement markings and patterns shall be placed as shown on the plans.

3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied pneumatically with approved equipment at rate of coverage specified . Provide guide lines and templates as

necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

3.2.1.1 Rate of Application

a. Reflective Markings: Pigmented binder shall be applied evenly to the pavement area to be coated at a rate of 105 plus or minus 5 square feet/gallon. Glass spheres shall be applied uniformly to the wet paint on road and street pavement at a rate of 6 plus or minus 0.5 pounds of glass spheres per gallon of paint.

b. Nonreflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet/gallon.

3.2.1.2 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

3.2.2 Thermoplastic Compounds

Thermoplastic pavement markings shall be placed upon dry pavement; surface dry only will not be considered an acceptable condition. At the time of installation, the pavement surface temperature shall be a minimum of 40 degrees F and rising. Thermoplastics, as placed, shall be free from dirt or tint.

3.2.2.1 Longitudinal Markings

All centerline, skipline, edgeline, and other longitudinal type markings shall be applied with a mobile applicator. All special markings, crosswalks, stop bars, legends, arrows, and similar patterns shall be placed with a portable applicator, using the extrusion method.

3.2.2.2 Primer

After surface preparation has been completed the asphalt and/or concrete pavement surface shall be primed. The primer shall be applied with spray equipment. Primer materials shall be allowed to "set-up" prior to applying the thermoplastic composition. The asphalt concrete primer shall be allowed to dry to a tack-free condition, usually occurring in less than 10 minutes. The Portland cement concrete primer shall be allowed to dry in accordance with the thermoplastic manufacturer's recommendations. To shorten the curing time of the epoxy resins an infrared heating device may be used on the concrete primer.

a. Asphalt Concrete Primer: Primer shall be applied to all asphalt concrete pavements at a wet film thickness of 0.005 inch, plus or minus 0.001 inch ( 265-400 square feet/gallon).

b. Portland Cement Concrete Primer: Primer shall be applied to all concrete pavements (including concrete bridge decks) at a wet film thickness of between 0.04 to 0.05 inch ( 320-400 square feet/gallon).

3.2.2.3 Markings

After the primer has "set-up", the thermoplastic shall be applied at temperatures no lower than 375 degrees F nor higher than 425 degrees F at the point of deposition. Immediately after installation of the marking, drop-on glass spheres shall be mechanically applied so that the spheres are held by and imbedded in the surface of the molten material.

a. Extruded Markings: All extruded thermoplastic markings shall be applied at the specified width and at a thickness of not less than 0.125 inch nor more than 0.190 inch.

b. Sprayed Markings: All sprayed thermoplastic markings shall be applied at the specified width and the thicknesses designated in the contract plans. If the plans do not specify a thickness, centerline markings shall be applied at a wet thickness of 0.090 inch, plus or minus 0.005 inch, and edgeline markings at a wet thickness of 0.060 inch plus or minus 0.005 inch.

c. Reflective Glass Spheres: Immediately following application, reflective glass spheres shall be dropped onto the molten thermoplastic marking at the rate of 1 pound/20 square feet of compound.

3.2.3 Preformed Tape

The pavement surface temperature shall be a minimum of 60 degrees F and the ambient temperature shall be a minimum of 60 degrees F and rising. The preformed markings shall be placed in accordance with the manufacturer's written instructions.

3.2.4 Raised Reflective Markers

Prefabricated markers shall be aligned carefully at the required spacing and permanently fixed in place by means of epoxy resin adhesives. To insure good bond, pavement in areas where markers will be set shall be thoroughly cleaned by sandblasting and use of compressed air prior to applying adhesive.

3.2.5 Reflective Media

Application of reflective media shall immediately follow application of pigmented binder. Drop-on application of glass spheres shall be accomplished to insure that reflective media is evenly distributed at the specified rate of coverage. Should there be malfunction of either paint applicator or reflective media dispenser, operations shall be discontinued immediately until deficiency is corrected.

3.3 MARKING REMOVAL

Pavement marking, including plastic tape, shall be removed in the areas shown on the drawings. Removal of marking shall be as complete as possible without damage to the surface. Aggregate shall not be exposed by the removal process. After the markings are removed, the cleaned pavement surfaces shall exhibit adequate texture for remarking as specified in paragraph SURFACE PREPARATION. Demonstrate removal of pavement marking in an area designated by the Contracting Officer. The demonstration area will become the standard for the remainder of the work.

3.3.1 Equipment Operation

Equipment shall be controlled and operated to remove markings from the pavement surface, prevent dilution or removal of binder from underlying pavement, and prevent emission of blue smoke from asphalt or tar surfaces.

3.3.2 Cleanup and Waste Disposal

The worksite shall be kept clean of debris and waste from the removal operations. Debris shall be disposed of at approved sites.

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SECTION 32 31 13

CHAIN LINK FENCES

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 A116 | (2011) Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric |
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A702 | (1989; R 2006) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought |
| ASTM A780/A780M | (2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A90/A90M | (2009) Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings |
| ASTM B117 | (2009) Standing Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM C 94/C 94M | (2011) Standard Specification for Ready-Mixed Concrete |
| ASTM F 1043 | (2011) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework |
| ASTM F 1083 | (2010) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures |
| ASTM F 567 | (2011) Standard Practice for Installation of Chain Link Fence |
| ASTM F 626 | (2008) Standard Specification for Fence Fittings |
| ASTM F 883 | (2009) Padlocks |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS RR-F-191 | (Rev K) Fencing, Wire and Post Metal (and Gates, Chain-Link Fence Fabric, and Accessories) |
| FS RR-F-191/1 | (Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Fabric) |
| FS RR-F-191/3 | (Rev E; Am 1) Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces) |
| FS RR-F-191/4 | (Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Accessories) |

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

Fence Assembly

Location of Corner, End, and Pull Posts

Erection/Installation Drawings

SD-03 Product Data

Fence Assembly

Zinc Coating

Fabric

Stretcher Bars

Concrete

SD-04 Samples

Fabric

Posts

Braces

Line Posts

Sleeves

Top Rail

Tension Wire

Stretcher Bars

Padlocks

Wire Ties

SD-07 Certificates

Certificates of Compliance

SD-08 Manufacturer's Instructions

Fence Assembly

Hardware Assembly

Accessories

1.3 ASSEMBLY AND INSTALLATION INSTRUCTIONS

Submit manufacturer's erection/installation drawings and instructions that detail proper assembly and materials in the design for fence, hardware, and accessories.

Submit erection/installation drawings along with manufacturer's catalog data for complete fence assembly, hardware assembly and accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.5 QUALITY ASSURANCE

1.5.1 Required Report Data

Submit reports of listing of chain-link fencing and accessories regarding weight in ounces for zinc coating.

1.5.2 Certificates of Compliance

Submit certificates of compliance in accordance with the applicable reference standards and descriptions of this section for the following:

a. Zinc coating

b. Fabric

c. Stretcher bars

d. Concrete

PART 2 PRODUCTS

2.1 GENERAL

Provide fencing materials conforming to the requirements of ASTM A116, ASTM A702, ASTM F 626, and as specified.

2.2 ZINC COATING

Provide hot-dip galvanized (after fabrication) ferrous-metal components and accessories, except as otherwise specified.

Provide zinc coating of weight not less than 1.94 ounces per square foot, as determined from the average result of two specimens, when tested in accordance with ASTM A90/A90M.

Provide zinc coating conforming to the requirements of the following:

a. Pipe: FS RR-F-191/3 Class 1 Grade A in accordance with ASTM F 1083.

b. Hardware and accessories: ASTM A153/A153M, Table 1

c. Surface: ASTM F 1043

d. External: Type B-B surface zinc with organic coating, 0.97 ounce per square foot minimum thickness of acrylated polymer.

e. Internal: Surface zinc coating of 0.97 ounce per square foot minimum.

Provide galvanizing repair material that is cold-applied zinc-rich coating conforming to ASTM A780/A780M.

2.3 FABRIC

FS RR-F-191 and detailed specifications as referenced and other requirements as specified.

FS RR-F-191/1; Type I, zinc-coated steel, 4 gage. Mesh size, 2 inches. Provide selvage knuckled at one selvage and twisted and barbed at the other. Height of fabric, as indicated.

Provide fabric consisting of No. 9-gage wires woven into a 2-inch diamond mesh, with dimensions of fabric and wire conforming to ASTM A116, ASTM A702 and ASTM F 626, with 1.29 ounces per square foot zinc galvanizing.

Provide one-piece fabric widths for fence heights up to 12 feet.

2.4 TOP AND BOTTOM SELVAGES

Provide knuckled selvages at top and bottom for fabric with 2 inch mesh and up to 60 inches high, and if over 60 inches high, provide twisted and barbed top selvage and knuckled bottom selvage.

Knuckle top and bottom selvages for 1-3/4-inch and 1-inch mesh fabric.

2.5 POSTS, TOP RAILS, BOTTOM RAILS, AND BRACES

FS RR-F-191/3 line posts; Class 1, steel pipe, Grade A. End, corner, and pull posts; Class 1, steel pipe, Grade A. Braces and rails; Class 1, steel pipe, Grade A. Steel pipe, Class 1, Grade B meeting the following performance criteria when subjected to salt spray testing in accordance with ASTM B117:

a. Exterior 1,000 hours with maximum 5 percent red rust.

b. Interior 650 hours with maximum 5 percent red rust.

2.6 LINE POSTS

Minimum acceptable line posts are as follows:

Up to 6-feet high:

Grade A: 1.900 inch O.D. pipe weighing 2.72 pounds per linear foot.

2.7 END, CORNER, AND PULL POSTS

Provide minimally acceptable end, corner, and pull posts as follows:

Up to 6 feet high:

Grade A: 2.375 inch O.D. pipe weighing 3.65 pounds per linear foot.

2.8 SLEEVES

Provide sleeves if needed for setting into concrete construction of the same material as post sections, sized 1-inch greater than the diameter or dimension of the post. Weld flat plates to each sleeve base to provide anchorage and prevent intrusion of concrete.

2.9 TOP RAIL

Provide a minimum of 1.660 inches O.D. pipe rails. Grade A weighing 2.27 pounds per linear foot. Provide expansion couplings 6-inches long at each joint in top rails.

2.10 CENTER RAILS BETWEEN LINE POSTS

For fencing over 6-feet high, provide 1.660 inches O.D. pipe center rails, Grade A weighing 2.27 pounds per linear foot.

2.11 POST-BRACE ASSEMBLY

Provide bracing consisting of 1.660 inches O.D. pipe Grade A weighing 2.27 pounds per linear foot and 3/8 inch adjustable truss rods and turnbuckles.

2.12 TENSION WIRE

Provide galvanized wire, No. 7-gage, coiled spring wire, provided at the bottom of the fabric only. Provide zinc coating that weighs not less than 1.6 ounces per square foot.

2.13 STRETCHER BARS

Provide bars that have one-piece lengths equal to the full height of the fabric with a minimum cross section of 3/16 by 3/4 inch, in accordance with ASTM A116, ASTM A702 and ASTM F 626.

2.14 POST TOPS

Provide tops that are steel, wrought iron, or malleable iron designed as a weathertight closure cap. Provide one cap for each post, unless equal protection is provided by a combination post-cap and barbed-wire supporting arm. Provide caps with an opening to permit through passage of the top rail.

2.15 STRETCHER BAR BANDS

Provide bar bands for securing stretcher bars to posts that are steel, wrought iron, or malleable iron spaced not over 15 inches on center. Bands may also be used in conjunction with special fittings for securing rails to posts. Provide bands with projecting edges chamfered or eased.

2.16 BARBED WIRE AND SUPPORT ARM

Barbed wire shall be 12 gauge steel wire, galvanized. Support arms shall be galvanized steel three-strand.

2.17 MISCELLANEOUS HARDWARE

Provide miscellaneous hot-dip galvanized hardware as required.

2.18 WIRE TIES

Provide 16-gage galvanized steel wire for tying fabric to line posts,spaced 12 inches on center. For tying fabric to rails and braces, space wire ties 24 inches on center. For tying fabric to tension wire, space 0.105-inch hog rings 24 inches on center.

Manufacturer's standard procedure will be accepted if of equal strength and durability.

FS RR-F-191/4. Provide wire ties constructed of the same material as the fencing fabric.

2.19 CONCRETE

Provide concrete conforming to ASTM C 94/C 94M, and obtaining a minimum 28-day compressive strength of 3,000 psi.

2.20 GROUT

Provide grout of proportions one part portland cement to three parts clean, well-graded sand and a minimum amount of water to produce a workable mix.

2.21 PADLOCKS

Provide padlocks conforming to ASTM F 883, with chain.

PART 3 EXECUTION

Provide complete installation conforming to ASTM F 567.

3.1 GENERAL

Ensure final grading and established elevations are complete prior to commencing fence installation.

3.2 EXCAVATION

Provide excavations for post footings which are drilled holes in virgin or compacted soil, of minimum sizes as indicated.

Space footings for line posts 10 feet on center maximum and at closer intervals when indicated, with bottoms of the holes approximately 3-inches

below the bottoms of the posts. Set bottom of each post not less than 36-inches below finished grade when in firm, undisturbed soil. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads.

Remove excavated soil from Government property.

When solid rock is encountered near the surface, drill into the rock at least 12 inches for line posts and at least 18 inches for end, pull, and corner posts. Drill holes at least 1 inch greater in diameter than the largest dimension of the placed post.

If solid rock is below the soil overburden, drill to the full depth required except that penetration into rock need not exceed the minimum depths specified above.

## 3.3 SETTING POSTS

Remove loose and foreign materials from holes and the soil moistened prior to placing concrete.

Provide tops of footings that are trowel finished and sloped or domed to shed water away from posts. Set hold-open devices, sleeves, and other accessories in concrete.

Keep exposed concrete moist for at least 7 calendar days after placement or cured with a membrane curing material, as approved.

Maintain vertical alignment of posts set in concrete construction until concrete has set.

### 3.3.1 Earth and Bedrock

Provide concrete bases of dimensions indicated. Compact concrete to eliminate voids, and finish to a dome shape.

### 3.3.2 Concrete Slabs and Walls

Set posts into zinc-coated sleeves, set in concrete slab or wall, to a minimum depth of 12 inches. Fill sleeve joint with lead, nonshrink grout, or other approved material. Set posts for support of removable fence sections into sleeves that provide a tight sliding joint and hold posts aligned and plumb without use of lead or setting material.

### 3.3.3 Bracing

Brace corner, end, and pull posts to nearest post with a horizontal brace used as a compression member, placed at least 12 inches below top of fence, and a diagonal tension rod.

## 3.4 CONCRETE STRENGTH

Provide concrete that has attained at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than 7 calendar days after placement, before rails, tension wire, or fabric are installed. Do not stretch fabric and wires until the concrete has attained its full design strength.

Take samples and test concrete to determine strength as specified.

3.5 TOP RAILS

Provide top rails that run continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by the fencing manufacturer.

3.6 CENTER RAILS

Provide single piece center rails between posts set flush with posts on the fabric side, using special offset fittings where necessary.

3.7 BRACE ASSEMBLY

Provide bracing assemblies at end posts and at both sides of corner and pull posts, with the horizontal brace located at midheight of the fabric.

Install brace assemblies so posts are plumb when the diagonal rod is under proper tension.

Provide two complete brace assemblies at corner and pull posts where required for stiffness and as indicated.

3.8 TENSION WIRE INSTALLATION

Install tension wire by weaving them through the fabric and tying them to each post with not less than 7-gage galvanized wire or by securing the wire to the fabric with 10-gage ties or clips spaced 24 inches on center.

3.9 FABRIC INSTALLATION

Provide fabric in single lengths between stretch bars with bottom barbs placed approximately 1-1/2-inches above the ground line. Pull fabric taut and tied to posts, rails, and tension wire with wire ties and bands.

Install fabric on the security side of fence, unless otherwise directed.

Ensure fabric remains under tension after the pulling force is released.

3.10 STRETCHER BAR INSTALLATION

Thread stretcher bars through or clamped to fabric 4 inches on center and secured to posts with metal bands spaced 15 inches on center.

3.11 TIE WIRES

Provide tie wires that are U-shaped to the pipe diameters to which attached. Twist ends of tie wires not less than two full turns and bent so as not to present a hazard.

3.12 FASTENERS

Install nuts for tension bands and hardware on the side of the fence opposite the fabric side. Peen ends of bolts to prevent removal of nuts.

3.13 ZINC-COATING REPAIR

Clean and repair galvanized surfaces damaged by welding or abrasion, and cut ends of fabric, or other cut sections with specified galvanizing repair material applied in strict conformance with the manufacturer's printed

instructions.

3.14 TOLERANCES

Provide posts that are straight and plumb within a vertical tolerance of 1/4 inch after the fabric has been stretched. Provide fencing that is true to line with no more than 1/2 inch deviation from the established centerline between line posts. Repair defects as directed.

3.15 SITE PREPARATION

3.15.1 Clearing and Grading

Clear fence line of trees, brush, and other obstacles to install fencing. Establish a graded, compacted fence line prior to fencing installation.

3.16 FENCE INSTALLATION

Install fence on prepared surfaces to line and grade indicated. Install fence in accordance with fence manufacturer's written installation instructions except as modified herein.

3.16.1 Post Spacing

Provide line posts spaced equidistantly apart, not exceeding 10 feeton center. Do not exceed 500 feet on straight runs between braced posts. Provide corner or pull posts, with bracing in both directions, for changes in direction of 15 degrees or more, or for abrupt changes in grade. Provide drawings showing location of corner, end, and pull posts.

3.16.2 Top and Bottom Tension Wire

Install bottom tension wires before installing chain-link fabric, and pull wires taut. Place bottom tension wires within 8 inches of respective fabric line.

3.17 ACCESSORIES INSTALLATION

3.17.1 Post Caps

Install post caps as recommended by the manufacturer.

3.18 GROUNDING

Ground fencing as specified.

Ground fences at each corner, at the closest approach to each building located within 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations can not exceed 650 feet. Ground fences crossed by powerlines of 600 volts or more at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing. Provide ground conductor consisting of No. 8 AWG solid copper wire. Provide copper-clad steel rod grounding electrodes 3/4 inch by 10 foot long. Drive electrodes into the earth so that the top of the electrode is at least 6 inches below the grade. Where driving is impracticable, bury electrodes a minimum of 12 inches deep and radially from the fence, with top of the electrode not less than 2 feet or more than 8 feet from the fence. Clamp ground conductor to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence

fabric, and ground rods. Total resistance of the fence to ground cannot exceed 25 ohms.

3.19 CLEANUP

Remove waste fencing materials and other debris from the work site.

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# SECTION 32 92 23

# 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

Not used.

### 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, sodded 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 01 99

# SLIP LINING (CIPP) OF EXISTING PIPING

## 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 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 638 | (2010) Standard Test Method for Tensile Properties of Plastics |
| ASTM D 790 | (2010) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| ASTM F 1216 | (2009) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube |
| ASTM F 1743 | (2008) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP) |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 9000 | (2005) Quality Management Systems - Fundamentals and Vocabulary |

### 1.2 SYSTEM DESCRIPTION

This section consists of the requirements and work needed to rehabilitate existing pipes by furnishing and installing pipe liners by the method of cured in place pipe (CIPP) slip lining. Use pipe liners of the sizes, types, design, and dimensions shown on the plans, and include all connections, joints, and other appurtenances as required to complete the work.

Specified in this section are requirements of CIPP slip lining of existing pipelines, including but is not limited to the following:

Cleaning

Flow diversion and temporary works

CCTV Inspection

Traffic management

Pipe lining fabrication, storage and placement

Service connections, connecting to access chambers and make water tight

Grouting

Testing

Reinstatement

1.2.1 Design Requirements

1.2.1.1 Gravity Sewer

Provide cured in place pipes designed to allow the maximum conveyance capacity possible.

The CIPP shall be designed as per ASTM F 1216, Appendix X.1. The CIPP design shall assume no bonding to the original pipe wall.

The Contractor must have performed long-term testing for flexural creep of the CIPP pipe material installed. Such testing results are to be used to determine the long-term, time dependent flexural modulus to be utilized in the product design. This is a performance test of the materials (Tube and Resin) and general workmanship of the installation and curing. A percentage of the instantaneous flexural modulus value (as measured by ASTM D 790 testing) will be used in design calculations for external buckling. The percentage, or the long-term creep retention value utilized, will be verified by this testing. Retention values exceeding 50% of the short-term test results shall not be applied unless substantiated by qualified third party test data to the Government's satisfaction. The materials utilized for the contracted project shall be of a quality equal to or better than the materials used in the long-term test with respect to the initial flexural modulus used in the CIPP design.

The Enhancement Factor 'K' to be used in 'Partially Deteriorated' Design conditions shall be assigned a value of 7. Application of Enhancement (K) Factors in excess of 7 shall be substantiated through independent test data to the satisfaction of the Government.

The layers of the CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers. If the layers separate during field sample testing, new samples will be required to be obtained from the installed pipe. Any reoccurrence may cause rejection of the work.

The CIPP material for pipes up to 24-inch diameter shall conform to the structural properties, as listed below. For pipe diameters over 24 inches, use liner and resin calculation for I Plus composite as developed In Situ Form Technologies, Inc. or approved equal.

MINIMUM CIPP PHYSICAL PROPERTIES

| Property | Test Method | Cured Polyester Composite | |
|---|---|---|---|
| | | Min per ASTM F 1216 | Enhanced Resin |
| Modulus of Elasticity | ASTM D 790 | 250,000 psi | 400,000 psi |
| Flexural Stress | ASTM D 790 | 4,500 psi | 4,500 psi |

The required structural CIPP wall thickness shall be based 6 mm.

1.2.1.2 Pressurized Water

The CIPP shall be designed as in accordance with ASTM F 1216, Appendix X1.3.2 for the Fully Deteriorated Pressure Pipe condition and shall be provided as a prequalification submittal. These detailed calculations shall provide the input data as well as the actual calculation for Eqs X1.1, X1.3, X1.4, and X1.7 of Appendix X1 of ASTM F 1216. The design submittal shall also clearly identify the physical properties used for design.

Other than what is allowed in ASTM F 1216, the CIPP design shall assume no contribution from the original host pipe.

The design of the CIPP shall be based on the following parameters:

| | |
|---|---|
| Diameter | 12 inch |
| Internal Design Pressure | 150 psi |
| Soil Depth (above invert) | 3 feet |
| Ground Water Depth (above invert) | 3 feet |
| Type of Live Load | AASHTO H20 Loading |
| Modulus of Soil Reaction | 100 pci |
| Soil Density | 90 percent Modified Proctor Maximum Dry Density ASTM D 1557 |

The physical properties used in the design submittal shall be clearly identified. At a minimum, the CIPP shall have the following physical properties:

| PROPERTY | TEST METHOD | MINIMUM VALUE* |
|---|---|---|
| Initial Flexural Modulus of Elasticity | ASTM D 790 | 300,000 psi |
| Initial Flexural Strength | ASTM D 790 | 7,000 psi |
| Initial Tensile Strength | ASTM D 638** | 6,500 psi |

*Values are for design conditions at 75 degrees F.

**For materials that do not allow sufficiently accurate hoop/weft testing per ASTM D 638, initial tensile strength may also be substantiated by short-term burst testing results.

1.2.2 Performance Requirements

Notify the Contracting Officer 24 hours in advance of tests, and perform

tests at the work site if practicable. Conform to local, state, and federal requirements.

## 1.3 SUBMITTALS

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

SD-01 Preconstruction Submittals

List of proposed subcontractors; G
List of proposed products; G
Construction Progress Schedule; G
Manufacturer's Certification of Florida Product Approval

SD-02 Shop Drawings

Survey of Pipe Locations

Submit manufacturer's detailed product data with complete information on pipeline materials, physical properties, and dimensions. Include a manufacturer's certificate of compliance with specifications for proposed materials.

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Cured in Place Pipes

SD-06 Test Reports

After liner installation, perform a hydrostatic test in accordance with ASTM F 1216 before the liner has been completely sealed into place. Check integrity of joints and verify that liner has not been damaged during installation. Repair if needed using liner manufacturer's recommended procedure and retest for leaks.

SD-08 Manufacturer's Instructions

Manufacturer's recommendations for shipping, handling, erection procedures, and care and maintenance upon completion of installation.

SD-09 Manufacturer's Field Reports

Manufacturer's Certification of Installation

## 1.4 QUALITY ASSURANCE

### 1.4.1 Survey of Pipe Locations

Submit a certified survey meeting the requirements specified herein.

### 1.4.2 Qualifications

#### 1.4.2.1 Gravity Sewer

Products and installers must meet all of the following criteria to be deemed Commercially Acceptable:

For a Product to be considered Commercially Proven, a minimum of 1,000,000 linear feet or 4,000 manhole-to-manhole line sections of successful wastewater collection system installations in the U.S. must be documented to the satisfaction of the Government to assure commercial viability

For an Installer to be considered as Commercially Proven, the Installer must satisfy all insurance, financial, and bonding requirements of the Government, and must have had at least 5 (five) years active experience in the commercial installation. In addition, the Installer must have successfully installed at least 50,000 feet of the product bid in wastewater collection systems. Acceptable documentation of these minimum installations must be submitted to the Government.

Sewer rehabilitation products submitted for approval must provide third party test results supporting the structural performance (short-term and long-term) of the product and such data shall be satisfactory to the Government. Test samples shall be prepared to simulate installation methods and trauma of the product. No product will be approved without independent third party testing verification.

Both the rehabilitation manufacturing and installation processes shall operate under a quality management system which is third-party certified to ISO 9000 or other recognized organization standards. Proof of certification shall be required for approval.

1.4.2.2 Pressurized Water

For a Product to be considered Commercially Proven, a minimum of 25,000 linear feet of successful water distribution system installations in the United States must be documented to the satisfaction of the Government to assure commercial viability.

For an Installer to be considered Commercially Proven, the Installer must satisfy all insurance, financial, and bonding requirements of the Government and must have had at least 5 (five) years active experience in the commercial installation. In addition, the Installer must have successfully installed at least 25,000 linear feet of the product bid in the water distribution systems. Acceptable documentation supporting the above must be submitted to the Government.

Water rehabilitation products submitted for approval must provide third party test results supporting the structural performance (short-term and long-term) of the product and such data shall be satisfactory to the Government. Test samples shall be prepared to simulate installation methods and trauma of the product. No product will be approved without independent third party testing verification.

Both the rehabilitation manufacturer and installation processes shall operate under a quality management system which is third-party certified to ISO 9000 or other recognized organization standards. Proof of certification shall be required for approval.

All required submittals must be satisfactory to the Government.

1.4.3 Pre-Installation Conference

At the Pre-installation conference provide, for approval, submit the following:

a. List of proposed products showing existing pipe diameters, with samples of the liner and resins

b. List of measured pipe diameters of each sewer segment to be lined with CIPP

c. Dates of liner placement,

d. Proposed Construction Progress Schedule

e. List of proposed subcontractors

f. Manufacturer's Certification of Florida Product Approval

1.5 DELIVERY, STORAGE, AND HANDLING

Prevent injury or abrasion to CIPP during loading, transportation, and unloading.

1.6 SEQUENCING AND SCHEDULING

Submit plan for final approval of construction sequence and schedule prior to commencing construction.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Gravity Sewer Tube

The sewn tube shall consist of one or more layers of absorbent non-woven felt fabric and meet the requirements of ASTM F 1216, Section 5.1 or ASTM F 1743, Section 5.2.1 The tube shall be constructed to withstand installation pressures, have sufficient strength to bridge missing pipe, and stretch to fit irregular pipe sections.

The wet out tube shall have a relatively uniform thickness so that when compressed at installation, pressures will equal or exceed the calculated minimum design thickness.

The tube shall be manufactured to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion. Overlapped layers of felt in longitudinal seams that cause lumps in the final product shall not be utilized.

The outside layer of the tube shall be coated with an impermeable, flexible membrane that will contain the resin and all the resin impregnation (wet out) procedure to be monitored.

The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.

The wall color of the interior pipe surface of CIPP after installation shall be a relatively light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.

Seams in the tube shall be stronger than the non-seamed felt material.

The tube shall be marked for distance at regular intervals along its entire length, not to exceed 5 feet. Such markings shall include the Manufacturers name or identifying symbol. The tubes must be manufactured in the United States. Liner materials shall be as manufactured by In situ Form Technologies, Inc. or approved equal.

2.1.2 Gravity Sewer Resin

The resin system shall be a corrosion resistant polyester, vinyl ester, or epoxy system including all required catalysts, initiators or hardeners that when cured within the tube create a composite that satisfies the requirements of ASTM F 1216 and ASTM F 1743, the physical properties herein, and those which are to be utilized in the design of the CIPP for this project. The resin shall produce a CIPP that will comply with the structural and chemical resistance requirements of this specification.

2.1.3 Pressurized Water Tube

The CIPP product shall consist of one or more layers of absorbent woven and/or non-woven synthetic fiber, with or without glass fiber reinforcement, which is impregnated with an epoxy resin system that is compatible with the installation process being used. The product shall meet the requirements of ASTM F 1216.

The tube shall be fabricated to dimensions such that when installed will fit tightly to the internal circumference of the host pipe being lined, making allowance for stretching during installation.

In the installed state, the inside layer of the tube shall be coated with a translucent, flexible plastic materials that acts to separate the curing heat medium from the thermoset resin system undergoing cure.

The tube shall have a uniform thickness that when compressed at installation pressures will meet or exceed the minimum required thickness specified in the design submittals.

Fabricate tube from materials which, when cured, will be chemically resistant to internal exposure to drinking water treated with common chemical additives.

The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. The tube shall contain reinforcement (glass, woven fiber, or equal) in order to withstand the internal pressure design requirements.

The wall color of the interior pipe surface of the CIPP after installation shall be a light reflective color so that a clear detail examination may be made of the final product.

Materials that are defective, damaged or otherwise deemed unacceptable for use prior to installation shall be rejected and replaced at the Contractor's expense. Liner materials damaged during installation shall be

repaired or replaced as recommended by the Contractor and approved by the Government.

PART 3 EXECUTION

3.1 PREPARATION

Complete the following preparations, unless approved otherwise by the Contracting Officer. The Contracting Officer makes no guarantee regarding the information, data, and physical condition of underground facilities or existing pipe lines. Before commencing with any work, or ordering any materials, physically measure and perform CCTV inspection of the existing pipe line to verify that the rehabilitation specified herein is appropriate.

3.1.1 Safety

Carry out all operations in strict accordance with all applicable OSHA Standards. Particular attention is directed to those safety requirements involving entry into a confined space. It is the Contractor's responsibility to familiarize themselves with OSHA Standards and Regulations pertaining to all aspects of the work.

It shall be the responsibility of the Government to locate and designate all manhole access points open and accessible for the work, and provide rights-of-access to these locations. If a street must be closed to traffic because of the orientation of the sewer, the Government shall institute the actions necessary to provide access during this for the mutually agreed time period. The Government shall also provide free access to water hydrants for cleaning, installation and other process related work items requiring water.

3.1.1.1 Cleaning of Sewer Lines

The Contractor shall perform internal pipe cleaning no more than 48 hours before lining and remove all internal debris out of the sewer line that will interfere with the installation of CIPP. The Government shall also provide a dumpsite for all debris removed from the sewers during the cleaning operation. Unless stated otherwise, it is assumed this site will be at or near the sewage treatment facility to which the debris would have arrived in absence of the cleaning operation. Any hazardous waste material encountered during this project will be considered as a changed condition.

3.1.1.2 Bypassing Sewage

The Contractor shall provide for the flow of sewage around the section or sections of pipe designated for repair. All service laterals in the line or line sections being lined shall be addressed as part of the bypass plan. The pump(s) and bypass line(s) shall be of adequate capacity to accommodate the sewage flow. The Government shall require a detailed bypass plan to be submitted.

3.1.1.3 Inspection of Pipelines

Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections using close circuit television (CCTV) inspection techniques. The pipeline interior shall be carefully inspected to determine the location of any conditions that may prevent proper installation of CIPP. These shall be noted and corrected. A DVD or videotape and suitable written log for each line section shall be

submitted for later reference by the Government.

3.1.1.4 Line Obstructions

It shall be the responsibility of the Contractor to clear the line of obstructions such as solids and roots that will prevent the insertion of CIPP. If pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, or a collapse that will prevent the installation process, that was not evident on the pre-bid video and it cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Government's representative prior to the commencement of the work and shall be considered as a separate pay item.

3.1.1.5 Public Notification

The Contractor shall make every effort to maintain sewer service usage throughout the duration of the project. In the event that a connection will be out of service, the longest period of no service shall be 8 hours. A public notification program shall be implemented, and shall as a minimum, require the Contractor to be responsible for contacting each affected facility connected to the sanitary sewer and informing them of the work to be conducted, and when the sewer will be off-line. The Contractor shall also provide the following:

Written notice to be delivered to each affected facility the day prior to the beginning of work being conducted on the section, and a local telephone number of the Contractor they can call to discuss the project or any potential problems.

Personal contact with any home or business, which cannot be reconnected within the time stated in the written notice.

The Contractor shall be responsible for confirming the locations of all branch service connections prior to installing the CIPP.

3.2 INSTALLATION

3.2.1 Gravity Sewer

CIPP installation shall be in accordance with ASTM F 1216, Section 7, or ASTM F 1743, Section 6, with the following modifications:

Resin Impregnation - The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin during installation through cracks and irregularities in the original pipe wall.If a vacuum impregnation process is used, the point of vacuum shall be no further than 25-feet from the point of initial resin introduction. After vacuum in the tube is established, a vacuum point shall be no further than 75-feet from the leading edge of the resin. The leading edge of the resin slug shall be as near to perpendicular to the longitudinal axis of the tube as possible. A roller system shall be used to uniformly distribute the resin throughout the tube. If the Installer uses an alternate method of resin impregnation, the method must produce the equivalent results. Any alternate resin impregnation method must be documented to the Government's satisfaction that the saturation of the CIPP is

sufficient.

Tube Insertion - The wet out tube shall be positioned in the pipeline using either inversion or a pull-in method. If pulled into place, a power winch should be utilized and care should be exercised not to damage the tube as a result of pull-in friction. The tube should be pulled-in or inverted through an existing manhole or approved access point and fully extend to the next designated manhole or termination point.

Temperature gauges shall be placed between the tube and the host pipe's invert position to monitor the temperatures during the cure cycle.

Curing shall be accomplished by utilizing hot water under hydrostatic pressure or steam pressure in accordance with the manufacturer's recommended cure schedule.

3.2.2 Pressurized Water

3.2.2.1 Project Planning

The Government shall ensure access to the existing water mains. The Contractor shall provide adequate notice to the Government prior to mobilization. The Government will notify customers and local fire department following receipt of the Contractor's notice.

The Government will operate all water main valves, curb stops, and fire hydrants. The Contractor will provide to the Government a specific time and date when the individual water services will be transferred from the water main to the temporary bypass piping system.

Water necessary for cleaning, disinfection, and flushing will be available, at no cost, from locations (fire hydrants) indicated by the Government prior to the start of Work. Water source provided shall be close to lines being worked on. The Contractor shall provide necessary piping or flexible hoses, fittings, and approved reduced pressure zone backflow prevention device for connection between fire hydrant and end of pipe section where water is required. The Government shall provide a location at no cost to the Contractor (e.g., sanitary sewer, etc.) for proper disposal of water after use.

3.2.2.2 Access, Cleaning, and Inspection

Prior to entering any permit required confined space, the Contractor shall evaluate the atmosphere to determine the presence of toxic or flammable vapors or lack of oxygen. This shall be undertaken in accordance with local, state, or federal safety regulations.

The Contractor shall identify the number and location of access points required. The Government shall provide rights of access to the pipeline. The Contractor or Government, as specified in the contract documents, shall provide the excavation, pipe work, reconnection, and restoration for access points.

Immediately upon opening the host main at the access points and prior to installation of liner, the ends of the adjacent existing water main that are not to be lined at the insertion/extraction points shall be covered/plugged by the Contractor so that no debris shall enter into them during reconstruction work.

The Contractor shall remove all internal debris out of the pipeline that will interfere with the installation. Pipes shall be cleaned by the Contractor, as needed, with high-velocity jet cleaners, mechanically powered equipment, cable-attached devices or fluid-propelled devices (e.g., pipe pigs). If required the Government shall provide a dump site for all debris removed from the pipe during the cleaning operation. Unless specified otherwise, this site shall be at or near the project site. Any hazardous waste material encountered during this project shall be considered as a changed condition.

Verification of readiness to install liner shall be performed by experienced personnel trained in locating services, breaks, obstacles, etc., This may include pipe mandrels or other devices up to and including closed-circuit television or man entry. The interior of the pipeline shall be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube. A videotape or suitable log shall be kept for reference. It will be the Government's responsibility to remove any unforeseen obstructions that may prevent liner installation. The Government may direct the Contractor to remove these obstructions and reimburse under the terms of the contract.

Any external water leaking back into the existing pipeline shall be kept to a minimum so as not to interfere with the proper installation and cure of the CIPP liner.

The Contractor shall field verify the length of water main sections to be cleaned and lined.

The Contractor shall isolate or remove any air release valves from water main section prior to liner installation.

The Contractor shall flush the host pipe with clean water to remove any loose debris from the pipe surface. Wherever practical, remove all standing water from the inside surfaces of the cleaned water main by passing a sufficient number of oversized foam swabs through the main or use a progressive expansion method to remove standing water.

The Contractor shall remove and dispose of any waste or debris generated by the cleaning operation to a site furnished by the Government.

3.2.2.3 Television Inspection

When required the Contractor shall perform closed-circuit television inspection of existing water mains at two intervals: prior to water main lining and upon completion of the lining process. The Contractor shall provide the Government with a complete set of all DVDs. The picture quality and definition shall be acceptable for viewing, and the DVDs shall be compatible with standard DVD equipment. Information on the DVD shall identify the water main section, direction of taping, and the date of inspection. Where applicable, the DVDs shall include a voice description of the location of any identified defects.

3.2.2.4 Resin Impregnation

The tube shall be impregnated (wet out) with resin under controlled conditions. The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and loss of resin through cracks

and irregularities in the original pipe wall.

The Contractor shall allow the Government to inspect the materials and procedures used to impregnate the tube.

3.2.2.5 Installation

The wet out tube shall be inserted through an approved access point by a pull-in place method or a direct inversion process, or a combination of the two. The head used to extend the liner tube though the length of pipe being rehabilitated shall be sufficient to fully extend the tube both circumferentially and longitudinally.

Before the installation begins, the Contractor shall determine the minimum pressure required to hold the tube tight against the existing pipeline and the maximum allowable pressure so as not to damage the tube. To ensure a proper fit of the CIPP tube to the host pipe, the pressure shall be maintained between the minimum and maximum pressures until the installation has been completed.

The use of a lubricant during the installation process may be needed to reduce friction. The lubricant used shall be a nontoxic, FDA or NSF certified product.

3.2.2.6 Curing

After installation is completed, a suitable heat source and related equipment shall be used to circulate heated water or injected steam throughout the pipeline. The equipment shall be capable of delivering hot water or steam throughout the pipeline to uniformly raise the temperature above the temperature required to affect a cure of the resin. Water or steam temperature in the line during the cure period shall be as determined by the Contractor.

The heat source shall be fitted with suitable monitors to gauge the temperature of the hot water or steam supply. To determine the temperatures during the cure cycle, a gauge shall be placed at the beginning and termination points of the section being lined. The temperature sensing device shall be placed between the impregnated tube and the invert of the existing pipe.

Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature shall be held at the post-cure temperature for a period as determined by the Contractor. The curing process shall take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

3.2.2.7 Cool-Down

Cool-down shall be accomplished by introducing cool water to replace water being drained from the system or by introducing air to replace the steam used in a steam cure. Care shall be taken in the release of the internal head so that a vacuum that could damage the newly installed CIPP will not be developed.

3.3 REINSTATEMENT OF BRANCH CONNECTIONS

3.3.1 Gravity Sewer

It is the intent of these specifications that branch connections to buildings be re-opened without excavation, utilizing a remotely controlled cutting device, monitored by a CCTV. Restore 95 percent of the opening, retrieve coupons, and smooth opening. The Contractor shall certify a minimum of two complete functional cutters plus key spare components are on the job site before each installation or are in the immediate area of the jobsite and can be quickly obtained. Unless otherwise directed by the Government or his authorized representative, all laterals will be reinstated. No additional payment will be made for excavations for the purpose of reopening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration work.

3.3.2 Pressurized Water

Prior to installation of the liner, the Contractor shall locate all existing service connection and plug or prepare the corporation valve connections as recommended by the manufacturer. All plugs shall be sized for the respective water taps. The service plugs used in this process shall be able to withstand the temperatures expected during the cure of up the CIPP.

After the lining is complete, reconnect existing services from the interior of the water main using a television camera directed robotic cutting device that removes a small, circular section of the liner to expose the corporation valve opening. A water-tight seal is provided by direct resin-to-host pipe adhesion.

Reconnections shall be free of burrs, frayed edges, and other restrictions preventing free water flow and shall be opened to the size of their original diameter and to a depth required to completely open the water service connection to the residence served.

3.4 INSPECTION

3.4.1 Gravity Sewer

CIPP samples shall be prepared and physical properties tested in accordance with ASTM F 1216 or ASTM F 1743, Section 8, using either method proposed. The flexural properties must meet or exceed the values listed in Table 1 of the applicable ASTM.

Wall thickness of samples shall be determined as described in paragraph 8.1.6 of ASTM F 1743. The minimum wall thickness at any point shall not be less than 87.5 percent of the minimum design wall thickness of 6 mm.

Visual inspection of the CIPP shall be in accordance with ASTM F 1743, Section 8.6.

Post-lining internal television inspection shall be performed within 24 hours of CIPP curing. All defects located shall be repaired as approved by the Government. A DVD or videotape of the internal inspection shall be submitted before line section identification.

3.4.2 Pressurized Water

After liner has been cooled down and before opening the service laterals, a preliminary television inspection of the newly installed liner may be performed to determine that the liner is properly installed.

The finished lining shall be continuous over the entire length and be free from visual defects such as foreign inclusions, dry spots, lifts, pinholes and delaminations. The lining shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to the inside of the lined pipe.

## 3.5 TESTING REQUIREMENTS

### 3.5.1 Chemical Resistance

The CIPP shall meet the chemical resistance requirements of ASTM F 1216, Appendix X2. CIPP samples for testing shall be of tube and resin system similar to that proposed for actual construction. It is required that CIPP samples with and without plastic coating meet these chemical-testing requirements.

### 3.5.2 Hydraulic Capacity

Overall, the hydraulic cross-section shall be maintained as large as possible. The CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation. Calculated capacities may be derived using a commonly accepted roughness coefficient for the existing pipe material taking into consideration its age and condition.

### 3.5.3 CIPP Field Samples

When requested by the Government the Contractor shall submit test results from field installations in the USA of the same resin system and tube materials as proposed for the actual installation. These test results must verify that the CIPP physical properties specified in Minimum CIPP Physical Properties table in the paragraph titled "Design Requirements" have been achieved in previous field applications. Samples for this project shall be made and tested as described in the article titled "INSPECTION."

### 3.5.4 Pressure Testing for Water-Tightness

Pressure testing for water tightness shall be provided on all CIPP sections identified by the Government in the contract documents or purchase order and shall be completed after inspection but before the reinstatement of service connections.

Perform hydrostatic pressure test on the lined water main, following the guidelines of ASTM F 1216, Section 8.3. The test section shall be subjected to a hydrostatic pressure of no more than 1-1/2 times the operating pressure of 150 psi.

As noted in ASTM F 1216, the allowable leakage during the pressure test shall be 20 U.S. gallons per inch of internal pipe diameter per mile of pipe per day (GIDMD), providing that all the air has been evacuated from the line prior to testing and the structural pipe lining system has cooled down to ambient temperature.

After the one hour test, the quantified make-up water shall be extrapolated to the 24-hour rate for comparison purposes. Any visible leakage at termination points shall be eliminated. If not feasible or possible at the

time of the test, the termination point leakage shall be kept to a minimum, collected and then deducted from the actual make up water rate. If the loss at test pressure exceeds the allowable, the Contractor shall endeavor to identify the source of the loss and minimize it in a manner acceptable to the Government. Trapped air can significantly affect internal pressure and may require extensive continued testing until stabilization occurs. The pressure test for water tightness shall be deemed acceptable if that actually measured during the one-hour test (which has been extrapolated to a 24-hour day rate) is equal to or less than the allowable make up water rate of 20 GIDMD.

## 3.6 CLEAN-UP

The work area shall be maintained and kept clean throughout the work. Upon acceptance of the installation work and testing, the Contractor shall restore the project area affected by the operations to a condition at least equal to that existing prior to the work.

After project completion, the Contractor shall return the piping system to service by closure of all access pits with appropriate pipe spools, valves, and other relevant pipe fittings.

Upon acceptance of the installation, the Contractor shall coordinate with the Contracting Officer to reinstate the project area affected by the operations.

## 3.7 INSTALLATION CERTIFICATION

Submit a signed copy of the Manufacturer's Certification of Installation to the Contracting Officer upon completion of final inspection.

-- End of Section --

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SECTION 33 05 23.16

BORING AND JACKING

PART 1 GENERAL

1.1 DEFINITIONS

Carrier Pipe: Sewer or water pipe as shown on the drawings.

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; R 2001) 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 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 or anchors.
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, Kennedy Space Center, 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: For water service, specified in 33 11 00 WATER DISTRIBUTION. For sewer service, specified in 33 30 00 SANITARY SEWERS.

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.

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.

-- End of Section --

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SECTION 33 05 23.33

PIPE BURSTING

PART 1 GENERAL

1.1 DEFINITIONS

Burst Head: Conical shaped portion of Burst Tooling used to expand fractured pipe and surrounding soil to accommodate Product Pipe.

Burst Pit: Excavation where Static Pull Pipe Bursting Machine is located. The Product Pipe is pulled toward this pit.

Burst Tooling: Tooling designed to crack the Host Pipe, expand the remains of the Host Pipe and surrounding soil to allow passage of the Product Pipe.

Host Pipe: Existing pipe buried in the ground that will be rehabilitated by bursting (cracking) and pulling in a new replacement pipe (Product Pipe).

Insertion Pit: Excavation where Product Pipe enters the Host Pipe and bursting begins. Product Pipe is pulled through the Insertion Pit towards the Burst Pit.

Product Pipe: Newly installed pressure pipe made from high density polyethylene (HDPE).

Rod String: Assembled string of rods that extend from Burst Pit to Insertion Pit and serve to transmit tensile pullback forces to Burst Tooling.

Utility Crossing Pit: An excavation created at any point where another buried utility crosses the host pipe.

Rod Payout: Rod payout is the process of assembling a string of rods and pushing them in a stepwise manner from Burst Pit through the interior of the Host Pipe to Insertion Pit.

1.2 SCOPE OF WORK

Provide all labor, materials, equipment, supplies, and incidentals required to provide for the complete rehabilitation/replacement of deteriorated pipe by using a pipe bursting system at the locations shown on the drawings. Pipe bursting is a process by which the bursting unit splits and/or fractures the existing pipe while simultaneously installing a new HDPE pipe of the same or larger size into the annulus created by the forward movement of the bursting tool.

1.3 RELATED WORK

Other related or references sections contained herein are as listed below:

| | |
|---|---|
| Section 01 33 00 | SUBMITTAL PROCEDURES |
| Section 01 57 20.00 10 | ENVIRONMENTAL PROTECTION |
| Section 31 00 00 | EARTHWORK |
| Section 33 30 00 | SANITARY SEWERS |

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 NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI/ASSE A10.16 | (1995; R 2001) Safety Requirements for Tunnels, Shafts, and Caissons |
| ANSI/AWWA C111/A21.11 | (2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| ANSI/AWWA C153/A21.53 | (2006) Ductile-Iron Compact Fittings for Water Service |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 242/A 242M | (2004; R 2009) Standard Specification for High-Strength Low-Alloy Structural Steel |
| ASTM A 536 | (1984; R 2009) Standard Specification for Ductile Iron Castings |

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

Pipe Bursting Plan; G

SD-06 Test Reports

DVDs of television inspection; G

SD-07 Certificates

Qualifications of the Trenchless Installation Contractor; G

1.6 DRAWINGS

The drawings provided by the Contracting Officer shall be marked by the Contractor to show actual locations of valves, fittings, and other reconnects. These redline drawings shall be done the day of the actual placement.

1.7 QUALIFICATIONS

Certificates of training by the pipe bursting systems manufacturer stating that the operators have been fully trained in the use of the pipe bursting equipment by an authorized representative of the equipment manufacturer.

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 install the trenchless pipe for this project.

List of similar projects undertaken during the last 2 years including the name of a contact person and telephone number.

Certification as specified above.

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 operation 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 be licensed in the State of Florida as a Certified Underground Utility Contractor.

The Contractor shall hold the Contracting Officer and Engineering Firm harmless in any legal action as a result of patent infringements.

1.8 REGULATORY REQUIREMENTS

Work in strict accordance with all Federal, State, and local ordinances, codes, statutes, rules, regulations, and requirements. Work shall comply with applicable criteria of ANSI/ASSE A10.16.

1.9 PIPE BURSTING PLAN

Submit a Pipe Bursting Plan to the Contracting Officer on a marked up copy of the drawings showing the construction phasing and plans for the proposed methods of pipe bursting installation. Plan details shall include:

a. Detail drawings and written description of the entire construction procedure to install pipe, bypass sewage flow and reconnection of sewer service connections, and force main connections to manholes, wetwells, and existing pressurized sewer pipe.

b. Pit locations for pipe insertion and burst machine location.

c. Location of utility crossing pits.

d. Schedule of when various sections are to be rehabilitated.

e. Distances of each pull.

f. Isolating points used to seal the system during the pipe burst.

g. Bypass plan and details.

h. Contact information for an on-call restoration/clean-up company able to respond to a sewage backup within 12 hours.

1.10 DELIVERY, STORAGE, AND HANDLING

Unload and handle materials with equipment of adequate capacity.

Store materials onsite 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.

Transport, handle, and store pipe, fittings, and other products as recommended by the manufacturer.

1.11 PROJECT CONDITIONS

In the event that during the execution of the work any existing utility is broken causing the disruption of service or an eminent hazard, it shall be the responsibility of the Contractor to immediately notify the Contracting Officer at the designated emergency telephone number and immediately undertake measures to repair the damaged utility at the Contractor's cost. Before starting work, ascertain that the necessary repair parts, tools, equipment, and labor are ready and available onsite to complete the repair work without delays. The Contracting Officer shall witness the repair work.

Settlement or heaving of the ground surface during of after construction is not allowed. The Contractor is solely responsible for the repair to all areas damaged by such occurrences including but not limited to manmade structures such as buildings, roads, utilities, and landscaping damaged during the execution of the work.

Video inspections of all buildings under which pipe bursting is executed shall be performed by the Contractor before and after bursting installation. Building video inspections shall include the following:

a. Preconstruction DVDs of the interior and exterior of the building documenting the existing conditions before pipe bursting activities shall be submitted to the Contracting Officer for approval before pipe bursting under the building begins.

b. Postconstruction DVDs of the interior and exterior of the building documenting the condition after the pipe bursting activities shall be submitted to the Contracting Officer for approval before final invoice.

c. DVDs to remain property of the Contracting Officer; Contractor to retain second copy.

d. Should any portion of the inspection DVDs be of inadequate quality or coverage as determined by the Contracting Officer, the Contractor will have the portion reinspected and provide DVDs at no additional expense to the Government.

The Contractor is solely responsible for quality assurance during the length of the project. The Contractor shall be responsible for any costs associated with corrective measures required to replace or repair items not meeting the quality standards specified by the Contracting Officer.

1.12 ADDITIONAL CRITERIA FOR WORK ADJACENT TO RAILROADS

Do not schedule work within 15 feet of a railroad until the Contracting

Officer and the Government approve submittals. Approval does not relieve the Contractor of responsibility for adequacy and safety of procedures.

Place safety, precautionary, and protective devices and services required by OSHA and other local regulations before work begins.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Product Pipe

Provide high-density polyethylene (HDPE) pipe as specified in 33 30 00 SANITARY SEWERS.

2.1.2 Fittings

Provide HDPE fittings as specified in Section 33 30 00 SANITARY SEWERS.

PART 3 EXECUTION

3.1 GENERAL

The pipe bursting operation described within provides guidance on the basic process. It is to be understood that the need to make exceptions or additions to this process are common. These changes are made to accommodate non-standard conditions. The Contractor experience requirements make it reasonable to put the responsibility of devising these exceptions upon the Contractor. If the Contractor deems it necessary to deviate from the execution outline in this specification, then the Contractor shall notify the Contracting Officer immediately and present the proposed execution method changes for approval by the Contracting Officer.

Notify the Contracting Officer immediately if obstructions stopping forward motion of operation are encountered during installation.

Locate equipment used to perform the work away from buildings to lessen the noise impact. Provide silencers or other devices to reduce machine noise as required to meet the contract requirements.

Install all pulleys, rollers, bumpers, alignment control devices, and other equipment required to protect existing manholes and to protect the pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Do not stress the product pipe under any circumstances beyond its yield stress.

3.1.1 Dewatering

Refer to Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

3.2 PREPARATION

Refer to Section 01 57 20.00 10 and Volume 3, Drawing EN2 for requirements when working in sites with potential contamination and environmental issues.

3.2.1 By-Pass Pumping

The Contractor must maintain flow of the existing sewer system at all times. The Contractor shall provide diversion for the pipe bursting/replacement

process. Provide pumps, wastewater storage, and by-pass lines of adequate capacity and size to handle all flows. All costs for by-pass pumping, wastewater storage, and wastewater disposal required during installation of the pipe shall be subsidiary to the pipe reconstruction item.

The Contractor is responsible for verifying LS capacities and for continuity of sanitary sewer service to each facility connected to the section of sewer during the execution of the work.

If sewage backup occurs and enters buildings, clean-up, repair, property damage cost, and claims are the responsibility of the Contractor.

3.3 INSTALLATION

The pipe bursting of force mains using HDPE product pipe will follow the method outlined below for each section of host pipe being rehabilitated. Perform these processes in series or in parallel with other sections of host pipe within the job; however each section will require these steps. The product pipe shall be free from defects before and after installation.

a. Excavate a Burst Pit at one end of the section down to pipe grade for placement of the pipe bursting equipment.

b. Excavate an Insertion Pit at the opposite end of the section down to grade for entry of the Product Pipe.

c. Excavate utility crossing pits.

d. Isolate the section to be rehabilitated from the rest of the system to maintain the pressure and flow of the system. Start bypass system.

e. Cut host pipe.

f. Excavate and remove valve tees from the Host Pipe.

g. Assemble Rod String as it is thrust through the Host Pipe from Burst Pit to Insertion Pit.

h. Attach Burst Tooling and Product Pipe to rod end at the insertion pit.

i. Pull back Rod String and disassemble simultaneously while tooling and Product Pipe travel from Insertion Pit to Burst Pit.

j. Perform hydrostatic test of the Product Pipe section in accordance with Section 33 30 00 SANITARY SEWERS.

k. Connect the replaced section of pipe into the system. Stop bypass system.

l. Visually inspect for leaks at new connections.

3.3.1 Pit Location and Excavation

Place Burst Pit and Insertion Pit locations such that excavations are minimized.

Burst length shall be 400 feet, plus/minus 50 feet, in length for first two bursts. After soil pipe friction is evaluated longer burst runs may be

performed.

Shore all pits to ensure worker safety in accordance with OSHA and other local regulations.

Rope off and cover all pits when not active in accordance with OSHA or local regulations to ensure public safety. Keep to a minimum the duration that pits are open.

Traffic control shall be accommodated for in accordance with the contract requirements. Ensure that safe traffic passage around pit excavations that are located in or adjacent to streets or highways is in accordance with Government requirements. Ensure that congestion and traffic delays are minimized due to parking of related employee vehicles, trucks, and auxiliary equipment.

Expose utilities crossing the Host Pipe using an excavation technique appropriate for the utility. The Utility Crossing Pit shall exist before starting bursting. Man-entry shoring is not required; however provide appropriate safety precautions.

Keep pits as dry as possible and excavate to at least 1 foot below the pipe invert to minimize the potential for contamination during connection of the new main, valves, and fittings.

3.3.2 Bursting Machine Location and Shoring

Shore Burst Pit in accordance with OSHA and other local regulations.

Maintain perpendicular burst machine alignment to the pipe during pullback.

Provide rearward shoring or anchoring to react to rod thrust forces during payout. While these forces are substantially lower than pullback forces, use shoring to stabilize the bursting machine to maintain perpendicular alignment of the machine during payout. The weight of the machine cannot be depended on to react to thrust forces. Only use the Host Pipe at the rear face of the pit for rearward shoring if it is scheduled for replacement.

Cut off pipe face for cast iron, ductile iron, or PVC using a saw or similar device to produce a square face for the bursting machine's forward face to bear against. Final separation of cast iron pipe with a wedge may provide a clean face. Remove host pipe in sufficient length to accommodate burst machine.

Position burst machine to have rod centerline at approximate centerline of Host Pipe.

Accommodate for rod box delivery and removal between temporary rod storage location and burst pipe with appropriate lifting equipment and techniques. Additionally, include movement and/or placement of lifting machine in traffic control plans.

3.3.3 Rod Payout Operation

Count rods during payout or quantity of rods per box so that the operator is aware of the distance between the burst machine and the lead end of the Rod String.

Thrust force shall be monitored by the operator. Should an unexpected sudden increase in thrust force be experienced, halt the process. The operator or Contractor shall:

a. Locate the front end of the Rod String by its distance from the Burst Pit. Paint and compare the location with the asbuilt drawings.

b. Take appropriate action to remedy the cause. This may include an additional pit at the obstruction to determine the cause and remove or accommodate for the obstruction.

Cut the Host Pipe in the Insertion Pit before the arrival of the Rod String. Remove sufficient length to allow the Burst Tooling to enter the Host Pipe and bend the product pipe within the allowable radius specified by the pipe manufacturer. Position or work the second end of the Host Pipe in the Insertion Pit so that the Product Pipe is not damaged as it travels through the Insertion Pit.

Do not enter the Insertion Pit when the Rod String is nearing the pit. A worker shall be in visual or radio contact with the burst machine operator so that the payout is halted in a position that allows attachment of the Burst Tooling.

3.3.4 Tooling and Attachment

Move the Product Pipe into position for attachment to the Rod String. Exercise appropriate traffic or pedestrian control along the path of the Product Pipe.

Paint the lead and second rod orange or yellow to give notice to the burst machine operator position of the Burst Tooling.

Attachment of the Burst Tooling to the rod shall be through the use of a removable pin joint allowing the tooling to pivot at least 46 degrees to the rod axis.

Choose Burst Tooling style based on anticipated properties of Host Pipe and Host Pipe repairs as recommended by burst tooling manufacturer.

Ensure that the Burst Head diameter is a minimum of 15 percent over size to the outside diameter of the Product Pipe.

Attach the Product Pipe to the Burst Tooling with a swivel that permits rotation to relieve torsional (twist) stress on the Product Pipe.

The Burst Head shall slide on the Rod String so that the rear of the Burst Head overlaps the forward end of the Product Pipe to eliminate the chance of damage to the Product Pipe. If soil flows into product pipe, then the product pipe shall be temporarily plugged, covered, or sealed during installation to prevent soil from filling the pipe.

3.3.5 Pullback Operation

Before starting pullback, there will be visual or radio contact between observers stationed adjacent to the Insertion Pit, the burst machine operator, and a Product Pipe observer stationed strategically along the length of the Product Pipe to watch for Product Pipe entanglement with aboveground obstructions.

The Insertion Pit observer will signal the burst machine operator to begin the pullback. Progress slowly until the observer sees the Burst Tooling has completely entered the Host Pipe.

Monitor pipe progress for the first 20 feet of pullback by the Insertion Pit observer and the Product Pipe observer.

As the Burst Tooling nears any Utility Crossing Pit, an observer in radio or visual contact with the burst machine operator will monitor and control movement of the Burst Tooling past the utility.

Existing bends less than or equal to 45 degrees may be burst through without installation of a replacement fitting if the resulting bend in the replacement pipe does not exceed the manufacturer's allowable bend radius. If the Contractor cannot maintain the allowable bend radius, then the fitting shall be removed and a new HDPE fitting of like size shall be installed.

3.3.6 Tooling Removal

Burst machine operator shall note rod count and anticipate entry of painted rods into the Burst Pit. As the pin joint connection nears the burst machine forward face, halt the burst. Relieve the load on the forward face by reversing the rod direction slightly.

Disassemble and remove the tooling string, in sections if necessary, until the Product Pipe face has been pulled beyond the face of the Burst Pit. The distance past the forward face of the Burst Pit shall be at the discretion of the Contractor anticipating the length required for connection/fusing.

3.3.7 Sealing Manholes

Connect replacement pipe to existing manholes as specified in Section 33 30 00 SANITARY SEWERS.

3.3.8 Sealing Wetwells

Connect replacement pipe to existing wetwells as detailed in Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

3.3.9 Connection to Existing Force Mains

Use DI/HDPE mechanical joint adaptors or transition fittings to connect to existing buried force main as specified in Section 33 30 00 SANITARY SEWERS.

Connections to existing force main shall be mechanical joint transition couplings or sleeves.

a. Mechanical joint fittings used with PVC pipe (3-inch- through 36-inch-diameter DR 18 pipe) shall be restrained with the EBAA Iron Megalug Series 2000 PV retainer or an equal approved by the Contracting Officer. The Series 200 PV retainers shall provide a minimum of 150-psi restraint with a 2 to 1 safety factor. The restraining device and Tee head bolts shall be manufactured of high-strength ductile iron meeting ASTM A 536, Grade 65-42-10. Clamping bolts and nuts shall be manufactured of corrosion-resistant, high-strength, low-alloy Cor-Ten steel meeting the requirements of ASTM A 242/A 242M.

b. Provide retainer glands for all buried DI mechanical joints, fittings, and DI pipe connections to buried valves. Retainer glands shall be designed for joint retaining through the use of a follower gland and set screw-anchoring devices that impart multiple wedging action against the pipe. The mechanical joint-restraint device shall be UL listed and shall have a working pressure of at least 250 psi with a minimum safety factor of 2.

1. Gland: Manufactured of DI conforming to ASTM A 536. Gland dimensions shall match ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53.

2. Restraining Devices: Manufactured of DI heat treated to a minimum hardness of 370 BHN. Restraining devices shall incorporate a set screw/twist-off nut bolt to ensure the proper actuating of the restraining device. The twist-off nut shall be designed to come off at the torque limit desired to anchor the restraining device in place on the pipe.

3. Joint Deflection: Retainer gland joint deflection shall be limited to manufacturer's recommended maximum deflection angle. Joint deflection shall be applied before the set screws are torqued.

4. Acceptable manufacturers: EBAA Iron, Inc. - Megalug 1100 Series, or approved equal.

3.3.10 Backfill and Surface Restoration

Backfilling and surface restoration shall be in accordance with Section 31 00 00 EARTHWORKS.

3.4 TESTING

Conduct hydrostatic testing as specified in Section 33 30 00 SANITARY SEWERS.

After the existing sewer is completely replaced, conduct internal inspection with television camera and videotape. Ensure that the finished installation is free of visual defects.

Repair defects or replace pipe which may affect the integrity or strength of the pipe in the opinion of the Contracting Officer. Repair or replacement is at the Contractor's expense.

Television inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit color television.

Television inspection shall include the following:

a. Submit post-construction DVDs to the Contracting Officer before final invoice.

b. DVDs to remain property of the Contracting Officer; Contractor to retain second copy.

c. Post-construction DVD upon completion of reconstruction of sewer with voice description and stationing of services indicated. Data and

stationing to be on screen on DVDs.

d. Should any portion of the inspection DVDs be of inadequate quality or coverage as determined by the Contracting Officer, the Contractor will have the portion reinspected and provide DVDs at no additional expense to the Government.

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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 | (2010a) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing |

| | |
|---|---|
| ASTM D 3350 | (2010) 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 | (2010) 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
Size, capacity, and arrangement of equipment
Location and size of drilling and receiving pits
Dewatering and methods of removing spoils material
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 of qualifications and records of previous similar jobs; G

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 DUCTILE IRON PIPE FOR HDD

Ductile iron piping for HDD shall be as specified in Section 33 11 00 WATER DISTRIBUTION.

2.6 DRILLING FLUIDS

Refer to Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION and Volume 1, Drawing EN2 for requirements when working in sites with potential contamination and environmental issues. Put in place additional environmental protection necessary to contain any hydraulic or drilling fluid spills, including berms, liners, turbidity curtains, and other measures. Do not store fuel in bulk containers within 200 feet of any

water body or wetland area.

Provide a self-contained, closed, drilling fluid mixing system of sufficient size to mix and deliver drilling fluid. The mixing system shall continually agitate the drilling fluid during operations.

Use a high quality bentonite drilling fluid to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Ensure that the composition of the fluid complies with API Spec 13A.

Mix the bentonite drilling fluid 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 re-usable. Spoils separated from the drilling fluid will be stockpiled for later use or disposal.

## 2.7 WIRE TRACING

For nonmetallic piping, provide tracing wire in accordance with Section 31 00 00 EARTHWORK. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

## 2.8 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 Pip |
| ANSI A21.53 | (2006) AWWA Standard for Ductile-Iron Compact Fittings for Water Service |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C104/A21.4 | (2008; Errata 2010) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water |
| AWWA C105/A21.5 | (2005) Polyethylene Encasement for Ductile-Iron Pipe Systems |
| AWWA C110/A21.10 | (2008) Ductile-Iron and Gray-Iron Fittings for Water |
| AWWA C111/A21.11 | (2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C115/A21.15 | (2005) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges |
| AWWA C150/A21.50 | (2002; Errata 2003) Thickness Design of Ductile-Iron Pipe |
| AWWA C151/A21.51 | (2009) Ductile-Iron Pipe, Centrifugally Cast, for Water |
| ANSI/AWWA C153/A21.53 | (2006) Ductile-Iron Compact Fittings for Water Service |
| AWWA C200 | (2005) Steel Water Pipe - 6 In. (150 mm) and Larger |
| AWWA C207 | (2007) Standard for Steel Pipe Flanges for |

| | |
|---|---|
| | Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in. |
| AWWA C220 | (1998) Stainless Steel Pipe, 4 in. (100 mm) and Larger |
| AWWA C502 | (2005) Dry-Barrel Fire Hydrants |
| AWWA C504 | (2006; R 2010) Standard for Rubber-Seated Butterfly Valves |
| AWWA C509 | (2009) Resilient-Seated Gate Valves for Water Supply Service |
| ANSI/AWWA C512 | (2007) Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service |
| ANSI/AWWA C515 | (2009) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service |
| AWWA C550 | (2005; Errata 2005) Protective Epoxy Interior Coatings for Valves and Hydrants |
| AWWA C600 | (2005) Installation of Ductile-Iron Water Mains and Their Appurtenances |
| AWWA C605 | (2005) Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water |
| AWWA C651 | (2005; Errata 2005) Standard for Disinfecting Water Mains |
| AWWA 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 | (2008) 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 |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.4/A5.4M | (2006) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding |
| AWS A5.9/A5.9M | (2006; Errata 2007) Specification for Bare Stainless Steel Welding Electrodes and Rods |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.20.1 | (1983; R 2006) Pipe Threads, General Purpose (Inch) |
| ASME B16.1 | (2005) Gray Iron Threaded Fittings; Classes 25, 125 and 250 |
| ASME B16.5 | (2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B16.9 | (2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B16.11 | (2009) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.21 | (2011) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B31.1 | (2010) Power Piping |
| ASME B36.10 | (2004; R 2010) Welded and Seamless Wrought Steel Pipe |
| ASME B18.2.1 | (2010) Square and Hex Bolts and Screws (Inch Series) |
| ASME B18.2.2 | (2010) Standard for Square and Hex Nuts |
| ASME B18.21.1 | (2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series) |
| ASME B18.22.1 | (1965; R 2008) Plain Washers |
| ASME B18.5.2.1M | (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 B31.3 | (2010) Process Piping |
| ASME B36.19M | (2004; R 2010) Stainless Steel Pipe |
| ASME BPVC SEC VIII | (2007; Addenda 2008) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessels, Division 1 |
| ASME SA-36/SA-36M | (2007) Carbon Structural Steel |
| ASME SA-675/SA-675M | (2007) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 105/A 105M | (2010) Standard Specification for Carbon Steel Forgings for Piping Applications |
| ASTM A 126 | (2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM A 153/A 153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A 182/A 182M | (2010a) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A 240/A 240M | (2011a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| 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 A283/A283M | (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 312/A 312M | (2011) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A 325 | (2009a) 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 380 | (2006) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems |
| ASTM A 403/A 403M | (2010a) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings |

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|---|---|
| ASTM A 47/A 47M | (1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings |
| 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 | (2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 530/A 530M | (2004a; R 2010) Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe |
| 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 774/A 774M | (2006) Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures |
| ASTM A 813/A 813M | (2007) Standard Specification for Single- or Double-Welded Austenitic Stainless Steel Pipe |
| 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 209 | (2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B 32 | (2008) Standard Specification for Solder Metal |
| ASTM B 584 | (2009a) Standard Specification for Copper Alloy Sand Castings for General Applications |
| ASTM B 62 | (2009) Standard Specification for Composition Bronze or Ounce Metal Castings |
| ASTM B 633 | (2007) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel |
| ASTM B 68 | (2002) Standard Specification for Seamless Copper Tube, Bright Annealed |
| ASTM B 75 | (2002) Standard Specification for Seamless Copper Tube |
| ASTM B 763 | (2008a) Standard Specification for Copper Alloy Sand Castings for Valve Application |
| ASTM B 88 | (2009) Standard Specification for Seamless Copper Water Tube |
| ASTM B828 | (2002; R 2010) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings |
| ASTM D 1330 | (2004) Rubber Sheet Gaskets |
| ASTM D 1784 | (2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D 1785 | (2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D 2464 | (2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D 2467 | (2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D 2564 | (2009) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM D 3261 | (2010a) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic |

Pipe and Tubing

| | |
|---|---|
| ASTM D 3350 | (2010) 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; R 2010) Standard Practice for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock |
| ASTM F 436 | (2010) Standard Specification for Hardened Steel Washers |
| ASTM F 477 | (2008) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F 593 | (2002; R 2008) Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F 594 | (2009) Standard Specification for Stainless Steel Nuts |
| ASTM F 656 | (2010) Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings |
| ASTM F 714 | (2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter |
| ASTM F 879 | (2010) Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws |

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

| | |
|---|---|
| EJMA Stds | (2008) EJMA Standards |

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (FDEP)

| | |
|---|---|
| FAC 62-555.335 | (2003) Guidance Documents for Public Water Systems |
| FAC 62-555.340 | (2003) Disinfection and Bacteriological Evaluation of Public Water System Components |

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) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |
| MSS SP-60 | (2004) Connecting Flange Joint between Tapping Sleeves and Tapping Valves |
| MSS SP-83 | (2006) Standard for Class 3000 Steel Pipe Unions Socket Welding and Threaded |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 24 | (2010) Standard for the Installation of Private Fire Service Mains and Their Appurtenances |

NSF INTERNATIONAL (NSF)

| | |
|---|---|
| NSF/ANSI 14 | (2009) Plastics Piping System Components and Related Materials |
| NSF/ANSI 61 | (2010a) 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 |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 789 | (2004; R 2008) Standard for Indicator Posts for Fire-Protection Service |

## 1.2 DESIGN REQUIREMENTS

### 1.2.1 Water Distribution Mains

Provide water main accessories, and gate valves as specified and where indicated.

Provide water distribution mains indicated as 6 through 16 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. Also provide water main accessories, gate valves, and automated flushing valves as specified and where indicated.

1.2.2 Water Service Lines

Provide water service lines indicated as 1- and 2-inch lines from water distribution main to building service at the point indicated. Water service lines shall be polyvinyl chloride (PVC) plastic pipe. PVC plastic pipe appurtenances, and valves as specified for water mains may also be used for service lines. Provide water service line appurtenances as specified.

1.3 SUBMITTALS

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

SD-02 Shop Drawings

Water Line Connection Plan; G

As-Built Drawings; G

SD-03 Product Data

Pipe Connections; G

Ductile Iron Pipe; G

Retainer Glands; G

Water service line piping, fittings, joints, valves, and coupling; G

Ductile Iron Fittings; G

Valves; G

HDPE Pipe and Fittings; G

Appurtenances; G

Polyvinyl Chloride (PVC) Pressure Pipe; G

Fittings for PVC Pressure Pipe; G

Galvanized Steel Pipe; G

Stainless Steel Pipe and Fittings; G

Copper Tube and Fittings; G

Unions; G

Valve Boxes; G

Hydrants; G

Corporation; G

Automatic Flushing Unit; G

Service Saddles; G

Indicator Posts; G

Submit manufacturer's instructions or catalog cuts.

Pipe Insulation; G

Include insulation protective coverings, vapor barrier, adhesives, sealants, coatings, reinforcing mesh, and bands.

SD-05 Design Data

Axial Deflection Calculations

SD-06 Test Reports

Hydrostatic Test; G

Leakage Test; G

Bacteriological Disinfection; G

Test results from commercial laboratory verifying disinfection

HDPE Pipe and Fittings; G

Tapping Valves; G

## 1.4 SHOP DRAWINGS

A Water Line Connection Plan shall be submitted by the Contractor for the complete water system prior to start of work. The plan shall describe connections to existing water main, including any necessary valve closures and temporary outages.

As-built drawings are required for all systems and will be prepared by a surveyor registered in the State of Florida. As-built drawing shall contain the following information:

Location of valves, fittings, hydrants, and meters.

Elevation of top of water line at all utility crossings.

Separation between other utilities within 10 feet horizontally.

Material used.

## 1.5 DELIVERY, STORAGE, AND HANDLING

### 1.5.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials, and rubber gaskets under cover out of direct sunlight. Do not exceed the manufacturer's recommended stacking height during storage. Do not store

materials directly on the ground. Keep inside of pipes, fittings, valves, and hydrants free of dirt and debris.

1.5.2 Handling

Handle pipe and accessories to ensure delivery to the trench in an undamaged conditions. Take particular care not to injure the pipe coating. When the coating or lining of any pipe or fitting is damaged, the Contractor shall repair at his expense in an approved manner. Do not place other pipe or material inside of a pipe or fitting after the coating has been applied. Carry the pipe into position. Only use pinch bars and tongs for aligning or turning the pipe on the bare ends of the pipe. Clean the interiors of pipe and accessories before the pipe or accessories are lowered into the trench keep clean during laying operations by an approved method. Before installation, inspect the pipe for defects. Replace material found to be defective before or after laying with sound material without additional cost to the Government. Store rubber gaskets that are not to be installed immediately in a cool dark place out of the direct rays of the sun.

1.5.3 Protective End Caps

The Contractor shall provide protective end caps on each piece of pipe or fabricated section, completely sealing the piece from contamination during shipment and storage. Provide the same type of seals on each fitting or ship and store fittings in sealed boxes or containers.

PART 2 PRODUCTS

Ensure that newly installed or constructed public water system (PWS) components that come into contact with drinking water or drinking water treatment chemicals conform to NSF/ANSI 61 or Section 6 of NSF/ANSI 14.

Ensure that any pipe and pipe fitting used in the construction, alteration, or repair of any PWS is lead free (contains not more than 8 percent lead). Ensure that any plumbing fitting or fixture that is intended to dispense water for human consumption and that is used in the construction, alteration, or repair of any PWS is lead free (in compliance with Section 9 of NSF/ANSI 61 as adopted in FAC 62-555.335).

Color code or mark all water main pipes, including fittings, using blue as a predominant color to differentiate drinking water from reclaimed or other water. Apply blue stripes to the pipe wall of underground metal pipe. Ensure that pipe striped during manufacturing of the pipe has continuous stripes that run parallel to the axis of the pipe, are located at no greater than 90-degree intervals around the pipe, and will remain intact during and after installation of the pipe.If tape or paint is used to stripe pipe during installation of the pipe, apply the tape or paint in a continuous line that runs parallel to the axis of the pipe and that is located along the top of the pipe; for pipes with an internal diameter of 24 inches or greater, apply tape or paint in continuous lines along each side of the pipe as well as along the top of the pipe.

2.1 WATER DISTRIBUTION MAIN MATERIALS

2.1.1 Piping Materials

Ensure that all materials in contact with potable water are NSF/ANSI 61 approved and are suitable for use with chloraminated water.

2.1.1.1 Ductile-Iron Piping

All ductile-iron piping shall be cement-lined manufactured in accordance with AWWA C150/A21.50 and AWWA C151/A21.51 for the following minimum operating conditions:

Pressure Class: All ductile-iron piping shall meet the following minimum working pressure classes:

(a) 4-inch through 12-inch: 350 psi
(b) Pipe greater than 12 inches: 250 psi

Provide buried pipe and fittings that are petroleum asphalt coated according to the manufacturer's recommendations and encased in 8-mil high-density polyethylene tubes in accordance with AWWA C105/A21.5 Method A. Paint all flanged and above-grade or exposed pipe and fittings in accordance with Section 09 90 00.00 98 PAINTING AND COATING.

Where new flanged pipe is joined with existing and other new flanges, provide adaptor flange pipe sections if necessary.

Ensure that all bolts, nuts, and stud provided are corrosion-resistant alloy with hex heads or heavy hex heads conforming to AWWA C115/A21.15 and Appendix A of AWWA C115/A21.15, except where otherwise indicated on the drawings.

2.1.1.1.1 Ductile-Iron Joints

Ductile-iron fittings below grade/buried shall be furnished with mechanical joints and ductile-iron fittings above grade/exposed shall be furnished with flanged joint ends as shown on the drawings and specified in this Section

Mechanical Joints: All buried ductile-iron fittings shall be furnished with mechanical joint ends unless noted otherwise. Mechanical joints shall conform to AWWA C111/A21.11. Glands shall be constructed of ductile-iron.

Flanged Joints: Pipe for threaded flange fabrication shall be Special Thickness Class 53 in accordance with AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C115/A21.15. Bolt circle and bolt holes shall match those of ASME B16.1 Class 125 flanges. The flanges shall be rated for a maximum working pressure of 250 psi. Threaded flanges shall be individually fitted and machine tightened on the pipe ends. Flange facing shall be smooth or with shallow serrations in accordance with AWWA C115/A21.15.

2.1.1.1.2 Ductile-Iron Fittings

General: Ductile iron pipe fittings shall be the compact type meeting the requirements of AWWA C111/A21.11, AWWA C110/A21.10, and be cement lined and seal coated. Fittings shall be manufactured in accordance with AWWA C110/A21.10. Where taps are 1/8-inch thick full-face-type and conform to the dimensions of Appendix A of AWWA C115/A21.15 shown on fittings, tapping bosses shall be provided. At a minimum, fittings shall have the same pressure rating as the connecting pipe.

Flanged Joint: AWWA C110/A21.10 and ASME B16.1, faced and drilled 125-pound ANSI standard.

Mechanical Joint: AWWA C110/A21.10.

Provide mechanical joint fittings for all buried fittings as shown in the drawings, unless noted otherwise.

Provide specified gaskets.

2.1.1.1.3 Lining and Coating

Perform all field measurements confirming the accuracy of the piping sizes and lengths shown on the drawings. Notify the Contracting Officer immediately before deviating from or altering the lining of ductile iron piping shown on the approved layout schedule.

Cement-Lined Ductile Iron Pipe and Fittings: Interior surfaces of all cement-lined ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with a standard thickness cement-mortar lining applied in conformity with AWWA C104/A21.4, Portland cement mortar. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, repair or replace damaged or unsatisfactory portions with lining conforming to these Specifications at no additional cost to the Government. Pipe linings for potable water lines shall be NSF/ANSI 61 approved.

All ductile iron pipe and fittings cement-mortar linings shall be surface sealed with an asphaltic seal coating, 1 mil, in accordance with AWWA C104/A21.4.

Coat all parts of the joint restraint system with coal tar epoxy as in Section 09 90 00.00 98 PAINTING AND COATING, Mega-Bond coating system by EBAA Iron, Inc. or Contracting Officer approved equal.

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.

2.1.1.1.4 Manufacturers

Acceptable ductile iron pipe manufacturers include US Pipe, American Ductile Pipe, Griffin Pipe, or approved equal.

2.1.1.1.5 Gaskets

Gaskets shall be EPDM, Viton, or an approved equal. Wherever contaminated groundwater or contaminated soils are present, gaskets shall be Viton, or an approved equal. Refer to drawings for locations.

Gaskets for mechanical joints shall be compatible with potable water pipe service and be in accordance with ANSI A21.11 and ASTM D 1330.

Flange gaskets shall be in accordance with AWWA C207, except as modified in this Section. Gaskets shall be ring type. All gasket material shall be suitable for potable water and shall be resistant to free chlorine concentrations up to 10 mg/L. All gasket material shall be rated to the surge pressures noted under the paragraph entitled "Ductile-Iron Piping" of this Section.

Gaskets for flanged joints shall be 1/8-inch-thick, cloth-inserted rubber

conforming to applicable parts of ASME B16.21 and AWWA C207. Gasket material shall be free from corrosive alkali or acid ingredients. Gaskets shall be full-face type for 125-pound flanges.

2.1.1.1.6 Retainer Glands

Retainer glands shall be provided for all buried ductile-iron mechanical joints, fittings, and ductile-iron pipe connections to buried valves. Retainer glands shall be designed for joint retaining through the use of a follower gland and set screw-anchoring devices that impart multiple wedging action against the pipe. The mechanical joint-restraint device shall be UL listed and shall have a working pressure of at least 250 psi with a minimum safety factor of 2.

a. Gland: Manufactured of ductile iron conforming to ASTM A536. Gland dimensions shall match ANSI A21.11 and ANSI A21.53.

b. Restraining Devices: Manufactured of ductile iron heat treated to a minimum hardness of 370 BHN. Restraining devices shall incorporate a set screw/twist-off nut bolt to ensure the proper actuating of the restraining device. The twist-off nut shall be designed to come off at the torque limit desired to anchor the restraining device in place on the pipe.

c. Joint Deflection: Retainer gland joint deflection shall be limited to manufacturer's recommended maximum deflection angle. Joint deflection shall be applied before the set screws are torqued.

d. Acceptable Manufacturers are EBAA Iron, Inc. - Megalug 1100 Series, or approved equal.

2.1.1.1.7 External Pipe Restraints

Ductile-iron pipe push-on (bell and spigot) joint restraint shall be provided by a restraining harness consisting of a restraint ring, connecting tie-rods, and split-ring assembly installed at all push-on joints. The restraint ring shall consist of wedging components made from 60-42-12 ductile-iron conforming to ASTM A 536 and wedges heat treated to minimum 370 BHN. Torque limiting twist-off nuts shall be provided on each wedge to ensure proper applied installation torque. The split ring shall be made from 60-42-12 ductile-iron conforming to ASTM A 536. The connecting rods shall be made of steel conforming to AWWA C111/A21.11. Sizes 4- to 16-inch-diameter restraining harnesses shall have 350-psi maximum working pressure rating and 18- to 36-inch-diameter restraining harnesses shall have 250-psi maximum working pressure rating. All harnesses shall be designed with a 2-to-1 safety factor applied to the maximum working pressure rating.

Acceptable manufacturers are EBAA Iron, Inc. - Series 1700 or approved equal.

2.1.1.1.8 Internal Pipe Restraint

Acceptable manufacturers are:

American Ductile Iron Pipe:

Fast Grip® Gasket
Flex Ring® Joint

US Pipe:

Field Lok® Gasket
TR Flex Restrained Joint Pipe and Fittings

or Contracting Officer-approved equal.

2.1.1.2 Pipe Connections

Provide fasteners in accordance with the following section unless otherwise noted.

1. General: For all exterior applications and where fastening aluminum, provide Type 304 stainless steel fasteners. Provide hot-dipped galvanized fasteners in all other applications in accordance with ASTM A 153/A 153M unless noted otherwise on the drawings. Select fasteners for type, grade, and class required.

2. High-Strength Bolts and Nuts: ASTM A 325 with heavy hex nuts ASTM A 563 and hardened carbon-steel washers ASTM F 436.

3. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, with hex nuts, ASTM A 563, and, where indicated, flat washers.

4. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group A4.

5. Stainless Steel Socket Button and Flat Countersunk Head Cap Screws: ASTM F 879.

6. Anchor Bolts: ASTM F 1554, Grade 36.

7. Eyebolts: ASTM A 489.

8. Machine Screws: ASME B18.6.3.

9. Lag Bolts: ASME B18.2.1.

10. Wood Screws: Flat head, ASME B18.6.1.

11. Plain Washers: Round, ASME B18.22.1.

12. Lock Washers: Helical, spring type, ASME B18.21.1.

13. Cast-in Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.

a. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized in accordance with ASTM A 153/A 153M.

14. Expansion Anchors: Anchor bolt and sleeve assembly with the ability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed

when installed in concrete, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.

a. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

b. Material for Anchors in Exterior Locations: Alloy Group (A4) stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.1.1.3 Polyvinyl Chloride (PVC) Pressure Pipe

2.1.1.3.1 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 AWWA C900 PVC 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. Also restrain joints on either side of fittings in accordance with Restrained Joint Table, Spec EBAA 1500, in drawings.

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 Gaskets for AWWA C900 PVC Pipe

Gaskets shall be compatible with potable water pipe service. Gaskets shall be EPR, Viton ETP, or an approved equal. Wherever contaminated groundwater or contaminated soils are present, gaskets shall be Viton ETP, or an approved equal. Refer to drawings for locations.

Gaskets for flanged PVC joints shall be full faced, 1/8-inch thick, having a Brinell Hardness of 50 to 70 durometer A. PVC flanges shall be Vanstone flanges.

2.1.1.3.3 3-Inch and Smaller PVC Pipe

Provide pipe that is Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D 1784 and ASTM D 1785.

Provide pipe that bears the NSF logo for potable water use.

2.1.1.3.4 Solvent Cement in Other than Chemical and Chemical Carrier Water Service

Solvent cement for socket joints shall comply with ASTM D 2564 and ASTM F 656.

2.1.1.3.5 Solvent Cement in Chemical and Chemical Carrier Water Service

Solvent cement shall be free of silica. Products: IPS "Weld-On 724" or Oatey "Low VOC PVC Heavy Duty Gray."

2.1.1.4 Joints and Fittings for PVC Pressure Pipe

2.1.1.4.1 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 AWWA C900 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 Flexible Polyester Reinforced Clear PVC Tubing/Hose

Provide NSF/ANSI 61 compliant clear PVC tubing with polyester reinforcement with smooth inside bore and smooth outside. Minimum operating pressure rating at 70 degrees F shall be 200 psi for tubing 3/4 inch and smaller, 150 psi for 1 inch, 100 psi for 1-1/4 and 1-1/2 inches, and 75 psi for 2-inch-diameter tubing. Burst pressure shall be at least four times the specified operating pressure.

For tubing size 1 inch and less, join tubing to rigid pipe with PVC adapter fittings, single-barb insert by Schedule 80 PVC solvent cement socket. Secure tubing to the barbed end of the fitting with stainless steel hose clamp. Connect tubing sections by means of single-barb PVC couplings with stainless steel clamps.

Products: Ryan Herco heavy duty "Herco-Braid Clear PV Tubing with Polyester Reinforcement" or approved equal.

2.1.1.6 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/ANSI 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.

2.1.1.6.1 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.

2.1.1.6.2 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.

2.1.1.7 Ductile Iron Pipe for HDD

2.1.1.7.1 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.

2.1.1.7.2 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.

2.1.1.7.3 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.

2.1.1.7.4 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.

2.1.1.7.5 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 (lb) | 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.

2.1.1.7.6 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.

2.1.1.7.7 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.

2.1.1.7.8 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.

2.1.1.7.9 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.

2.1.1.8 Galvanized Steel Pipe

Pipe: Steel piping shall conform to the requirements of ASTM A 53/A 53M, Type S, Grade B, and ASME B36.10, Schedule 40 as indicated on the drawings.

Fittings: Forged steel conforming to ASTM A 105/A 105M and ASME B16.11, Class 2000.

Joints: Threaded conforming to ASME B1.20.1.

Galvanizing: Conform to ASTM A 90/A 90M.

2.1.1.9 Stainless Steel Pipe and Fittings

2.1.1.9.1 Pipe

Pipe 3 inches and larger shall conform to ASTM A 312/A 312M, Grade TP 304L.

Pipe sizes and wall thicknesses shall conform to ASME B36.19M as follows:

| Pipe Size | Wall Thickness |
|---|---|
| 1-1/4 inches through 3 inches | Schedule 80S |
| 3-1/2 inches through 8 inches | Schedule 40S |

2.1.1.9.2 Fittings

Fittings 3 inches and smaller shall be socket welded, conforming to ASME B16.11, 3,000-pound CWP. Material for socket-welded fittings shall conform to ASTM A 403/A 403M, Class WP 304L or ASTM A 182/A 182M, Grade F304L.

Fittings for buried or submerged pipe that are 4 inches shall be butt-welded, conforming to ASTM A 403/A 403M, Class WP or ASTM A 774/A 774M, the same material and wall thickness as the pipe, conforming to ASME B16.9. Elbows shall be long radius.

2.1.1.9.3 Preparation and Final Cleaning

Pipe and fittings shall be final cleaned, pickled, and passivated in accordance with ASTM A 380. Passivation shall be the removal of exogenous (not inherent in the base metal) iron or iron compounds from the surface of

the stainless steel by a chemical dissolution, a treatment with an acid solution that will completely remove the surface contamination but will not significantly affect the stainless steel itself. After final cleaning, wet surfaces with water and inspect for rust spots after 24 hours. Reclean if there is any evidence of rusting.

2.1.1.9.4 Quality Control

Include the "Hydrostatic Test" and "Flattening Test" requirements described in ASTM A 530/A 530M.

2.1.1.9.5 Unions

Unions shall be 3,000-pound WOG-forged stainless steel, with dimensions conforming to MSS SP-83. Ends shall be socket-welded type. Material shall conform to ASTM A 182/A 182M, Grade F304L for socket-welded type.

2.1.1.9.6 Joints

Joints for pipes 3 inches and smaller shall be socket welded, the same material as specified for fittings, 3,000-pound WOG, conforming to ASME B16.11.

Joints for buried or submerged pipe larger than 3 inches shall be butt-welded.

Where piping connects to wall pipes, meters, valves, or other equipment, the pipe ends shall match the ends of the wall pipes, meters, valves, or equipment.

2.1.2 Valves, Hydrants, and Other Water Main Accessories

2.1.2.1 Gate Valves

2.1.2.1.1 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 ASME B1.20.1.

Gate valves shall be manufactured by Mueller, American Flow Control or Kennedy.

2.1.2.1.2 Ductile-Iron Resilient Wedge Gate Valves, 3 Inches through 20 Inches, for Exposed and Buried Service (ANSI/AWWA C515)

Provide valves that are cast-iron or ductile-iron body valves and comply with ANSI/AWWA C515 and the following. Ensure that valves are of the

bolted-bonnet type with nonrising stems. Ensure that the valve gate is of ductile-iron with a resilient wedge. Ensure that valve stems are Type 304 or 316 stainless-steel or cast, forged, or rolled bronze. Ensure that stem nuts are made of solid bronze. Ensure that bronze conforms to ASTM B 62 or ASTM B 584. Ensure that body bolts are Type 316 stainless-steel. Ensure that end connections for exposed valves are flanged. Ensure that end connections for buried valves are mechanical joint type. Provide reduction-thrust bearings above the stem collar. Ensure that stuffing boxes are O-ring seal type with two rings located in the stem above the thrust collar. Ensure that each valve has a smooth unobstructed waterway free from any sediment pockets. Ensure that valves are lined and coated at the place of manufacture with either fusion-bonded epoxy or heat-cured liquid epoxy. Ensure that minimum epoxy thickness is 8 mil.

Gate valves 16 inches and larger will include an integrated bypass gate valve with a minimum diameter of 1.5 inches. The integrated gate valve shall meet the requirements of Part 2.1.2.1.1. All piping associated with the bypass gate valve is Type 316 stainless steel.

Manufacturers: Clow, AVK, American Flow Control, Kennedy, or approved equal.

2.1.2.2 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, ASME 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.

2.1.2.3 Butterfly Valve

2.1.2.3.1 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.

2.1.2.3.2 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 designed with 125-pound flanged ends faced and drilled in accordance with ASME B16.1 for cast-iron flanges.

2.1.2.4 Combination Air Valve, Single Body

All valves shall meet or exceed all applicable provisions of the latest revision of ANSI/AWWA C512, Standard for Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service. All valves for drinking water services shall comply with NSF/ANSI 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 ASME B1.20.1. Flanges shall comply with ASME 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.

2.1.2.5 Transition Coupling--HDPE to Stainless Steel

HDPE to stainless steel transition coupling shall be capable of withstanding operating pressures of 150 psi. The transition coupling shall be the ETCO Specialty Products, Inc. E-Loc® Transition Coupling or approved equal.

2.1.2.6 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.

2.1.2.7 Ball Valves

2.1.2.7.1 Stainless Steel 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/ANSI 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 (ASME 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.

2.1.2.8 Double-Union PVC Ball Valves, 3 Inches and Smaller, with Vented Ball for Chemical Service

Vented PVC ball valves 3 inches and smaller for chemical service shall be rated at a pressure of 230 psi at a temperature of 70 degrees F and 150 psi at a temperature of 105 degrees F. Provide a machined vent hole, deburred, in the ball to allow gases to vent. Body, ball, and stem shall be PVC conforming to ASTM D 1784, Cell Classification 12454-A. Stems shall have double O-rings and be of blowout-proof design. Seats shall be PTFE and shall have an elastomeric backing cushion of the same material as the valve seals. O-ring seals shall be FKM. Valve ends shall be of the double-union design. Ends shall be socket-welded except where threaded or flanged-end valves are specifically shown in the drawings. Valves shall have handles for manual operation. Valves shall be Asahi/America Type 21 or approved equal.

2.1.2.9 True Union PVC Ball Check Valves

True Union PVC Ball Check Valves shall have full port true union design. End connections shall be socket. Minimum working pressure rating shall be 150 psi at 70 degrees F. True Union PVC Ball Check Valves shall be Hayward Flow Control TC Series or approved equal.

2.1.2.10 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.

2.1.2.11 Indicator Posts

UL 789. Provide for gate valves where indicated. The face of the indicator post shall face the nearest roadway, driveway, or parking lot.

2.1.2.12 Valve Boxes

Valve boxes shall be cast iron, complete with lock-type covers requiring a special wrench for removal. Cast-iron boxes shall be the extension type with slide adjustments and with flared bases. Concrete boxes shall be constructed in accordance with details indicated. The word "WATER" shall be cast in the cover. Boxes shall be installed over each gate valve. Boxes shall be of such a length as can be adapted, without full extension, to the depth of cover required over the pipe at the valve location. Concrete boxes may be installed only in locations not subjected to traffic.

2.1.2.13 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.

2.1.2.14 Warning Tape and Tracing Wire for Buried Piping

Warning tape and tracing wire for buried pipe is specified under Section 31 00 00 EARTHWORK.

2.1.2.15 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.

2.1.2.16 Transition Couplings

Transition Coupling shall consist of a high-strength steel body, two steel or malleable iron flange or follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675MGR60, free of surface defect.
Followers: AISI C1012 or ASME SA-36/SA-36M
Bolts: AWWA C111/A21.11
Gasket: Grade 27 BUNA-S.
Shop Paint: Fusion bonded epoxy coating.
Acceptable Manufacturers:
Dresser Manufacturing Division of Dresser Industries, Inc.; Dresser Styles 62 and 162 or approved equal.

2.1.2.17 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.

2.1.2.18 Tapping Valves

Provide resilient wedge gate valves with mechanical and flanged ends in accordance with requirements of ANSI/AWWA C515. 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. One end shall have slotted bolt holes in accordance with ANSI/AWWA C515, Paragraph 4.4.1.3.4 to fit tapping machines. Valve body shall be iron, bronze fitted. Valves shall be of the bolted bonnet type with nonrising stems.

Valve stems shall be Type 304 or 316 stainless-steel or cast, forged, or rolled bronze. Stem nuts shall be made of solid bronze. Bronze for internal working parts, including stems, shall conform to ASTM B 62 or ASTM B 584 (Alloy C83600), except that the stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and a minimum of 10 percent elongation in 2 inches (ASTM B 584 or ASTM B 763, Alloy C87600 or C99500). Body bolts shall be Type 316 stainless-steel. Provide reduction-thrust bearings above the stem collar. Stuffing boxes shall be O-ring seal type with two rings located in the stem above the thrust collar. Each valve shall have a smooth unobstructed waterway free from any sediment pockets. 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 at the place of manufacture with either fusion-bonded epoxy or heat-cured liquid epoxy. Minimum epoxy thickness shall be 8 mil. 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.

2.1.2.19 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.

2.1.2.20 Flanged Coupling Adapters

Adapters shall consist of a cast-iron or high-strength steel body, two steel or ductile iron follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

3-24-inch DIP Flange Adapters

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675M GR60, free of surface defect.

Flanges: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675M GR60, free of surface defect. Bolt circles and bolt holes shall match those of ASME B16.1 Class 125 flanges.

Bolts and nuts: Alloy to AWWA C111/A21.11

Gasket: Grade 27 BUNA-S.

Acceptable Manufacturers:

Dresser Manufacturing Division of Dresser Industries, Inc.;
Dresser Style 128W or approved equal.

2.1.2.21 Transition Couplings

Transition Coupling shall consist of a high-strength steel body, two steel or malleable iron flange or follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675/SA-675MGR60, free of surface defect.
Followers: AISI C1012 or ASME SA-36/SA-36M
Bolts: AWWA C111/A21.11
Gasket: Grade 27 BUNA-S.
Shop Paint: Fusion bonded epoxy coating.
Acceptable Manufacturers:
Dresser Manufacturing Division of Dresser Industries, Inc.;
Dresser Styles 62 and 162 or approved equal.

2.1.2.22 Retainer Glands

Provide retainer glands for all buried ductile-iron mechanical joints, fitting, and ductile-iron pipe connections to buried valves. Design retainer glands for joint retaining through the use of a follower gland and set screw-anchoring devices which impart multiple wedging action against the pipe. The mechanical joint restraint device shall be UL listed and shall have a working pressure of at least 250 psi with a minimum safety factor of 2.

1. Gland: Manufactured of ductile iron conforming to ASTM A 536. Gland dimensions shall match AWWA C111/A21.11 and ANSI/AWWA C153/A21.53.

2. Restraining Devices: Manufactured of ductile iron heat treated to a minimum hardness of 370 BHN. Incorporate a set screw/twist-off nut bolt into restraining devices to ensure the proper actuating of the restraining device. Design the twist-off nut to come off at the torque limit desired to anchor the restraining device in place on the pipe.

3. Joint Deflection: Limit retainer gland joint deflection to manufacturer's recommended maximum deflection angle. Apply joint deflection before the set screws are torqued.

4. Acceptable manufacturers:

a. EBAA Iron, Inc.; Megalug 1100 Series or approved equal.

2.1.2.23 Restraining Harness

Provide ductile iron pipe push-on (bell and spigot) joint restraint by a restraining harness consisting of a restraint ring, connecting tie-rods, and split-ring assembly installed at all push-on joints. The restraint ring shall consist of wedging components made from 60-42-12 ductile iron conforming to ASTM A 536 and wedges heat treated to minimum 370 BHN. Provide torque limiting twist-off nuts on each wedge to ensure proper applied installation torque. Make the split ring from 60-42-12 ductile iron conforming to ASTM A 536. Make steel connecting rods conforming to AWWA C111/A21.11. Sizes 4- to 16-inch-diameter restraining harnesses shall have a 350-psi maximum working pressure rating and a 18- to 36-inch

diameter restraining harnesses shall have 250-psi maximum working pressure rating. Design all harnesses with a 20-to-1 safety factor applied to the maximum working pressure rating.

Acceptable manufacturers:

EBAA Iron, Inc.; Series 1700 or approved equal.

2.1.2.24 Pump Expansion Joint Couplings (Metallic Bellows Flexible Connectors)

Booster pump suction 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 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.

2.1.2.25 Hanger and Support Systems

2.1.2.25.1 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 ASME 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. Pipe supports shall not induce point loadings, but shall distribute pipe loads evenly along the pipe circumference.

6. 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.

7. 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.

8. 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.

2.1.2.25.2 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 |
| 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 |

| Type Number | Description | Manufacturer and Model (or Equal) |
|---|---|---|
| 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 |
| 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).

2.1.2.26 Tracer Wire for All Piping Including Horizontal Directional Drilling

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

2.1.2.27 Polyethylene Bagging

Polyethylene bagging for buried ductile iron pipe, fittings, and valves shall be 8 mils thickness minimum polyethylene. The installation of polyethylene bagging shall be in accordance with AWWA C105/A21.5.

2.1.2.27.1 Polyethylene Bagging for DI HDD Applications

The initial piece of pipe will require that the polyethylene bagging be securely attached to the pipe barrel, approximately 1 foot from the end of the pipe, using several circumferential wraps of tape. To prevent drilling fluid or cuttings to get under the polyethylene, the tape should be applied directly to both the polyethylene and metal barrel of the pipe. To prevent drilling fluid and cuttings from being forced under the polyethylene bagging during the pull-back, when applying the polyethylene bagging to the assembled joint, the polyethylene overlap should always have the forward pipe's polyethylene bagging overlap the next pipe's polyethylene. To secure the polyethylene at the joint area, a plastic tie strap or tape should be snugly installed/circumferentially wrapped on each side of the joint.

2.1.2.28 Line Stop Sleeves

Line stop sleeves shall be the high strength type having a wide body, made of a minimum of ASTM A283/A283M 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.

2.1.2.29 Automated Flushing Valves

2.1.2.29.1 Automatic Water Distribution Flushing System Components

The automatic water distribution flushing system is comprised of an automatic flushing unit constructed of brass piping and a brass adjustable 2-inch control valve with dechlorination capabilities and an integrated programmer. The device must also be protected against the environment and vandalism by a non-corrosive, polyethylene enclosure.

2.1.2.29.2 Automatic Flushing Unit

The automatic flushing unit shall be a single unit consisting of the major components described below:

a. Integral Piping and Control Valve:

The piping and control valve components shall include the following:

1. The control valve shall be a globe valve type design capable of passing sand and other debris up to 5/8-inch in diameter without obstructing the valve's throat.

2. Pressure rating: 200 psi.

3. Solid brass construction.

4. Slow closing. No water hammer, surge or noise.

5. Manual operation in the event of power failure with a solid brass heavy duty drain cock.

6. Cross handle flow control (standard).

7. Self-cleaning orifice.

8. Diaphragm of one-piece molded construction with integral O-ring seal reinforced with 600-pound test fabric.

9. The unit's standard internal piping shall be constructed of brass.

10. The unit's internal piping and control valve shall have an operational rating of 200 psi.

b. Protective Enclosure

The self-contained unit shall be supplied with a below-grade base to provide stability and anti-buoyancy capabilities. The base shall be constructed of HDPE or other non-corrosive, high quality, polyethylene material.

The enclosure is to be vented to have a minimum inside width of 17 inches, a minimum inside above grade height of 17 inches, a minimum inside length of 30 inches, and must have a below grade base offering a minimum bury depth of 9 inches.

The unit's above-grade components shall be constructed of a non-corrosive maintenance-free material and shall be permanently colored light green. The material shall be specifically designed for direct exposure to the sun and weather and have a minimum life expectancy of 15 years.

All mounting brackets and hardware shall be stainless steel.

The enclosure shall be Charles Industries Ltd., LLPH Series or approved equal.

c. Backflow Prevention

The self-contained unit shall be supplied with an RPZ for the purpose of backflow prevention in order to prevent discharged water from being reintroduced into the potable water main.

d. Sampling System

The sampling system shall include the following features:

1. The sampling system shall be constructed of stainless steel or other material with equal or greater resistance to bacterial regrowth and be connected with brass fittings.

2. The sampling system shall be design in such a way to reduce the potential for sampling system contamination by allowing access and inspection of the internal piping compartment and components without disassembly or depressurization of the sampling system.

3. Connection to the unit's sampling system shall be by means of a quick-disconnect. The unit's sampling connection shall be housed in a secure weathertight area to minimize contamination of the sampling connection. The sampling connection itself shall be provided with a protective sanitary cover.

e. Electrical/Electronic System

The electrical/electronic system shall include the following features and capabilities:

1. Be capable of storing instructions via an integrated programmer and capable of operating the unit's internal control valve using two replaceable standard Alkaline AA size batteries as a power supply.

2. Offer a minimum nine flushing program events per day.

3. Be leap-year compatible, automatically accounting for February 29th every 4 years.

4. Incorporate LCD readout of clock and programming functions.

5. Offer manual on and off functions.

6. Be secured and water-resistant to a maximum of 6 feet of water.

7. Have heavy-duty power cable.

8. Use an integrated latching solenoid to operate the control valve.

2.1.2.30 Pipe Insulation

Fire hazard rating: Except for materials listed below, all insulation materials, adhesives, coatings, and other accessories shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed. Excepted are:

1. Urethane insulation for smoke developed only.
2. Asphaltic and coal tar coatings.

2.1.2.30.1 Insulation Performance

Rigid cellular foam urethane with the following requirements:

1. Density: 1.8 to 2.2 pounds per cubic foot.
2. Dimensional stability: 4 percent.
3. Thermal conductivity (BTU in/hr sw. ft. degrees F):

    a. Initial: .11
    b. Design: .14 to .16
    c. Aged: .18

4. Compressive strength: 25 psi with 10 percent deflection.
5. Open cell content: 10 percent or less by volume.
6. Temperature range: 30 degrees F to 220 degrees F.

2.1.2.30.2 Insulation Requirements

Supply all insulation in curved cylindrical segments.

Fabricate insulation in contact with the pipe to suit pipe outside dimensions.

Insulation thickness shall be 1-1/2 inches thick.

Acceptable manufacturers:

1. Owens Corning.
2. CPR Upjohn.
3. Or approved equal.

2.1.2.30.3 Insulation Adhesives, Sealants, and Coatings

Adhesives, sealants, and coatings shall be compatible with materials to which they are applied and shall not corrode, soften, or otherwise attack insulation in any manner. Materials shall be suitable for intended service.

Suitable for a minus 30 degrees F to 200 degrees F operating service.

Acceptable manufacturers:

1. Childers Products Company.
2. Benjamin Foster Company.
3. Lion Oil Company.
4. Or approved equal.

Adhere insulation to piping with suitable adhesive.

Seal all exposed edges of insulation with two coats of suitable flexible sealer.

Seal lap, butt, and longitudinal joints in insulation with one coat of flexible sealer or adhesive.

2.1.2.30.4 Insulation Protective Coverings

Exposed outside piping: Protect insulation with a 0.016-inch-thick corrugated aluminum jacket. Aluminum shall be Type 3003 or 5005, ASTM B 209, Temper H14. Exterior shall have a factory-applied baked-on acrylic coating. The inside of the covering shall have a factory-applied moisture barrier of polyethylene film on Kraft Paper. Covering shall be as manufactured by Childers, Insul-Coustic, or approved equal.

2.1.2.31 Static Mixers

General:

a. Each static mixer shall incorporate tabular mixing arrays, which shall include high-efficiency mixing vortices.

b. Each static mixer shall achieve 95 percent uniform mixing within a distance of three pipe diameters from the last element in each mixer.

c. Each static mixer shall incorporate the required number of tabular arrays to provide complete mixing at all design conditions.

d. Each static mixer shall incorporate mixing arrays of sufficient thickness and flexural rigidity to withstand the hydrodynamic forces of the process flow and the design pressures.

e. Renewable parts shall not be of a lower quality than specified below.

f. Mixer elements shall be continuously sealed to the pipe walls.

g. Mixer ends shall be Class 150 flanged ends flat faced and drilled in accordance with ASME B16.5. Flange facing shall be in accordance with AWWA C115/A21.15. The ends will be connected to ASME B16.1 Class 125 cast iron flanges.

h. The inner diameter of the static mixers shall be the same size as the inner diameter of the adjoining pipes.

i. The projected area of the mixing elements, in the plane perpendicular to the mainstream flow, cannot exceed one-sixth of the total cross-sectional area.

j. At no point may any components of an individual element or adjacent elements intersect or come in direct contact with one another.

Stainless steel:

a. The 16-inch stainless steel static mixer and associated appurtenances shall comply with the criteria in Table 1 and these specifications.

**TABLE 1 CRITERIA FOR 16-INCH DIAMETER STAINLESS STEEL STATIC MIXER**

| Item/Design Conditions | Criteria |
|---|---|
| Mixer Type | Static, in-line type, with no moving parts |
| Mixer Description | Each static mixer shall be flanged ends, flange gaskets, and Type 316 SS flange nuts and bolts for connection to adjacent flanged piping |
| Model* | 16 HEV-6 |

| TABLE 1 CRITERIA FOR 16-INCH DIAMETER STAINLESS STEEL STATIC MIXER | |
|---|---|
| **Item/Design Conditions** | **Criteria** |
| Materials of Construction | SS 316 |
| Number of Elements | 6 |
| Capacity | 300 GPM minimum flow rate<br>2,500 GPM maximum flow rate |
| Pressure Rating | 100 psig (Design Working Pressure)<br>200 psig (Design Total Pressure - Working Plus Surge) |
| Head Loss | Less than or equal to psi/unit at 3,500 GPM |
| Number of Injector Nozzles per Unit | 2 injection nozzles with flanged connections (size and locations as shown on the drawings) |
| Chemical Injection Flow Rate | 1.1 GPH maximum, 0.003 GPH minimum |
| Number of Units | 1 |
| Operation | Continuous |

* Chemineer-Kenics model number of equivalent

b. Each mixing element shall be attached directly to the housing wall and cannot rely on adjacent elements, rods, retaining gates, fasteners, or any other device for retention within the mixer.

c. The static mixers shall incorporate materials, construction, and workmanship equal to or in excess of that required by ASTM A 240/A 240M.

Approved manufacturers:

a. The static mixers shall be manufactured by:

1. Chemineer-Kenics, Inc.; Dayton, Ohio.
2. or approved equal.

2.2 WATER SERVICE LINE MATERIALS

2.2.1 Copper Tube and Fittings

Copper tubing shall meet the requirements of Federal Specification WW-T 7996 and shall conform to ASTM B 75, ASTM B 88, and ASTM B 68 as they apply to Type K Copper Tubing. Rolled copper tubing is acceptable provided the Contractor installs the tubing without kinking.

2.2.2 Water Service Line Appurtenances

2.2.2.1 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.

2.2.2.2 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.

2.2.2.3 Curb or Service Stops

Curb stops shall be manufactured from cast bronze with machined fitting surfaces. Curb stops shall withstand a minimum working pressure of 150 psi. For curb stops (through 2 inches in diameter), the inlet and outlet connections shall be threaded or have 2-hole flanges to connect to the adjoining equipment, tubing, piping, couplings, unions, adapters, reducers, etc. as coordinated by the Contractor. The nuts and bolts for the flanges shall be cadmium-coated or zinc-plated. The inlet and outlet size shall be the same diameter, unless otherwise approved by the Contracting Officer. The curb stop inlet and outlet shall have the required all-bronze adapters, unions, bushings, or couplings to properly secure it to the adjacent items and appurtenances. Curb stops shall have padlock wings and be lockable with standard size padlocks. Curb stops shall be as manufactured by Ford Meter Box Company, Inc., or approved equal. Each curb stop shall be furnished with a solid bronze square-head plug for plugging the curb stop outlet. For stainless steel, insert stiffeners shall be used as required for connection to tubing, PVC pipe, HDPE pipe, or as required.

2.2.2.4 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.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

Any utilities damaged, both new and existing, as a result of this project shall be repaired per manufacturer's recommendations at no cost the Government.

3.1.1 General Requirements for Installation of Pipelines

3.1.1.1 Cutting Of Pipe

Cutting of pipe shall be done without damage to the pipe. Cutting shall be

done with an approved mechanical cutter. Wheel cutters shall be used when practical.

3.1.1.2 Location

For the location and separation requirements of the water main with respect to other utilities, refer to the Typical Utility Conflict Detail in the drawings.

3.1.1.3 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.4 Placing, Laying And Pipe Connections

Pipe and accessories shall be carefully lowered into the trench by suitable equipment. Under no circumstances shall materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Poles used as levers for removing skids across trenches shall be made of wood and have broad flat faces to prevent damage to the pipe or coating. Except where necessary in making connections with other lines or as authorized, pipe shall be laid with the bells facing upstream. Full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that foreign material will not enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor in an approved manner, at no additional expense to the Government.

Pipe ends left for future connections shall be valved, plugged, or capped and anchored. Where connections are made between new work and existing mains, the connections shall be made by using special sections and fittings to suit the actual conditions. Where made under pressure, connections shall be installed in accordance with the recommendations of the manufacturer of the pipe being tapped.

3.1.1.5 Rubber Gaskets

Rubber gaskets shall be handled, lubricated, and installed in accordance with the pipe manufacturer's recommendations.

3.1.1.6 Couplings And Joints

Installation of couplings, mechanical joints, and flanged joints shall be in accordance with the manufacturer's recommendations. Pipe Connections between different types of pipe and accessories shall be made with transition fittings as recommended by the manufacturer.

3.1.1.7 Deflection

Maximum allowable deflection for ductile iron bell-and-spigot pipe and mechanical-joint pipe, shall be as recommended by the manufacturer.

When the alignment requires deflections in excess of the manufacturer's recommendations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set

forth, as approved. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflections does not exceed the maximum recommended by the pipe manufacturer. Short-radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated special sections.

3.1.1.8 Installation of Tracer Wire

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

3.1.1.9 Anchoring and Restraining

Refer to drawings for thrust block requirements.

3.1.1.10 Locating Devices

Locating devices shall be located as indicated in the contract documents. For all subsurface fittings with thrust blocks, embed the device into the top surface on the thrust block such that half the device is exposed and the location is at the centroid of the thrust block top surface area. For all subsurface elbows, tees, and valves without thrust blocks installed, install the device 6 inches above the fitting unless noted otherwise. The locating devices shall be Omni Marker Model 161 Water Marker or approved equal. Locating devices shall not be installed at vertical bends.

3.1.1.11 Connections to Existing Water Lines

Make connections to existing water lines after approval is obtained and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.

3.1.1.12 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.1.13 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.

3.1.1.15 Stainless Steel Pipe and Fittings

3.1.1.15.1 Fabrication, Assembly, and Erection

Beveled ends for butt-welding shall conform to ANSI B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding. When welding the reverse side, chip out slag before welding.

Fabrication shall comply with ASME B31.3, Chapter V. Welding procedure and performance qualifications shall be in accordance with Section IX, Articles II and III, respectively, of the ASME Boiler and Pressure Vessel Code.

The minimum number of passes for welded joints shall be as follows:

| Steel Cylinder Thickness (inch) | Minimum Number of Passes for Welds |
|---|---|
| Less than 0.1875 | 1 |
| 0.1875 through 0.25 | 2 |
| Greater than 0.25 | 3 |

Welds shall be full penetration.

Use the shielded metal arc welding (SMAW) submerged arc welding (SAW),

flux-cored arc welding (FCAW), or gas-metal arc welding (GMAW) process for shop welding. Use the SMAW process for field welding.

Welding preparation shall comply with ASME B31.3, Paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ASME B31.3, Table 341.3.2, and Paragraph 341.4 for visual examination.

Identify welds in accordance with ASME B31.3, Paragraph 328.5.

Clean each layer of deposited weld metal before depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.

Use an inert or shielding gas welding method. Do not use oxygen fuel welding. The interior of the pipe shall be purged with inert gas before the root pass.

Welded butt joints (both longitudinal and circumferential) shall comply with AWWA C220, Section 4. Do not use backing rings. Provide full penetration and smooth internal diameters for the root bead of welds. Grind the inside weld of socket welds flush with the pipe internal diameter. Welds shall be of smooth finish. Use anti-spatter compounds specifically formulated or designed for use with stainless steel. Do not allow heat tint to form in the heat-affected zone or remove heat tint completely from the heat-affected zone of the finished weld. The maximum depth of grinding or abrasive blasting to remove defects shall not exceed 10 percent of the wall thickness. Do not perform abrasive blasting with steel shot, grit, or sand.

No iron or steel surfaces shall come into contact with the stainless steel. This includes placing the stainless steel on steel tables, racks, pipe supports, etc. Do not use carbon steel wire brushes or grinders.

Welding electrodes shall comply with AWS A5.4/A5.4M. Bare wire shall comply with AWS A5.9/A5.9M. Use electrodes as follows:

| Pipe Material | Welding Electrode Material |
|---|---|
| Type 304 | E 308 |
| Type 304L | E 347 |
| Type 316 | E 316 |
| Type 316L | E 318 |

3.1.1.15.2 Shop Testing of Fabricated or Welded Material

After completion of fabrication and welding in the shop and before the application of any lining or coating, test each component according to the referenced standards. Test fabricated fittings as specified in AWWA C200. Test the seams in fittings that have not been previously shop hydrostatically tested by the dye penetrant method as described in ASME BPVC SEC VIII, Appendix B. In lieu of the dye penetrant method of testing, completed fittings may be hydrostatically tested. Use the field hydrostatic test pressure or 125 percent of the design pressure, whichever is higher.

3.1.1.15.3 Installing Buried Piping

Install in accordance with Section 31 00 00, EARTHWORK, and as follows.

When installing pipe in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure for grade at the pipe invert.

3.1.1.15.4 Field Hydrostatic Testing

The Contractor shall hydrostatically test pipe and fittings in the field in accordance with paragraph entitled "TESTING--NON-HDPE PIPE AND FITTINGS" of this section.

Do not allow test water to remain in the pipe for more than 5 days. Drain and dry the piping after completing the testing.

3.1.1.15.5 Painting and Coating

Do not coat buried stainless steel piping.

3.1.1.16 Copper Piping--Joint Construction

Soldered Joints: Use ASTM A 813/A 813M, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B828 procedure, unless otherwise indicated.

3.1.2 Installation of Automated Flushing Valves

Remove rock or other debris that might create uneven pressure on the unit from the bottom of the hole. Compact the bottom of the hole to minimize settling after installation.

Install a 4-inch lift of non-compacted sand or similar bedding material into the bottom of the hole.

Backfill the hole around the automatic flushing valve with a combination of #57 stone and clean fill, free of rock or other debris. Backfilling shall be accomplished in 6-inch lifts. Use a level to ensure the unit is level after each lift.

The automatic flushing valve shall be disinfected in accordance with ADH and AWWA standards.

3.1.3 Installation of Valves and Hydrants

a. Installation of Valves: Installation of valves shall be in accordance with manufacturer's recommendations.

b. Installation of Hydrants: Installation of hydrants shall be in accordance with manufacturer's recommendations. Install hydrants with the 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, contact the Contracting Officer for further instructions.

3.1.4 Installation of Pipe Insulation

All insulation work shall be executed by skilled insulation workmen regularly employed in the trade.

All insulation shall be applied in strict accordance with these Specifications and with factory-printed recommendations on items not mentioned in this Section. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many

times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of 3 years experience specializing in the trade.

Do not apply insulation until all surfaces to be covered are tested for leaks and approved, cleaned, dried, and all foreign material such as rust, scale, dirt, etc., has been removed.

Clean and dry insulation when installing and during the application of any finish.

Do not install insulation when temperature is less than 45 degrees F.

Insulate fittings and flanges with sections fabricated from standard insulation sections, rigid urethane boards or blocks, or a combination of both.

Fit insulation to eliminate voids. Seal all joints.

For heat-traced piping, insulate fittings, joints, and valves with insulation compatible with the heating cables and associated equipment. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams on the bottom side of horizontal piping.

3.1.4.1 Exposed Outside Piping

Install aluminum covering only after the insulation application has been inspected and approved by the Contracting Officer.

Seal lap-type covering systems on butt and longitudinal seams. Overlap shall be 2 inches minimum on side and edge laps with longitudinal cut edge turned under to provide a smooth edge.

Seal lock joint systems on longitudinal and butt or end seams.

Position all horizontal joints to shed water.

Fasten aluminum covering with 1/2-inch-wide-by-0.105-inch-thick stainless steel bands installed on 9-inch center.

3.1.5 Installation of Water Service Piping

3.1.5.1 Service Line Connections to Water Mains

Connect service lines 2 inch size to the main by a corporation stop and gooseneck 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.

3.1.6 Installation of Transition Coupling--HDPE to Stainless Steel

Install transition coupling per manufacturer's requirements and recommendations.

3.2 TESTING -- NON-HDPE PIPE AND FITTINGS

3.2.1 Hydrostatic Test of Above ground or Exposed Piping

Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges.

Subject the piping system to the test pressure of 150 psi. Maintain the test pressure for a minimum of 2 hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

3.2.2 Leakage Test for Buried Piping

Leakage tests shall be conducted concurrently with the pressure test. Duration of each leakage test shall be at least 2 hours. During the test, the main shall be subjected to a pressure of 150 psi. Leakage is defined as the additional quantity of water supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system. The allowable leakage volume is defined by the formula:

| **DUCTILE IRON PIPE** | **PVC PIPE** |
|---|---|
| $L = \frac{SD(P)^{1/2}}{C}$ | $L = \frac{ND(P)^{1/2}}{C}$ |
| in which: | in which: |
| L = allowable leakage (gallons) | L = allowable leakage (gallons) |
| S = length of pipe tested (feet) | N = number of rubber-gasketed joints in the pipe tested |
| D = diameter of the pipe (inches) | D = diameter of the pipe (inches) |
| P = specified test pressure (psig) | P = specified test pressure (psig) |
| C = 133,200 | C = 7,400 |

Should any test of laid pipe disclose a leakage greater than that shown, the defective joints shall be located and repaired until the leakage is within the specified tolerance, at no additional cost to the Government.

3.2.3 Test Timing

Except where concrete-reaction backing necessitates a 72-hour delay, pipelines jointed with rubber gaskets, mechanical, or bolted joints may be subjected to hydrostatic pressure, inspected, and tested for leakage after partial completion of backfill.

3.2.4 Retesting

Before permanent paving is placed over the pipeline, a measured leakage test of the entire pipeline shall be required. Leakage loss shall be within approved tolerances.

3.2.5 Sterilizing

Water piping, including valves, fittings, and other devices, shall be sterilized and tested according to AWWA C651. After successful sterilization, the piping shall be flushed before placing into service. Water for sterilization will be furnished by the Government, but disposal shall be the responsibility of the Contractor.

3.3 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 |

*These allowances only apply to the test phase and not to the initial expansion phase.*

3.4 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
Type of Assembly
Manufacturer
Model Number
Serial Number
Size
Location
Test Pressure Readings

Data on Testing Firm
Name
Address
Certified Tester
Certified Tester No.
Date of Test

Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.5 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.

3.6 DISINFECTION CRITERIA FOR KSC POTABLE WATER SYSTEM INSTALLATION, REPAIR, OR MODIFICATION TO WATER MAINS

The KSC Pollution Control and Sanitation Officer (PCSO) or designated representative shall approve the disinfection procedure to be used and be present during the process. A minimum of 24 hours lead time is required to schedule attendance of disinfection by PCSO or representative. Contact should be made through the Construction Management Office. Ensure proper disinfection protocol/bacteriological sampling occurs if water line is broken, tapped, modified, or if loss of pressure occurs. All repaired, modified or newly installed water system components shall be disinfected after pressure and leak tests have been performed. All existing mains closed for outage shall be disinfected and tested prior to use. The system components to be disinfected shall be thoroughly flushed with potable water before introducing the chlorinating solution. This flushing is required to remove all debris from the systems components. The chlorinating solution shall provide a dosage of not less than 50 parts per million (ppm). The chlorine solution shall be introduced into the water line in an approved manner and be evenly distributed throughout the entire effected systems components long enough to destroy all non-spore forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and tests shall reveal not less than 25 ppm of chlorine residual after the 24 hour retention period. The line shall be flushed with potable water until the residual chlorine level is reduced to less than 1.0 ppm or to the normal background level in the area. Discharge of highly chlorinated water from disinfection shall be coordinated with URS Water and Wastewater. Samples will be collected by the Contractor or designated representative from several points in the water system for bacteriological examination. The system will remain closed and will not be accepted for use until two consecutive days of satisfactory bacteriological results have been obtained and approval has been given by the PCSO and regulatory agencies.

Taps, modification, repairs, or new lines added to the system shall be tested and disinfected following AWWA C651 and KNPR 8500.1. Successful disinfection shall be demonstrated by bacteriological testing following FAC 62-555.340(1) and FAC 62-555.340(2).

Bacteriological testing shall be provided by the Government. The Contractor shall coordinate the scheduling of tests with the Government and take corrective actions if results do not meet required standards.

3.7 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.

3.8 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 30 00

SANITARY SEWERS

PART 1 GENERAL

1.1 RELATED SECTIONS

The provisions of other sections of the General and Supplementary Conditions are fully applicable to this Section as if incorporated herein.

Other related or referenced sections contained herein are as listed below:

| | |
|---|---|
| Section 03 01 30.71 | CONCRETE REHABILITATION |
| Section 03 30 00 | CAST-IN-PLACE CONCRETE |
| Section 03 40 00.00 10 | PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION |
| Section 09 90 00.00 98 | PAINTING AND COATING |
| Section 31 00 00 | EARTHWORK |

1.2 REFERENCES

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

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI C1012 | (2007; Errata 2009) Ductile Iron or Malleable Iron for 1/2-inch thru 1-1/2-inch |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C111/A21.11 | (2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C200 | (2005) Steel Water Pipe - 6 In. (150 mm) and Larger |
| AWWA C504 | (2006; R 2010) Standard for Rubber-Seated Butterfly Valves |
| AWWA C606 | (2006) Grooved and Shouldered Joints |
| AWWA M11 | (2004; 4th Ed) Manual: Steel Water Pipe: A Guide for Design and Installation |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME BPVC | (2010) Boiler and Pressure Vessels Code |
| ASME B1.20.1 | (1983; R 2006) Pipe Threads, General Purpose (Inch) |
| ASME B16.1 | (2005) Gray Iron Threaded Fittings; |

| | |
|---|---|
| | Classes 25, 125 and 250 |
| ASME B16.11 | (2009) Forged Fittings, Socket-Welding and Threaded |
| ASME B18.2.1 | (2010) Square and Hex Bolts and Screws (Inch Series) |
| ASME B18.21.1 | (2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series) |
| ASME B18.22.1 | (1965; R 2008) Plain Washers |
| ASME B18.6.1 | (1981; R 2008) Wood Screws (Inch Series) |
| ASME B18.6.3 | (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 |
| ASME B31.1 | (2010) Power Piping |
| ASME B31.3 | (2010) Process Piping |
| ASME B36.19M | (2004; R 2010) Stainless Steel Pipe |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 105/A105M | (2010a) Standard Specification for Carbon Steel Forgings for Piping Applications |
| ASTM A 181/A181M | (2006) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping |
| ASTM A 126 | (2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM A 153/A 153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A 182/A 182M | (2010a) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| 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 312/A 312M | (2011) Standard Specification for |

| | |
|---|---|
| | Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A 325 | (2009a) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A 380 | (2006) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems |
| ASTM A 403/A 403M | (2010a) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings |
| ASTM A 47/A 47M | (1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A 489 | (2004e1) Standard Specification for Carbon Steel Lifting Eyes |
| ASTM A 513 | (2008a) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing |
| ASTM A 530/A 530M | (2004a; R 2010) Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe |
| ASTM A 563 | (2007a) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A 635/A 635M | (2009b) Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for |
| ASTM A 743/A 743M | (2006) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application |
| ASTM D 2564 | (2009) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM B 633 | (2007) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel |
| ASTM C 478 | (2009) Standard Specification for Precast Reinforced Concrete Manhole Sections |
| 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 2680 | (2001) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping |
| ASTM D 2855 | (1996; R 2010) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings |
| ASTM D 3034 | (2008) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings |
| ASTM D 3261 | (2010a) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing |
| ASTM D 3350 | (2010) 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 436 | (2010) Standard Specification for Hardened Steel Washers |
| ASTM F 593 | (2002; R 2008) Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F 594 | (2009) Standard Specification for Stainless Steel Nuts |
| ASTM F 656 | (2010) Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings |

| | |
|---|---|
| ASTM F 714 | (2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter |
| ASTM F 879 | (2010) Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws |
| ASTM F 1417 | (1992; R 2005) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.4/A5.4M | (2006) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding |
| AWS A5.9/A5.9M | (2006; Errata 2007) Specification for Bare Stainless Steel Welding Electrodes and Rods |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 9001 | (2008; Corr 1 2009) Quality Management Systems- Requirements |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-70 | (2006) Gray Iron Gate Valves, Flanged and Threaded Ends |
| MSS SP-83 | (2006) Standard for Class 3000 Steel Pipe Unions Socket Welding and Threaded |
| MSS SP-97 | (2006) Integrally Reinforced Forged Branch Outlet Fittings - Socket Welding, Threaded, and Buttwelding Ends |

## 1.3 SYSTEM DESCRIPTION

### 1.3.1 Sanitary Sewer Gravity Pipeline

Provide new exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.

### 1.3.2 Sanitary Sewer Pressure Lines

Provide pressure lines of high density polyethylene (HDPE) pipe.

## 1.4 SUBMITTALS

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

SD-01 Preconstruction Submittals

Submit method of testing in accordance with the paragraph entitled "Gravity Piping."

SD-03 Product Data

Pipeline materials; G
Pipeline Appurtenances; G

Submit manufacturer's standard drawings or catalog cuts.

SD-06 Test Reports

Air Test; G
Hydrostatic Test; G
Leakage Test; G

Reports for the following shall be submitted in accordance with paragraph entitled "Reports" of this section.

Reports; G

Test and inspection reports, as specified.

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Installing Contractor's License shall be current and be state certified or state registered.

1.5.1.1 Quality Control For Stainless Steel Pipe

Include the "Hydrostatic Test" and "Flattening Test" requirements described in ASTM A 530/A 530M.

Use only certified welders meeting procedures and performance outlined in Section IX of the ASME BPVC and other codes and requirements in accordance with local building and utility requirements. Obtain Welder's certificates for the project record before beginning any welding on the project. The Welder must be certified for all positions (flat, vertical, and overhead).

Have all welds conform to highest industrial practice in accordance with ASME B31.3 and ASME B31.1 or other codes and requirements in accordance with local building and utility requirements.

1.5.2 Drawings

a. Installation drawings shall be submitted showing complete detail, both plan and side view details with proper layout dimensions and elevations.

b. Record drawings for the complete sanitary sewer system shall be submitted showing complete detail with all dimensions, both above and below grade, including invert elevations.

c. Record drawings shall be signed and sealed by a Professional

Surveyor. Include the following statement: "All potable water lines crossed by sanitary hazard mains are in accordance with the permitted utility separation requirements."

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery and Storage

1.6.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.6.1.2 Metal Items

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.6.1.3 Cement, Aggregate, and Reinforcement

As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.6.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench.

PART 2 PRODUCTS

2.1 PIPELINE MATERIALS

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 PVC Plastic Sewer Piping

2.1.1.1 PVC Plastic Pipe and Fittings

Polyvinyl chloride (PVC) pipe and fittings shall conform to ASTM D 3034, Cell Classification 12454-B DR 35 with push-on joints and shall be green.

2.1.2 PVC Plastic Pressure Pipe and Fittings

2.1.2.1 Pipe

Pipe shall be Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D 1784 and ASTM D 1785.

2.1.2.2 Fittings

Fittings shall be Schedule 80 and shall conform to ASTM D 2464 for threaded fittings and ASTM D 2467 for socket-type fittings.

2.1.2.3 Unions

Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 80. Material shall be Type I, Grade 1 PVC, conforming to ASTM D 1784.

2.1.2.4 Joints

Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to valves and equipment.

2.1.2.5 Solvent Cement

Solvent cement for socket joints shall comply with ASTM D 2564 and ASTM F 656.

2.1.3 HDPE Plastic Pressure Pipe and Fittings

2.1.3.1 General

All HDPE shall be DriscoPlex PE 3408 HDPE or approved equal.

All HDPE pipe 4 inches in diameter or greater shall have a ductile iron pipe outside diameter, and HDPE pipe 3 inches in diameter and smaller shall be IPS unless otherwise specified or drawing in the drawings.

All HDPE piping system components shall be the products of one manufacturer.

Pipe and fittings shall be manufactured by an ISO 9001-certified manufacturer.

2.1.3.2 HDPE Pipe

HDPE pipe 4 inches in diameter and larger shall conform to material standard ASTM D 3350 345435 E cell classification rated as PE 3408 by the Plastic Pipe Institute. Minimum pressure rating shall be in accordance with Piping Schedule Drawing or 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 3 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 800 psi at 73.4 degrees 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.

2.1.3.3 HDPE Pipe Fittings

Use molded or fabricated polyethylene fitting. The polyethylene fittings shall be molded or fabricated by the pipe manufacturer. 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.

a. Molded Fittings shall be manufactured in accordance with ASTM D 3261

and shall be so marked. Each production lot of molded fittings shall be subject 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.

b. 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.

The manufacturer of the HDPE pipe shall supply all DI/HDPE mechanical joint adapters and accessories required to connect plain-end HDPE piping to mechanical joint fittings, valves, and appurtenances.

The DI/HDPE mechanical joint adapter shall consist of:

a. A molded or fabricated HDPE mechanical joint transition fitting.

b. A gasket for a DI mechanical joint.

c. A ductile iron mechanical joint backup drive ring.

d. Mechanical joint tee bolts.

e. A stainless-steel sleeve stiffener molded or fabricated within the MJ end of the HDPE mechanical joint adapter fitting.

The DI/HDPE mechanical joint adapter shall be connected to the HDPE pipe by a heat-fused joint on one end and connected to a ductile iron pipe valve, fitting, or appurtenance with the internally stiffened mechanical joint end.

The tee bolts and backup drive ring shall act as a joint restraint for connections to mechanical joints.

The HDPE mechanical joint adapter fitting shall be molded or fabricated by the manufacturer of the HDPE pipe. All molded fittings shall be fully pressure rated to match the SDR pipe pressure rating. Fabricated fittings shall be rated for internal pressure service equivalent to the full pressure rating of the mated IPS pipe.

If rework compounds are required, only those generated in the manufacture's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.

Solvent epoxy cementing and mechanical joining with bolt on wrap-around clamps shall not be used.

2.1.3.4 HDPE Pipe Jointing Method

HDPE pipe shall be jointed by butt fusion in accordance with 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 a restrained joint. Same-diameter pipe may be

joined by using HDPE flange adapters and backup rings bolted to each other.

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, the spool shall be Schedule 40 Type 304 stainless steel piping with IP threads stainless steel.

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.

2.1.4 Stainless Steel Pipe and Fittings

2.1.4.1 Stainless Steel Pipe

Pipe smaller than 3 inches shall conform to ASTM A 312/A 312M, Grade TP 304L. Pipe 3 inches and larger shall conform to ASTM A 312/A 312M, Grade TP 304L.

Pipe sizes and wall thicknesses shall conform to ASME B36.19M as follows:

| Pipe Size | Wall Thickness |
|---|---|
| 1-1/4 inches through 3 inches | Schedule 80S |

2.1.4.2 Fittings

Fittings 3 inches and smaller shall be socket welded, conforming to ASME B16.11, 3,000-pound CWP. Material for socket-welded fittings shall conform to ASTM A 403/A 403M, Class WP 304L or ASTM A 182/A 182M, Grade F304L.

2.1.4.3 Preparation and Final Cleaning

Pipe and fittings shall be final cleaned, pickled, and passivated in accordance with ASTM A 380. Passivation shall be the removal of exogenous (not inherent in the base metal) iron or iron compounds from the surface of the stainless steel by a chemical dissolution, a treatment with an acid solution that will completely remove the surface contamination but will not significantly affect the stainless steel itself. After final cleaning, wet surfaces with water and inspect for rust spots after 24 hours. Reclean if there is any evidence of rusting.

2.1.4.4 Protective End Caps

The Contractor shall provide protective end caps on each piece of pipe or

fabricated section, completely sealing the piece from contamination during shipment and storage. Provide the same type of seals on each fitting or ship and store fittings in sealed boxes or containers.

2.1.4.5 Unions

Unions shall be 3,000-pound WOG-forged stainless steel, with dimensions conforming to MSS SP-83. Ends shall be socket-welded type. Material shall conform to ASTM A 182/A 182M, Grade F304L for socket-welded type.

2.1.4.6 Joints

Joints for pipes 3 inches and smaller shall be socket welded, the same material as specified for fittings, 3,000-pound WOG, conforming to ASME B16.11.

Provide plain-end pipe where flexible pipe couplings are to be provided. Provide lugs for thrust harnesses in accordance with the paragraph titled "Fittings."

Where piping connects to wall pipes, meters, valves, or other equipment, the pipe ends shall match the ends of the wall pipes, meters, valves, or equipment.

2.1.4.7 Outlets and Nozzles

Outlets of 3 inches and smaller in piping 4 inches and larger shall be of the Thredolet type, in accordance with MSS SP-97 and AWWA M11, Figure 13-23. Outlets shall be 3,000-pound WOG stainless steel in accordance with ASTM A 182/A 182M, Grade F304L F316L or ASTM A 403/A 403M, Grade WP304L WP316L. Threads shall comply with ASME B1.20.1. Outlets shall be Bonney Forge Co. "Thredolet," Allied Piping Products Co. "Branchlet," or equal.

Alternatively, threaded openings not less than 2 inches or more than 3 inches in nominal size shall be a flat-bottom half-coupling conforming to ASME B16.11, Class 3000. Where the mounting surface is curved to a diameter of 36 inches or less, the mounting diameter shall be the same as that of the surface upon which it is to be mounted. Forge the threaded outlet and its plug from steel conforming to ASTM A 105/A105M or ASTM A 181/A181M, Class 70.

For outlets 3 inches and smaller in piping smaller than 4 inches, use a tee with a threaded outlet.

For outlets larger than 3 inches, use a tee with a flanged outlet.

2.1.4.8 Groove-End Couplings

Grooved-end couplings for piping 24 inches and smaller shall be Type 316 stainless steel. Couplings shall be flexible type, square-cut grooved, in accordance with AWWA C606. Couplings shall be Victaulic Style 77-S, Gustin-Bacon Figure 100, or equal.

Gaskets shall be EPDM and shall conform to ASTM D 2000.

Bolts in exposed service shall conform to stainless steel. Bolts in buried or submerged service shall be stainless steel.

Couplings for connecting to grooved-end valves shall be Victaulic Style 75

to match the valve ends.

Grooved-end adapter flanges for pipe 18 inches and smaller having a maximum test pressure of 200 psi shall comply with ASME B16.1, Class 125 dimensions. Flanges shall be Victaulic Style 741 or 742, Gustin-Bacon Figure 154, or equal.

2.1.4.9 Lubricant for Stainless Steel Bolts and Nuts

Anti-seize thread lubricant shall be applied to the thread portion of all (above grade and below grade) stainless steel bolts (stainless steel tie rods, etc.) during assembly. Anti-seize lubricant shall be chloride free and shall be nongalling NSF approved. Anti-seize thread lubricant shall be Jet-Lube "Nikal," John Crane "Thred Gard Nickel," Never-Seez "Pure Nickel Special," or Permatex "Nickel Anti-Seize."

2.1.5 Ductile Iron Pipe

Ductile iron piping and appurtenances shall conform to the ductile iron pipe section in Section 33 11 00 WATER DISTRIBUTION with protective 401 lining or approved equal instead of cement lining and shall be painted green.

2.1.6 Pipeline Appurtenances

Provide fasteners in accordance with the following section unless otherwise noted.

1. General: For all exterior applications and where fastening aluminum, provide Type 304 stainless-steel fasteners. Provide hot-dipped galvanized fasteners in all other applications in accordance with ASTM A 153/A 153M unless noted otherwise on the drawings. Select fasteners for type, grade, and class required.

2. High-Strength Bolts and Nuts: ASTM A 325 with heavy hex nuts ASTM A 563 and hardened carbon-steel washers ASTM F 436.

3. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, with hex nuts, ASTM A 563, and, where indicated, flat washers.

4. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group A4.

5. Stainless Steel Socket Button and Flat Countersunk Head Cap Screws: ASTM F 879.

6. Anchor Bolts: ASTM F 1554, Grade 36.

7. Eyebolts: ASTM A 489.

8. Machine Screws: ASME B18.6.3.

9. Lag Bolts: ASME B18.2.1.

10. Wood Screws: Flat head, ASME B18.6.1.

11. Plain Washers: Round, ASME B18.22.1.

12. Lock Washers: Helical, spring type, ASME B18.21.1.

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.

2.1.7 Transition Couplings

Transition Coupling shall consist of a high-strength steel body, two steel or malleable iron flange or follower rings, a wedge shaped resilient gasket and sufficient number of follower bolts.

Adapter: Steel construction, ASTM A 513, ASTM A 635/A 635M or ASME SA-675GR60, free of surface defect.
Followers: AISI C1012 or ASME SA-36
Bolts: AWWA C111/A21.11
Gasket: Grade 27 BUNA-S.
Shop Paint: Fusion bonded epoxy coating.
Acceptable Manufacturers:
Dresser Manufacturing Division of Dresser Industries, Inc.; Dresser Styles 62 and 162 or approved equal.

2.2 VALVES

2.2.1 Plug Valve

Conform plug valves to MSS SP-70.

Ensure that all plug valves are eccentric plug valves unless otherwise specified.

Plug valves shall be of the nonlubricated rectangular ported eccentric type with resilient faced plugs. Furnish valves in vaults or above-grade with flanged end connections. Furnish buried valves with mechanical joint end connections. Face and drill flanged valves to the ANSI 125/150-pound standard. Mechanical joint ends shall conform with AWWA C111/A21.11, grooved ends shall conform with AWWA C606. Screwed ends shall conform to the NPT standard.

Valve bodies shall be made of Class B cast iron conforming to ASTM A 126.

Furnish bodies in 4-inch and larger valves with a 1/8 inch welded overlay seat of not less than 90 percent pure nickel. Seat area shall be raised with raised surface completely covered with weld to ensure that the plug face contacts only nickel. Screwed-in seats are not acceptable.

Plugs shall be cast iron conforming to ASTM A 126 Class B. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat with the plug in the closed position shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be chloroprene (CR) or resilient facing suitable for application. VE option of round port valves is not acceptable.

Bearings shall have sleeve type metal bearings and shall be of sintered, soil impregnated permanently lubricated Type 316 ASTM A 743/A 743M Grade CF-8M. Non metallic bearings are not acceptable.

Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable and repackable without removing the actuator or bonnet from the valve under pressure. Valves using O-ring seals or non-adjustable packing are not acceptable. All exposed nuts, bolts, springs, washers, and other fasteners shall be 300-series stainless steel.

Pressure ratings shall be 175 psi. Test every valve with a hydrostatic and seat test and furnish certified copies of proof-of-design test reports as outlined in AWWA C504, Section 5.5.

Unless noted otherwise, equip manual valves with the following actuators:

Exposed valves 4 inches: removable lever actuators.

Equip all valves 6 inches and larger with worm-gear type actuators. Geared actuators shall be worm-gear type. Geared actuators and mounting brackets shall be designed for buried and submerged service and shall be totally enclosed in a cast iron housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. Support the actuator shaft and the quadrant on permanently lubricated bronze bearings.

Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque and to provide adjustment to compensate for change in pressure differential or flow direction change.

Ensure that valves and gear actuators for buried or submerged service have seals on all shaft and gaskets on the valve and actuator covers to prevent the entry of water. Totally enclose actuator mounting brackets for buried or submerged service and provide gasket seals.

All actuators shall be furnished by the valve manufacturer and shall be factory assembled, adjusted, and tested with the valve. Test reports shall be available upon request.

The exterior of valves and actuators shall be factory prepared and primed, and field finish coated in accordance with Section 09 90 00.00 98 PAINTING AND COATING. Buried valves shall be polyethylene encased as specified herein for ductile iron pipe and fittings.

Plug valves shall be DeZURIK PEC or approved equal.

2.2.2 Air Release Valves

Use air release valves designed to permit release of air from an empty pipe during filling and capable of discharging accumulated air in the line while the line is in operation and under pressure. Attach valves with threaded pipe connections. Ensure that valves are vented to the atmosphere.

2.2.2.1 Combination Valve

Automatic combination valves shall be capable of withstanding operating pressures of 150 psi. The valves shall have a threaded outlet. The body and cover of the valve shall be made of iron with a stainless steel float. All internal parts shall be stainless steel or bronze. The valve shall be specifically adapted for use with sewage. Each valve shall be complete with hose and blow-off valves to permit backflushing without dismantling the valve. The valve shall be the Valmatic Combination Air Valve Series 800S or approved equal.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Precast Concrete Manholes

Precast concrete manhole risers, base sections, and tops shall conform to ASTM C 478 and be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser shall be monolithic.

2.3.2 Transition Coupling--HDPE to Stainless Steel

Refer to paragraph entitled "Transition Coupling--HDPE to Stainless Steel" of Section 33 11 00, WATER DISTRIBUTION.

2.3.3 Tracer Wire for All Piping Including Horizontal Directional Drilling

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

2.4 REPORTS

Submit Test Reports. Compaction and density test shall be in accordance with Section 31 00 00 EARTHWORK. Submit Inspection Reports for daily activities during the installation of the sanitary system. Information in the report shall be detailed enough to describe location of work and amount of pipe laid in place, measured in linear feet.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

Any utilities damaged, both new and existing, as a result of this project shall be repaired per manufacturer's recommendations at no cost the Government.

3.1.1 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.1.1.1 Location

For the location and separation requirements of the water main with respect to other utilities, refer to the Typical Utility Conflict Detail in the Drawings.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Bottom of trench shall be shaped to give uniform circumferential support to the lower fourth of each pipe. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid true to line and grade in a manner to form a close concentric joint with the adjoining pipe and prevent sudden offsets of the flow line. Interior of the sewer shall be cleared of superfluous materials at all times. Where cleaning after laying is difficult, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after jointing has been completed. When the maximum width of the trench at the top of the pipe is exceeded for any reason other than by direction, the Contractor shall install, at no additional cost to the Government, such bedding as may be required to satisfactorily support the added load of the backfill. Trenches shall be kept free from water until the pipe-joining material has set. Pipe shall not be laid when the condition of the trench or the weather is unsuitable for such work. When work is not in progress, open ends of pipe and fittings shall be closed to prevent intrusion of foreign materials.

Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for ABS and PVC composite pipe shall conform to Figure 2 of ASTM D 2680; saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

3.1.1.4 Connections to Existing Lines

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

3.1.1.5 Installation of Tracer Wire

Tracer wire for all piping is specified under Section 31 00 00 EARTHWORK.

3.1.2 Special Requirements

3.1.2.1 Installation of HDPE Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with requirements of ASTM F 714.

3.1.2.2 Solvent-Welded Joints

Before solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least 1 hour.

Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent-welded pipe ends as recommended by the pipe manufacturer.

Wipe away loose dirt and moisture from the inside and outside of the pipe end and the inside of the fitting before applying solvent cement. Clean the surfaces of both pipes and fittings that are to be solvent welded with a clean cloth moistened with acetone or methylethyl ketone. Do not apply solvent cement to wet surfaces.

The pipe and fitting socket shall have an interference fit. The diametrical clearance between pipe and entrance of the fitting socket shall not exceed 0.04 inch. Check the fit at every joint before applying solvent cement.

Make up solvent-welded joints in accordance with ASTM D 2855. Application of cement to both surfaces to be joined and assembly of these surfaces shall produce a continuous bond between them with visual evidence of cement at least flush with the outer end of the fitting bore around the entire circumference.

Allow at least 8 hours of drying time before moving solvent-welded joints or subjecting the joints to any internal or external loads or pressures.

Acceptance criteria for solvent-welded joints shall be as follows:

Unfilled Areas in Joint: None permitted.

Unbonded Areas in Joint: None permitted.

Protrusion of Material into Pipe Bore, Percent of Pipe Wall Thickness: Cement, 50 percent.

3.1.2.3 Stainless Steel Pipe

3.1.2.3.1 Fabrication, Assembly, And Erection

Fabrication shall comply with ASME B31.3, Chapter V. Welding procedure and performance qualifications shall be in accordance with Section IX, Articles II and III, respectively, of ASME BPVC.

The minimum number of passes for welded joints shall be as follows:

| Steel Cylinder Thickness (inch) | Minimum Number of Passes for Welds |
|---|---|
| Less than 0.1875 | 1 |
| 0.1875 through 0.25 | 2 |
| Greater than 0.25 | 3 |

Welds shall be full penetration.

Use the shielded metal arc welding (SMAW) submerged arc welding (SAW), flux-cored arc welding (FCAW), or gas-metal arc welding (GMAW) process for shop welding. Use the SMAW process for field welding.

Welding preparation shall comply with ASME B31.3, Paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ASME B31.3, Table 341.3.2, and Paragraph 341.4 for visual examination.

Identify welds in accordance with ASME B31.3, Paragraph 328.5.

Clean each layer of deposited weld metal before depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.

Use an inert or shielding gas welding method. Do not use oxygen fuel welding. The interior of the pipe shall be purged with inert gas before the root pass.

Provide full penetration and smooth internal diameters for the root bead of welds. Grind the inside weld of socket welds flush with the pipe internal diameter. Welds shall be of smooth finish. Use anti-spatter compounds specifically formulated or designed for use with stainless steel. Do not allow heat tint to form in the heat-affected zone or remove heat tint completely from the heat-affected zone of the finished weld. The maximum depth of grinding or abrasive blasting to remove defects shall not exceed 10 percent of the wall thickness. Do not perform abrasive blasting with steel shot, grit, or sand.

No iron or steel surfaces shall come into contact with the stainless steel. This includes placing the stainless steel on steel tables, racks, pipe supports, etc. Do not use carbon steel wire brushes or grinders.

Welding electrodes shall comply with AWS A5.4/A5.4M. Bare wire shall comply with AWS A5.9/A5.9M. Use electrodes as follows:

| Pipe Material | Welding Electrode Material |
|---|---|
| Type 304 | E 308 |
| Type 304L | E 347 |
| Type 316 | E 316 |
| Type 316L | E 318 |

3.1.2.3.2 Shop Testing Of Fabricated Or Welded Components

After completion of fabrication and welding in the shop and before the application of any lining or coating, test each component according to the referenced standards. Test fabricated fittings as specified in AWWA C200. Test the seams in fittings that have not been previously shop hydrostatically tested by the dye penetrant method as described in Section VII of ASME BPVC, Appendix B. In lieu of the dye penetrant method of testing, completed fittings may be hydrostatically tested. Use the field hydrostatic test pressure or 125 percent of the design pressure, whichever is higher.

3.1.2.3.3 Installation Of Stainless Steel Bolts And Nuts

Coat threaded portions of stainless steel bolts and nuts with lubricant before assembly.

3.1.2.3.4 Painting And Coating

Do not coat stainless steel grooved-end couplings and Van Stone flanges.

Do not coat buried stainless steel piping, bolts, nuts, or tie rods.

3.1.3 Installation of Transition Coupling--HDPE to Stainless Steel

Refer to paragraph entitled "Installation of Transition Coupling--HDPE to Stainless Steel" of Section 33 11 00, WATER DISTRIBUTION.

3.1.4 Miscellaneous Construction and Installation

3.1.4.1 Connecting to Existing Manholes

Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

3.2 INSPECTION AND TESTING

3.2.1 General

Inspect all work constructed for faults or defects and correct any deviation from these documents or omissions at once. Conduct all tests and provide necessary equipment and personnel for lamping the system in the presence of the Contracting Officer. The Contractor shall bear all costs for these tests and inspections.

Test sewers by a low-pressure air test.

Ensure that pipe testing closely follows pipe laying. No more than 1,000 feet of pipe shall remain untested at any time.

3.2.2 Gravity Piping

Submit the proposed method of testing to the Contracting Officer for approval. Perform air testing in accordance with the procedures described in ASTM F 1417. Ensure that the equipment is specifically designed and manufactured for testing pipelines with low-pressure air and is provided with an air regulator valve or air safety valve set to prevent the air pressure in the pipeline from exceeding 8 psig. If the results of the air test are unsatisfactory, perform the exfiltration test as outlined above.

The following low-pressure air testing procedures may be used. Ensure that the sewer line has an orifice through which to pass air into the pipe. Connect an air supply to the orifice at one end of the line. The air supply line will contain an on/off gas valve and a pressure gauge with a range of 0 to 5 psi. Ensure that the gauge has minimum divisions of 0.10 psi and has an accuracy of plus/minus 0.04 psi. Properly block the seals at each manhole to prevent displacement while the line is under pressure. Pressurize the pipe line under test to 4 psig. Allow the line to stabilize between 4 psig and 3.5 psig for no less than 5 minutes. If necessary, add air to the line to maintain the pressure above 3.5 psig. After the

stabilization period, close the gas valve. When the line pressure drops to 3.5 psig, begin timing with a stop watch. Allow the stop watch to run until the line pressure drops to 2.5 psig. Then stop the watch and compare the time lapse to the allowable time lapse in these Specifications. If the time lapse is greater than that specified, the section undergoing the test shall have passed the low-pressure air test and the test will be discontinued at that time. If the time is less than that specified, the line has not passed the test (see Table 1 for test times).

**TABLE 1 AIR TEST TABLE**

| Length (feet) | 4 | 6 | 8 | 10 | 12 | 15 | 18 | 21 | 24 |
|---|---|---|---|---|---|---|---|---|---|
| 25 | 0:04 | 0:10 | 0:18 | 0:28 | 0:40 | 1:02 | 1:29 | 2:01 | 2:38 |
| 50 | 0:09 | 0:20 | 0:35 | 0:55 | 1:19 | 2:04 | 2:58 | 4:03 | 5:17 |
| 75 | 0:13 | 0:30 | 0:53 | 1:23 | 1:59 | 3:06 | 4:27 | 6:04 | 7:55 |
| 100 | 0:18 | 0:40 | 1:10 | 1:50 | 2:38 | 4:08 | 5:56 | 8:05 | 10:34 |
| 125 | 0:22 | 0:50 | 1:28 | 2:18 | 3:18 | 5:09 | 7:26 | 9:55 | 11:20 |
| 150 | 0:26 | 0:59 | 1:46 | 2:45 | 3:58 | 6:11 | 8:30 | -- | -- |
| 175 | 0:31 | 1:09 | 2:03 | 3:13 | 4:37 | 5:05 | -- | -- | -- |
| 200 | 0:35 | 1:19 | 2:21 | 3:40 | 5:17 | -- | -- | -- | 12:06 |
| 225 | 0:40 | 1:29 | 2:38 | 4:08 | 5:40 | -- | -- | 10:25 | 13:36 |
| 250 | 0:44 | 1:39 | 2:56 | 4:35 | -- | -- | 8:31 | 11:35 | 15:07 |
| 275 | 0:48 | 1:49 | 3:14 | 4:43 | -- | -- | 9:21 | 12:44 | 16:38 |
| 300 | 0:53 | 1:59 | 3:31 | -- | -- | -- | 10:12 | 13:53 | 18:09 |
| 350 | 1:02 | 2:19 | 3:47 | -- | -- | 8:16 | 11:54 | 16:12 | 21:10 |
| 400 | 1:10 | 2:38 | -- | -- | 6:03 | 9:27 | 13:36 | 18:31 | 24:12 |
| 450 | 1:19 | 2:50 | -- | -- | 6:48 | 10:38 | 15:19 | 20:50 | 27:13 |
| 500 | 1:28 | -- | -- | 5:14 | 7:34 | 11:49 | 17:01 | 23:09 | 30:14 |

3.2.3 Infiltration

After the work is complete, test the sewers or sections for infiltration. Any section in which the infiltration of water is detected will be rejected until corrective work has been performed. No infiltration will be allowed for any one trunk, main, lateral, or segment between manholes.

3.2.4 Exfiltration

The Contracting Officer may require tests for exfiltration. Ensure that exfiltration is in accordance with the requirements of ASTM requirements as

modified by the Contracting Officer. Permit an allowance of 10 percent of exfiltration gallonage for each additional 10-foot head over the basic top-of-manhole head.

3.2.5 Television Inspection

Inspect all new sewer mains by internal television inspection, providing accurate distances to all service, with logs and video record of inspection. Provide all equipment and labor for such inspection. Any subcontractor must be approved by the Government before work. Acceptable procedures for televising and video recording are available from the Contracting Officer. Take digital video records of all inspection, including the manholes. Prepare the DVD and, after review by the Contracting Officer, deliver it to the Government. The Contracting Officer or Government's representative shall observe the television inspection.

3.2.6 Alignment and Deflection

Ensure that lines show full circle of light when lamped between manholes for line sections with complete pipe replacement.

Pass a nine-point mandrel through each new flexible pipe section installed after full backfill has been placed. Ensure that the maximum pipe diameter deflection does not exceed 5 percent.

3.2.7 Repair of Piping

At the option of the Contracting Officer, if piping is found to be defective during the warranty test period and if the Contracting Officer does not approve a method of pipe repair by the Contractor, the Contractor shall remove and replace the faulty pipe in an approved manner at no additional cost to the Government.

3.2.8 Tests of Pressure Lines

3.2.8.1 Hydrostatic Test of Aboveground or Exposed Piping

Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges.

Subject the piping system to the test pressure of 150 psi. Maintain the test pressure for a minimum of 2 hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

3.2.8.2 DIP Leakage Test for Buried Piping

Leakage tests shall be conducted concurrently with the pressure test. The 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

Should any test of laid pipe disclose a leakage greater than that shown, the defective joints shall be located and repaired until the leakage is within the specified tolerance, at no additional cost to the Government.

3.2.8.3 HDPE Leakage Test

The test procedure consists of initial expansion and test phases.

a. 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.

b. 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.

c. 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 (inch** | **Allowances for Expansion (US Gal/100 Feet of pipe)** | | |
|---|---|---|---|
| | **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 |

| Nominal Pipe Size (inch | Allowances for Expansion (US Gal/100 Feet of pipe) | | |
|---|---|---|---|
| 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 | 8.9 | 13.3 |
| 30 | 6.2 | 12.6 | 19.1 |
| 36 | 9.0 | 18.0 | 27.0 |
| 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.

3.3 CLEANING

Thoroughly clean all precast structures of all silt, debris, and foreign matter of any kind before final inspections.

3.4 ACCEPTANCE

Sections of the sewer and manholes found defective in material, alignment, grade, or joints shall be corrected at no additional cost to the Government before acceptance.

-- End of Section --

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SEWAGE LIFT STATIONS

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 WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C207 | (2007) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in. |
| AWWA C550 | (2005; Errata 2005) Protective Epoxy Interior Coatings for Valves and Hydrants |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B16.1 | (2005) Gray Iron Threaded Fittings; Classes 25, 125 and 250 |
| ASME B31.3 | (2010) Process Piping |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 126 | (2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM A 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 584 | (2009a) Standard Specification for Copper Alloy Sand Castings for General Applications |
| ASTM C 443 | (2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM D 1784 | (2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D 3753 | (2005e1) Glass-Fiber-Reinforced Polyester Manholes and Wetwells |

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 |

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 Material, Equipment, and Fixtures List in accordance with paragraph entitled, "General Requirements," of this section.

Listing of Product Installations

SD-02 Shop Drawings

Submit the following in accordance with paragraph entitled, "Design Requirements," of this section.

Erection/Installation Drawings; G
Bypass Pumping and/or Outage Plan; G

SD-03 Product Data

Submit Spare Parts Data also for the following in accordance with paragraph entitled, "General Requirements," of this section.

Submit manufacturer's catalog data and equipment and performance data for the following items:

Package Lift Station; G
Access Covers; G
Sewage Pumps; G
Pump Controls; G
Impellers; G
Nameplate; G
Couplings; G
Stuffing Boxes; G
Valves; G
Quick Disconnect; G
Piping; G
Valve Vault; G
Electric Motors; G
Lift Station Controls; G

Submit paint and manufacturer's recommendations for painting including material storage, mixing, and thinning surface preparation, number and thickness of coats, application drying between coats and final etc. shall be submitted.

Submit the following in accordance with paragraph entitled, "General," of this section:

SD-06 Test Reports

Pump Down Test; G

SD-07 Certificates

Manufacturer Certification

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA; G

1.3 QUALITY ASSURANCE

1.3.1 Drawings

a. Erection/installation drawings shall be submitted showing complete detail, both plan and side view details with proper layout dimensions and elevations.

b. Record drawings for the complete sanitary sewer system shall be submitted showing complete detail with all dimensions, both above and below grade, including invert elevations.

c. Record drawings shall be signed and sealed by a Professional Surveyor. Include the following statement: "All potable water lines crossed by sanitary hazard mains are in accordance with the permitted utility separation requirements."

1.4 DESIGN REQUIREMENTS

The lift stations shall have two submersible, centrifugal non-clog or grinder, pumps as specified herein with pump controls capable of operating the pumps either simultaneously or individually, depending on the load conditions.

The Contractor shall submit drawings covering necessary or recommended changes to accommodate the equipment offered. Drawings shall clearly show the wet well, with dimensions and elevation levels with reference to those elevations indicated.

Submit a sanitary sewer bypass pumping and/or outage plan in accordance with the drawings that show the temporary bypass pumping and/or outage plan of the wastewater during renovation/demolition/replacement of the manhole preceding the lift station. The plan shall include pump size and capacity; the methodology of capping influent pipes; a diagram of pumping system, pipe routing, and temporary point of connection to existing lift station.

1.5 NAMEPLATES

Provide the manufacturer's name or trademark on a corrosion-resistant identification plate or cast integrally, on each item of equipment, stamped, or otherwise permanently marked in a conspicuous place. Include on the pump identification plate the pump capacity in gpm, pump head in feet and speed of rotation. Cast on the body of the pump the direction of

rotation. Indicate all necessary information to complete identification such as the manufacturer.

1.6 FIELD REPRESENTATIVE

A representative of the lift station pump manufacturer hired by the Contractor shall inspect the pump installation and direct the startup of the station and shall instruct representatives of the Government in startup and operating procedures. The Contractor shall procure the services of the lift station pump manufacturer representative for the following:

1. A minimum of 1 full day on site to inspect, adjust, and test the lift station installation and provide certification as specified.

2. A minimum of 1 full day on site to place the station in operation to demonstrate compliance with the requirements of the Contract Documents.

3. A minimum of 1 full day onsite to train representatives of the Government in the operation, maintenance, and repair of station pumps, control panel, and related appurtenances.

The manufacturer's services specified represent an absolute minimum acceptable level of service, and are not intended to limit the responsibilities of the Contractor to comply with all requirements of the Contract Documents. At no additional cost to the Government, the Contractor shall procure all services required, including additional cost to the Government to the jobsite by the manufacturer's representative to comply with these requirements.

The Contractor shall submit written certification from the lift station pump manufacturer's representative that he has inspected, adjusted, tested, etc., the lift station installation and that all aspects of the installation meet requirements of the pump manufacturer for satisfactory performance and working life of the equipment. The written certification shall state that the system is installed and operating properly and is ready for acceptance by the Government.

1.7 GENERAL REQUIREMENTS

Submit Material, Equipment, and Fixtures List of all major components including manufacturer's catalog numbers, specification and drawing reference number, warranty information, and fabrication site.

Submit Listing of Product Installations similar to the package lift station the Contractor is installing.

Submit Spare Parts Data, including a complete list of parts and supplies with current unit prices and source of supply. List parts and supplies that are either normally furnished at no extra cost with the purchase of equipment, or specified to be furnished as a part of the contract, and list additional items recommended by the manufacturer to ensure an efficient operation for a period of one year.

For Lift Station 1B and 9B, the pump supplier shall provide submersible pumps, slide rail assemblies, control panel, float switches, aluminum hatches, and accessories to ensure proper operations and warranty. The complete package pumping station shall have pump bases, rail assemblies, and discharge piping assembled by Hydromax or approved equal and ready for

field installation.

Submit an Operation and Maintenance Manual for all components of the lift stations.

PART 2 PRODUCTS

Verify conformance of materials and equipment for package lift station to the referenced publications or as specified. Verify manufacturers are regularly engaged in the manufacture of such products.

Submit manufacturer's data indicating percentage of recycled material content in packaged sewage lift stations to verify affirmative procurement compliance.

2.1 PRECAST WET WELLS AND VALVE VAULTS -- LIFT STATION 4A1, LIFT STATION 4D, LIFT STATION 4N4, LIFT STATION 4S1, LIFT STATION 5C, LIFT STATION 9D

The precast wet wells and valve vaults shall be sized as shown on the drawings and shall conform to the requirements of Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

The precast wet wells shall be lined with the protective liner specified in Section 09 97 24 CONCRETE REPAIR AND HYDROGEN SULFIDE PROTECTIVE COATING at the precast factory.

2.2 BASIN AND VALVES VAULTS -- LIFT STATION 1B, LIFT STATION 9B

The basin shall be fiberglass reinforced polyester (FRP) resin with a 3-inch ballast support flange. Each basin shall be furnished with the number of flexible inlet flanges (shipped loose to facilitate field location) to accept the pipe size(s) shown on the Drawings. Inlet and conduit locations can vary to accommodate ease of installation. Basin dimensions shall be as shown on the drawings or as specified herein. The basin FRP wall laminate thickness shall vary with the wetwell depth to provide the aggregate strength to meet the tensile and flexural physical property requirements. The basin FRP wall laminate must be designed to withstand wall collapse or buckling based on a hydrostatic pressure of pounds per square foot, a saturated soil weight of 120 pounds per cubic foot, a soil modulus of 700 pounds per square foot. Basin must comply with the pipe stiffness values as specified in ASTM D 3753. The basin laminate must be constructed to withstand or exceed 150 percent of the assumed loading on any depth. The finished FRP laminate will have a Barcol hardness of at least 90 percent of the resin manufactures specified hardness for the fully cured resin. The Barcol hardness shall be the same for both interior and exterior surfaces. Manufacturer must submit documentation including calculation and production certification that basin (s) on the project comply with the requirements above.

The precast valve vaults shall be sized as shown on the drawings and shall conform to the requirements of Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

2.3 ACCESS COVERS

The access covers for wet wells shall be aluminum plate designed for 300 pounds per square foot live load. The covers shall be securely bolted to each concrete structure with stainless steel hinges and hardware. Covers shall have a diamond pattern non-skid surface and stainless steel recessed

handles. Covers shall meet the requirements of Section 05 50 13 MISCELLANEOUS FABRICATIONS.

2.4 HATCH COVER -- LIFT STATION 1B, LIFT STATION 9B

The hatch cover shall be 2/3 hinged to allow maximum access to the wet well. The hatch cover shall be aluminum with stainless steel fasteners, rated for 150 psf or greater. The hatch cover shall include a single or dual door of dimensions specified by the pump manufacturer for proper pump clearance. The cover shall be manufactured by US Fabrication or approved equal.

2.5 SEWAGE PUMPS

2.5.1 Centrifugal Pumps

Provide submersible sewage centrifugal pumps as manufactured by Hydromatic Pumps, or approved equal. The pump volute, motor, and seal housing shall be high-quality gray cast iron in accordance with ASTM A 48/A 48M, Class 30. All fasteners exposed to the pumped liquids shall be 316 stainless steel.

2.5.1.1 Pump and Motor Characteristics

2.5.1.1.1 Lift Station 1G

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 78 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.2 Lift Station 1H

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 37 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.3 Lift Station 1I

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 13 feet |

| | |
|---|---|
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.4 Lift Station 1N

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 40 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.5 Lift Station 1P

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 107 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.6 Lift Station 1T

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 75 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.7 Lift Station 4A1

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |

| | |
|---|---|
| Shutoff Head: | 33 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.8 Lift Station 4B2

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Secondary Design Point: | 166 gpm at 8 TDH |
| Shutoff Head: | 12 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.9 Lift Station 4C1

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 49 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.10 Lift Station 4D

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 106 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.11 Lift Station 4F

| | |
|---|---|
| Liquid Pumped: | Raw sewage |

| | |
|---|---|
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 51 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.12 Lift Station 4L

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 54 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.13 Lift Station 4N4

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 36 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.14 Lift Station 4N5

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 98 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.15 Lift Station 4N6

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 74 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.16 Lift Station 4O1

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 17 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.17 Lift Station 5C

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 42 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.18 Lift Station 5D

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 15 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.1.1.19 Lift Station 17C

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 32 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.2 Grinder Pumps

Provide submersible sewage grinder pumps as manufactured by Hydromatic Pumps or approved equal. The pump volute, motor, and seal housing shall be high-quality gray cast iron in accordance with ASTM A 48/A 48M, Class 30. All fasteners exposed to the pumped liquids shall be 316 stainless steel.

2.5.2.1 Pump and Motor Characteristics

2.5.2.1.1 Lift Station 4K1

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 91 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.2.1.2 Lift Station 4S1

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Secondary Design Point: | 20.5 gpm at 65.5 TDH |
| Shutoff Head: | 77.5 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.2.1.3 Lift Station 5E

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |

| | |
|---|---|
| Shutoff Head: | 90 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.2.1.4 Lift Station 5E2

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 27 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.2.1.5 Lift Station 9D

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 57 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.2.1.6 Lift Station 17A

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 96 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.2.1.7 Lift Station 17D

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |

| | |
|---|---|
| Number of Units Required: | 2 |
| Shutoff Head: | 185 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.3 Grinder Pumps -- Lift Station 1B, Lift Station 9B

Pumps shall be of the submersible type. Each pump shall be mounted on a 2-inch-diameter rail system. The rail system shall be self-engaging resulting in a leakproof coupling. The rail system shall include the base elbow, discharge flange assembly, 1-inch-diameter 304 Stainless Steel guide rails, 316 Stainless Steel upper guide bracket, 316 Stainless Steel lifting bail and cable, and a six-hook 316 Stainless Steel cable holder. The rail system shall be mounted and pre-piped by the pump supplier.

2.5.3.1 Pump and Motor Characteristics

2.5.3.1.1 Motor

The motor shall be mounted in a sealed, submersible type housing. The stator shall be securely held in place with a removable end ring and threaded fasteners for ease of removal without the use of heat or a press. The motor will have two heavy-duty ball bearings, one upper (radial) and one lower (thrust), to support the shaft. The motor shall be equipped with a winding thermostat that automatically shuts the motor off in case of motor overheating.

2.5.3.1.2 Lift Station 1B

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 47 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.5.3.1.3 Lift Station 9B

| | |
|---|---|
| Liquid Pumped: | Raw sewage |
| Pumping Temperature: | Ambient temperature |
| Number of Units Required: | 2 |
| Shutoff Head: | 45 feet |
| Design Conditions: | See drawings |
| Rated Pump Speed: | See drawings |
| Motor Power: | See drawings |

| | |
|---|---|
| Discharge Elbow Outlet Diameter: | See drawings |
| Model: | See drawings |
| Motors: | Oil cooled induction/insulation Class H/60 hz Service Factor 1.2 NEMA design, Type B |

2.6 PUMP CONSTRUCTION

Fabricate castings from cast iron or steel free from injurious defects. Design castings to permit easy replacement of parts. Gasket all joints to prevent leakage under a test pressure equal to 50 percent more than the pump discharge pressure or total dynamic head, whichever is greater. Design and install passageways to permit the smooth flow of sewage and free from sharp turns and projections. Provide pump castings with cleanout plates in the suction line and drain plugs.

2.7 PUMP CONSTRUCTION -- LIFT STATION 1B, LIFT STATION 9B

The pump volute, motor, and seal housing shall be constructed of cast iron, ASTM A 48/A 48M. All external fasteners shall be Series 300 Stainless Steel. The pump shaft shall be constructed of Series 416 Stainless Steel.

2.8 IMPELLERS

For end-suction pumps, impeller shall be non-metallic, semi-open Valox molded to bronze insert. For grinder pumps, impeller shall be red brass ASTM B 584-836. For centrifugal pumps, impeller shall be cast iron. Pump out vanes shall preclude material buildup around the shaft and seal.

Impellers shall be dynamically balanced. The tolerance values shall be according to the International Standard Organization grade 6.3 for rotors in rigid frames. The tolerance is to be split equally between the two balance planes, which are the two impeller shrouds.

2.9 IMPELLERS -- LIFT STATION 1B, LIFT STATION 9B

The impeller shall be of multi-vane, semi-open bronze construction. The impeller shall include pump-out vanes on the back of the impeller and shall be statically and hydraulically balanced.

2.10 CUTTERS -- LIFT STATION 1B, LIFT STATION 9B

A two-stage cutter assembly shall be mounted on the suction side of the pump with direct discharge into the pump impeller. The grinder shall be capable of grinding all materials found in normal, domestic sewage, including plastics, rubber, sanitary napkins, disposable diapers, and wood particles into a fine slurry. Both the stationary and rotating cutters shall be constructed of hardened 440C Stainless Steel.

2.11 COUPLINGS

For end-suction pumps, provide heavy-duty flexible type couplings, keyed to the shaft. Provide universal type couplings for vertical pumps.

2.12 SHAFT SLEEVES

For end-suction pumps, protect the shaft from the liquid being pumped, points in contact with the stuffing boxes, and other wearing parts with sleeves designed in bronze or a suitable alloy.

2.13 STUFFING BOXES

For end-suction pumps, grease-seal stuffing boxes with a seal ring, designed to ensure tight packing without excessive wear or friction on the shafts, and prevent the leakage of air or water. Provide split type glands which can be easily removed for repacking.

2.14 BALANCE

Balance rotating parts of the equipment mechanically and hydraulically to operate throughout the required range without excessive end thrust, vibration, and noise. Conform allowable vibration limits with ISO 1940-1, Table 1. Existence of defects that cannot be eliminated by adjustment will be sufficient cause for rejection of the equipment.

2.15 SHAFTS

For centrifugal and grinder pumps, provide high-grade 3300 series stainless steel shafts of a size and strength to perform the work required.

2.16 BEARINGS AND SHAFTS

An upper radial bearing and a lower thrust bearing shall be required. These shall be heavy-duty single-row ball bearings that are permanently lubricated by the dielectric oil that fills the motor housing. Double-row, sealed-grease packed bearings shall not be acceptable. Bearings which require lubrication according to a prescribed schedule shall not be acceptable. The upper radial housing shall have a minimum B-10 life at the specified condition of 40,000 hours and the lower thrust bearing shall have a minimum B-10 life at the specified condition of 40,000 hours.

The shaft shall be machined from a solid 300 series stainless steel forging and shall be designed with a large diameter, having a minimum overhang to reduce shaft deflection and prolong bearing life.

2.17 LUBRICATION

Provide self lubricating, permanently lubed bearings.

2.18 SEALS

The pump shall have two mechanical seals, mounted in tandem, with an oil chamber between the seals. Units that required the use of tungsten-carbide seals or foreign manufactured seals shall not be acceptable.

The pump shall be equipped with a seal leak detection probe and warning system. This shall be designed to alert maintenance personnel of lower seal failure without having to take the unit out of service for inspection or requiring access for checking the seal chamber oil level and consistency.

Install an electric probe or seal failure sensor in the seal chamber between the two tandem mechanical seals. If the lower seal fails, contaminants which enter the seal chamber shall be detected by the sensor and sent a signal to operate the specified warning device.

Units equipped with opposed mechanical seals shall not be acceptable.

2.19 PIPING CONNECTIONS

Provide pump discharge with flanged connections of the proper size for the pump type and capacity. Conform pipe flanges to ASTM A 536 for ductile iron or gray-iron threaded flanges and piping or AWWA C207. Piping is to conform to the requirements of ASME B31.3.

## 2.20 VALVES

### 2.20.1 Check Valve

1. Check valves shall be swing-check type with outside lever and weight and shall permit free flow of sewage forward and provide a positive check against backflow. Check valves 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.

2. Swing check valves shall exceed the minimum requirements of AWWA C508 with a heavy-duty body of cast iron conforming to ASTM A 126 Class B with integral flanges, faced and drilled in accordance with ASME B16.1 Class 125. Bolts, nuts, washers, etc., shall be 316 stainless steel.

3. The valve body shall be the full waterway type, designed to provide a net flow, not less than the nominal inlet pipe size, when swung open no more than 25 degrees. The valve shall have a replaceable stainless steel body seat, a cast iron disc faced with a renewable resilient seat ring of rubber, and shall be held in place by stainless steel screws.

4. The disk arm shall be ductile iron or steel, suspended from and keyed to a stainless steel shaft, which 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.

5. The check valve shall be GA Industries, Inc. Figure 220-DS or an approved equal.

6. The valve interior shall be painted with epoxy coating by the valve manufacturer in accordance with AWWA C550. The valve exteriors shall be factory prepared and primed, and field finish painted in accordance with Section 09 90 00.00 98 PAINTING AND COATING.

### 2.20.2 Check Valves Smaller than 3 Inches

Check valves shall be of solid PVC construction with an external lever and weight. Valves shall incorporate a single disc design suitable for either horizontal or vertical installations. Valves shall be of top entry bonnet design for maintenance purposes. PVC shall conform to ASTM D 1784 Cell Classification 12454-A. Valves shall be rated to 150 psi with EPDM or FKM seals at 70 degrees F. Valves shall be as manufactured by Asahi/America, Inc. or an approved equal.

### 2.20.3 Plug Valve

Plug valves are specified under Section 33 30 00 SANITARY SEWERS in the paragraph entitled "Plug Valves".

### 2.20.4 Valves -- Lift Station 1B, Lift Station 9B

Valves shall be sewage swing check with clean-out ports and brass gate valves.

2.21 QUICK DISCONNECT

Quick disconnect shall be rated for a minimum pressure rating of 150 psi and shall be constructed of 316 stainless steel. The quick disconnect outlet shall be male American Standard Taper Pipe Thread. Size shall be as indicated on the drawings. The quick disconnect shall be product number 633-F by OPW or approved equal.

2.22 DUST CAP

The dust cap shall be compatible with the quick disconnect and shall be constructed of 316 stainless steel. The dust cap shall be product number 634-B by OPW or approved equal.

2.23 PIPING

Terminate discharge lines 5-feet outside the lift station in flanged connections. Include the pipe from the wet well manhole in the suction line. External connection joints for pipe using rubber gaskets are to comply with the standards of ASTM C 443.

Piping shall be in accordance with Section 33 30 00 SANITARY SEWERS, except that non-potable piping shall have Protecto 401 interior lining or approved equal.

2.24 ELECTRICAL POWER CORD

Electrical power cord shall be water resistant 600 V, 140 degree F, UL and CSA approved and applied depending on amp draw for size.

The pump shall be triple protected with a compression fitting and two epoxy-potted areas at the power cord entry to the pump. A separation between the junction box area of the pump and motor by a stator lead sealing gland or terminal board shall not be acceptable.

The power cable entry into the cord cap assembly shall first be made with a compression fitting. Each individual lead shall be stripped down to bare wire at staggered intervals, and each strand shall be individually separated. This area of the cord cap shall then be fitted with an epoxy compound potting that will prevent water contamination from gaining entry if wicking or capillary attraction occurs.

The power cord leads shall then be connected to the motor leads with extra heavy connectors having brass inserts with a screwed wire-to-wire connection.

The connection box wiring shall be separated from the motor housing wiring by stripping each lead down to bare wire, at staggered intervals and separating each strand. This area shall be filled with an epoxy compound potting. Fiberglass terminal boards that are subject to heat fatigue and cracking, and which may lead to possible leaks, shall not be acceptable.

The cord cap assembly where bolted to the connection box assembly shall be sealed with a Buna N Rubber O-ring on a beveled edged to ensure proper sealing.

## 2.25 ELECTRIC MOTORS

The stator, rotor, and bearings shall be mounted in a sealed submersible type housing. The stator windings shall have Class F insulation, and a dielectric oil-filled motor, NEMA B design.

The pump and motor shall be specifically designed so that they may be operated partially or completely submerged in the liquid being pumped.

Stators shall be securely held in place with a removable end ring and threaded fasteners so they may be easily removed in the field and must be capable of being repaired or rewound by a local motor service station. No special tools shall be required for pump and motor disassembly.

The pump motor shall be equipped with heat sensors. The heat sensors shall be a low-resistance, bi-metal disc that is temperature sensitive. They shall be mounted directly in the stator, sized to open at 250 degrees F, and automatically reset at 90 to 95 degrees F differential. The sensor shall be connected in series with the motor starter coil so that the starter is tripped if a heat sensor opens. The motor starter shall be equipped with overload heaters so all normal overloads are protected by an external heater block.

Each pump motor shall have a sensor to monitor moisture in the stator cavity. Provide a conductivity-sensitive relay for installation in the control panel to alarm excessive moisture content, which may be indicative of an outer mechanical seal FAILURE.

### 2.25.1 Lift Station Controls

All instrumentation, control, and electrical components provided under this section shall be of an industrial quality equal to the components specified in Division 26, ELECTRICAL, and Section 40 95 00 PROCESS CONTROL SYSTEM, except as noted otherwise.

The instrumentation and controls system, specified herein, shall accept single-phase, 120V, 60-Hz AC electrical power, except were noted herein.

#### 2.25.1.1 Scope

This paragraph (2.20.1 Lift Station Controls) pertains to all the lift stations.

#### 2.25.1.2 Enclosure(s)

Control Panel - 304 SST, NEMA 3R rated, 3-point latch, complete with swing-out, dead-front panel. Provide a solar-shield for each panel as illustrated in the drawings.

#### 2.25.1.3 Operator Interface

Provide the following interface devices:

a. Lift Station Pumps (one complete set for each pump).

1. HAND/OFF/AUTO selector switch.
2. 'RUN' status pilot light.
3. Elapsed time meter.

b. Alarm Annunciation.

1. Alarm horn 'SILENCE' pushbutton.
2. Alarm 'RESET' pushbutton.
3. Pump No. 1 'Seal Leak'.
4. Pump No. 1 'Motor Temp HIGH'.
5. Pump No. 2 'Seal Leak'.
6. Pump No. 2 'Motor Temp HIGH'.
7. Wet Well 'Level High'.

Mount all controls and indicators on the swing-out, dead-front panel. Do not mount any device on the enclosure door.

Mount the alarm beacon and horn on control panel enclosure as indicated on the drawings.

2.25.1.4 External Interfaces

Provide the following signal interface(s) each of which terminated at the terminal strip, clearly designated as external signal interface:

a. Discrete outputs:

1. Control Power ON
2. Pump No. 1 RUN Status
3. Pump No. 2 RUN Status
4. Common Pump FAIL
5. Wet Well Level HIGH

b. Discrete inputs:

The following signals interface with components located in a classified environment (see electrical drawings). Provide suitable safety barrier(s) as needed to comply with NEC.

1. Wet Well Level HIGH HIGH Alarm
2. Wet Well Level START LAG
3. Wet Well Level START LEAD
4. Wet Well Level STOP ALL
5. Wet Well Level LOW LOW Alarm
6. Pump No. 1 Seal Failure
7. Pump No. 1 Motor Temperature HIGH
8. Pump No. 2 Seal Failure
9. Pump No. 2 Motor Temperature HIGH

2.25.1.5 Functional Requirements

a. Provide electro-mechanical (i.e. hard-wired, relay-based logic, using electro-mechanical relays and solid-state logic circuits) controls. The operating functions shall be as specified under 'General Lift Station Sequence of Operation' provided in the drawings, and as provided below.

b. Indicate the ALARM condition, both visually and audibly whenever wet well level exceeds the HIGH HIGH level setpoint. Provide silence function for the audible alarm.

c. Maintain all ALARM conditions until the offending condition is removed and the alarm is manually RESET.

2.25.1.6 Special Requirements

a. Provide and install a control power transformer to convert the 480-VAC, 60-Hz power feed provided to the control panel to 120-VAC, single-phase control voltage. Provide for one power feed to the control panel only.

b. Provide and install a Main Circuit Breaker (MCB) and Generator Circuit Breaker (GCB); the MCB for the power utility 480 VAC, 208 VAC, or 120 VAC as applicable, 60 Hz power feed; and the GCB for the generator 480 VAC, 208 VAC, or 120 VAC as applicable, 60 Hz power feed. Inter-lock the two breakers to avoid having both simultaneously closed. Allow operation of the breaker with the swing-out, dead-front panel closed. Interlock the swing-out panel with the operation MCB/GCB to prohibit opening of the swing-out panel while the MCB/GCB is energized. Provide the generator receptacle as indicated on the drawings.

c. Provide and install motor feed with non-reversing, motor starters for each pump. Allow for operation of the motor feeder circuit breakers with the swing-out, dead-front panel closed. Starters shall be as specified in Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES and as shown on the drawings. Equip starters with Solid State Overload (SSOL) relays as specified in Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

d. Provide and install non-mercury float switches as noted on the drawings, complete with intrinsically safe relays. Float switches shall be of the suspended type with polypropylene or PVC body. Units shall have an integral electrical cable with two #19 AWG stranded conductors. Switches shall be pilot duty, normally open or normally closed, as required for application.

e. Provide and install elapsed time meters for each motor. The meters shall be non-resettable, having six-digit indication of run time, and resolution of 0.1 hours. Run the meters whenever the pump motor starter is energized.

f. Provide and install a phase-loss/unbalance/reversal and under-voltage protection assembly with adjustable nominal voltage setting. Configure the pump logic to automatically lockout pump operation if all phases drop below 90 percent or of one phase drops below 80-83 percent nominal voltage. The device dropout delay shall be 1/2 second, nominally. The phase failure relay shall be Diversified Electronics.

g. Provide an alarm horn. Mount the alarm horn on the side of the panel.

h. Provide an alarm beacon. Mount the alarm beacon on the top of the panel.

i. Provide and install one (1) convenience receptacle.

2.26 PAINT

Surfaces to be painted include the wet well interior and all piping, conduit, etc., within the wet wells, and aluminum surfaces in contact with concrete.

Provide painting and coatings requirements in accordance with 09 90 00.00 98

PAINTING AND COATING and 09 97 24 CONCRETE REPAIR AND HYDROGEN SULFIDE PROTECTIVE COATING.

2.27 GUIDE RAIL ASSEMBLY

If applicable, guide rails shall be mounted to the basin floor on stainless steel riser supports. Guide rails shall be 300 Series stainless steel and size shall be in accordance with the pump manufacturer's recommendation. Each pump shall be equipped with a stainless steel upper and lower guide assembly, stainless steel lifting bail, and stainless steel lifting cable.

PART 3 EXECUTION

3.1 GENERAL

Install lift station as indicated, in accordance with drawings and the manufacturer's instructions.

Preventative Maintenance and Inspection procedure is required for package lift stations sewage pumps. Include in procedures the frequency of preventative maintenance, inspection, adjustment, lubrication, and cleaning necessary to minimize corrective maintenance and repair.

3.2 PIPING

3.2.1 Flanged and Threaded Joints

3.2.1.1 Flanged Joints

Flanged joints shall be faced true, provided with gaskets, and made perfectly square and tight. Flanged joints shall be used in special cases where connected equipment is available with only flanged joints, or when specifically shown on the drawings.

3.2.1.2 Threaded Joints

Threaded joints shall have graphite or inert filler and oil, graphite compound, or polytetrafluoroethylene (PTFE) tape applied to the male threads only. Unions shall be provided at all screwed valves, strainers and connections to equipment 3/4 inch and smaller. Dielectric unions shall be used at connections of dissimilar metals in 3/4 inch and smaller piping.

3.2.2 Pipe Supports in Valve Vaults

Horizontal and vertical runs of pipe in valve vaults shall be securely supported.

3.3 VALVE VAULTS AND ACCESSORIES

3.3.1 Piping and Equipment in Valve Vaults

Piping and equipment in valve vaults shall be installed to provide easy access without stepping on piping or equipment, and to provide sufficient working room. Piping and equipment in valve vaults shall be installed and supported as shown on the drawings. All plug and check valves shall be installed with the stems horizontal or above.

3.4 TESTS

Commercial testing shall be required and include the following:

The pump shall be visually inspected to confirm that it is built in accordance with the specification as to HP, voltage, phase, and hertz.

The motor and seal housing chambers shall be meggered to test for moisture content and/or insulation defects.

Pump shall be allowed to run dry to check for proper rotation.

Discharge piping shall be attached, the pump submerged in water and amp readings shall be taken in each leg to check for an imbalanced stator winding. If there is a significant difference in readings, the stator windings shall be checked with a bridge to determine if an unbalanced resistance exists. If so, the stator will be replaced.

Perform a pump down test to verify that pumps are operating as expected.

For testing of the wet well refer to Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.

3.5 OPERATION AND MAINTENANCE

Refer to Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.6 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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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 06-1; TIA 07-1; TIA 07-2; TIA 07-3; Errata 07-2; TIA 08-4; TIA 08-5; TIA 08-6; TIA 08-7; TIA 08-8; TIA 08-9; TIA 08-10; TIA 08-11; TIA 09-12; TIA 09-13; TIA 09-14; Errata 09-3; TIA 09-15; TIA 09-16; TIA 10-17) 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 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

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) 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

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 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 |

3.4.1 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.

3.4.2 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.

3.4.3 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.

3.4.4 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.

3.4.5 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.

3.4.6 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.

3.4.7 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.

3.4.8 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.

3.4.9 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.

3.5 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with Section 31 00 00 EARTHWORK.

3.5.1 Reconditioning of Surfaces

3.5.1.1 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.

3.5.1.2 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.

3.6 CAST-IN-PLACE CONCRETE

3.6.1 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.

-- End of Section --

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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.

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

| | |
|---|---|
| FCC Part 15 | Radio Frequency Devices (47 CFR 15) |

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; R 2008) Guide on the Surges Environment 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 802.1d | (2004) Local and Metropolitan Area Networks - Media Access Control (MAC) Bridges |
| IEEE Std 802.1p | (2004) LAN Layer 2 QoS/CoS Protocol For Traffic Prioritization |
| IEEE Std 802.1q | (2005) IEEE Standard for local and metropolitan area networks - Virtual bridged local area networks |
| IEEE Std 802.3 | (2009)IEEE Standard for Information Technology--Telecommunications and Information Exchange Between Systems--Local and Metropolitan Area Networks--Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications |

| | |
|---|---|
| | Corrigendum 1: Timing Considerations for PAUSE Operation |
| IEEE Std 802.3ad | (2000) IEEE Standard for Information Technology - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications-Aggregation of Multiple Link Segments |
| IEEE Std 802.3u | (2005) IEEE Local and Metropolitan Area Networks-Supplement - Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units and Repeater for 100Mb/s Operation, Type 100BASE-T (Clauses 21-30) |
| IEEE Std 802.3x | (1997) IEEE Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex Operation |

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

| | |
|---|---|
| IEC 60529 | (2009) Degrees of Protection Provided by Enclosures (IP Code) |
| IEC 61000-4-5 | (2005; Corr 2009) Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques; Surge Immunity Test; Ed 2.0 |

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 |

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; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 4 | (2010) Terminal Blocks |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2011; TIA 11-1; Errata 2011) National Electrical Code |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

| | |
|---|---|
| NIST SP 250 | (1991) Calibration Services Users Guide |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1059 | (2001; Rev thru Dec 2006) Terminal Blocks |
| UL 508 | (1999; Reprint Apr 2010) 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 is organized in five volumes of work, as illustrated in the drawings. A description of the work items for each volume is as follows:

Volume 1 - Water System

- Water Quality Analyzers, four sites, with remote telemetry units (RTU)

Volume 2 - Lift Stations

- RTU at select lift stations (see drawings)
- Provide, install, and commission a PLC based system to monitor and control two separate wastewater pumping stations. The pump station includes wet well aeration.

Volume 3 - Force Mains

- No work specified in this Section for this volume.

Volume 4 - Water System Additional

- No work specified in this Section for this volume.

Volume 5 - W1 Pump Station Replacement

- Provide, install, and commission a PLC based system to monitor and control a potable water booster pump station and chemical feed system.

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 subcontractor's scope of work, including monitoring and control features required for each volume:

General

Provide one complete Water Quality Analyzer Field Panel as designated in the Volume 1 drawings and one RTU panel "A" as designated in the Volume 2 drawings. Configure with power pig-tails and stands suitable for use as a development or training unit.

Provide full development copies of applications software required to support this project. A list of the anticipated software is provided below:

PLC Programming
Radio Configuration
Operator Interface Configuration

The HMI system is existing. Additional copies of HMI development software is unnecessary.

Volume 1 - Water System

Continuously monitor, on-line, the potable water combined chlorine residual sampled at select locations within the distribution system (see drawings).

Operate (open/close) a solenoid-actuated, flushing valve at these same locations. The operating cycle shall be programmable for frequency and duration which the flushing valve is to be open. Include provisions in the control to initiate the flush cycle prematurely both manually and in the event the chlorine residual falls below an operator entered value.

Provide, install, and configure an RTU at each location to support data transmission to/from the Government's SCADA application. Configure the Government's SCADA application for remote monitoring of the facility.

Volume 2 - Lift Stations

Lift Station LS-1AA

Continuously monitor the wet well level and the station's discharge flow rate.

Operate blowers to maintain an aerobic condition in the wet well.

Operate the sewage transfer pumps, varying discharge flow rate step-wise with respect to pre-configured ranges in wet well level using the wet well as a surge basin. The flow rate set points shall be an operator-entered value.

Remove and replace the existing Field Interface Controller (FIC), complete, and re-establish network communication with the KCCS Utility Wide Area Network (WAN) for data transmission to/from the Government's SCADA application. Configure the Government's SCADA application for remote monitoring of the facility.

Lift Station LS-4A

Continuously monitor the wet well level and the station's discharge flow rate.

Operate blowers to maintain an aerobic condition in the wet well.

Operate the sewage transfer pumps, varying discharge flow rate step-wise with respect to pre-configured ranges in wet well level using the wet well as a surge basin. The flow rate set points shall be an operator-entered value.

Remove and replace the existing FIC, complete, and re-establish network communication with the KCCS Utility WAN for data transmission to/from the Government's SCADA application. Configure the Government's SCADA application for remote monitoring of the facility.

Select Lift Stations

Provide, install, and configure an RTU at each location to support data transmission to/from the Government's SCADA application. Configure the RTU to communicate with KCCS using Modbus TCP and Ethernet protocol. The communication media varies with location, choices being radio telemetry, fiber optic, or copper (Cat 5E). Select lift stations shall communicate using discrete signals via an existing Telephone Termination Cabinet (TTC) with KCCS. Configure the Government's SCADA application for remote monitoring of the facility.

Volume 5 - W1 Pump Station Replacement

W-1 Pump Station - Monitor and control a potable water booster pump station, designed to maintain pressure at station discharge to an operator-entered set point value. Monitor and control a chemical feed system, designed to inject two chemicals, sodium hypochlorite and ammonium sulfate, to produce the system disinfectant, monochloramine. Provide remote monitoring capability via the KCCS.

Implement the controls in a new 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.

1.2.2 Operation

Provide monitoring and control features as described in the Sequence of Operation and the Control Narratives provided as an Attachment herein.

1.2.3 Points

Inputs and Outputs to be monitored/controlled by the RTUs or FICs are provided in tabular form as an ATTACHMENT to this Section.

1.2.4 Data Transmission Systems (DTS)

Data transmission between the RTUs and the SCADA application shall use the Government's standard, Ethernet-based, communication protocol; Modbus-TCP. Communication media varies with communication site between 900 MHz spread spectrum radio transmission, fiber optic, or copper (Cat 5e).

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 |
| EiRP: | Effective Isotropically Radiated Power |
| 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
TTC: Telephone Termination Cabinet

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 dc 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 24 V dc or 120 V 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 30 V 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 color graphic screens representative of the work described herein. The screens shall be produced using Citect Graphics Builder. Include the navigation map(s), Genies, Super Genies, Cicode functions, and metadata proposed for this work. The submittal shall be reproducible, hard-copy as a minimum.

SCADA Application 90 Percent Development Submittal; G

Submit the completed color graphic screens for the work described herein. The screens shall be produced using Citect Graphics Builder. Include the navigation map(s), Genies, Super Genies, Cicode functions, and metadata proposed for this work. The submittal shall be reproducible, hard-copy as a minimum. The submittal also shall include 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 shall provide an example presentation of metadata from previous work. Presentation of the metadata shall comply with this example, be clearly and logically organized, and clearly describe the monitored/controlled data. This data shall be used to facilitate the integration of the Citect projects unique to this work with the Government's overall SCADA application.

SD-06 Test Reports

Radio Path Testing; G

Testing, Adjusting and Commissioning; G
Performance Verification Test (PVT); G

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.

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 format 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

Complete the Radio Path Study before to submitting Product Data for the radio towers. If this sequence is not followed, the radio tower submittals will be returned to the Contractor un-reviewed. The radio tower product data submittal shall include the recommended antenna heights presented in the report for each location.

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 project programming/configuring the select PLC logic, completed within the last 3 years.

Certificate of Completion:

Select PLC programming training, sponsored or certified by the PLC manufacturer.

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 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.

Also included are control narratives descriptive of the control performance required for the W1 Pump Station. These narratives are intended to supplement and expand upon the functional descriptions provided in the drawings as Sequence of Operation.

### 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 RTU and FIC Input/Output List

The Input/Output for each RTU or FIC are listed in the RTU/FIC Input/Output List referenced in Article ATTACHMENT. Furnish all equipment and labor necessary to achieve the required 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.

All panels shall be UL 508 certified.

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 exterior with white baked epoxy, unless otherwise noted. Damaged surfaces shall be repaired and refinished using original type finish.

Enclosures shall be Type 3R, 304 stainless steel unless otherwise noted.

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 V ac or 24 V dc. 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 V ac, 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 V ac 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 V ac synchronous motor.

2.5.3 Electrical Requirements

Each panel shall be powered by a dedicated separate 120 V ac circuit, or 120 V ac 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 for antenna connection: RG8 type, air-dielectric coaxial cable, solid inner conductor bare copper-clad aluminum, foam polyethylene dielectric, and aluminum tape outer conductor. Jacket shall be black polyethylene. Cable attenuation at 900 MHz shall be 3.9 dB per 100 feet or less. Cable shall be Times Microwave Systems LMR-400 or equal.

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: | 600 V ac |
| Rated Current: | 30 amp |
| Wire Size: | 22- to 10-AWG |
| Rated Wire Size: | 10-AWG |
| Color: | Gray 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: | 600 V ac |
| Rated Current: | 10-amp |
| Wire Size: | 22- to 12-AWG |
| Rated Wire Size: | 12-AWG |
| Color: | Gray body, orange switch |
| Spacing: | 0.25 inch, maximum |
| Manufacturer and Product: | Entrelec; Type M4/6.SN.T |

Terminal Block, Fused, 24 V dc:

| | |
|---|---|
| Rated Voltage: | 600 V dc |
| Rated Current: | 16-amp |
| Wire Size: | 22- to 10-AWG |
| Rated Wire Size: | 10-AWG |
| Color: | Gray body |
| Fuse: | 0.25 inch by 1.25 inch |
| Indication: | LED diode 24 V 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 120 V 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 V ac, maximum/

Breaker Manufacturers and Products: Square D, Type QOU.

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, 120 V ac branch circuit.

Provide 120-volt AC plug-mold for panel components with line cords.

Signal Distribution:

Within Panels: 40 to 20 mA DC signals may be distributed as 1 to 5 V 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 5 V dc Signals: 0.05V, maximum.

Power Supplies:

Provide power for devices requiring external dc power, including two-wire transmitters (instruments) and dc relays. Unit shall convert 120 V ac, 60-Hz power to 24 V dc power, 10 A as a minimum. Provide unit with battery backup to power the connected devices during periods of complete or partial interruption of incoming power. The power supply shall provide 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.

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.

The unit shall have sufficient capacity to provide 'trickle charge' to the batteries. Provide the unit with two 7 Ah, 12 V dc lead gel type, wired in series. The assembly shall support continuous no-break power with no measurable transfer time.

The unit shall have isolated contact closures, suitable for external interface, to monitor the following conditions:

AC FAIL
Low Battery
Battery Supervision

The Unit shall be as manufactured by Altronix, or equal.

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 data or phone line to PICS equipment.

All field 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 V ac, 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 a second-stage clamping voltage rating of 210 volts or less. The power supply electrical transient protection device be suitable for continuous operation 30 amps minimum at 130 V ac.

Encapsulate the devices in a flame-retardant epoxy.

Test analog signal lines (1 - 5 V dc 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.

Antenna cable surge suppression shall be dc pass type, complying with IEC 60529 and Bellcore TA-NWT-000487. The unit shall be suitable for use in frequency range from 600 MHz to 2.7 GHz and have an insertion loss of less than 0.1 dB over the frequency range. Unit shall handle maximum surge current of 20kA in compliance with IEC 61000-4-5 for a 8/20 microsecond wave form. Unit shall be Polyphaser DGXE, or equal.

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. Ducts and wireways mounted inside an enclosure shall be screwed to the panel. Mounting with adhesive or tape is not acceptable.

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 24 V 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.

Land all field wiring on terminal blocks and not on individual components, except where noted.

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.

PART 3 EXECUTION

3.1 RADIO PATH STUDY

3.1.1 Data Collection

Establish the actual fade margin for each radio link using representative radio, antennas, cable, surge suppressor, and connectors. As a minimum, measure the actual signal strength for a specific link with the antennas located at the heights listed in the Drawings. If required, adjust the antenna heights to achieve a fade margin greater than 20 dB. At no time shall the Contractor operate the radios at EiRP levels in excess of 36 dB, in compliance with FCC Part 15 regulations.

Prepare and submit a report documenting the results of a Radio Path Study. For each radio path, list the measured fade margin, the recommended antenna heights and gain, radio transmission power, and maximum cable/connector losses necessary to achieve or exceed the measured fade margin. Briefly describe in the report the testing protocol and include manufacturer's cut sheets for the radio and antennas documenting conformance with the recommended performance criteria.

3.2 SCADA APPLICATION DEVELOPMENT

3.2.1 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.

3.2.2 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.

3.2.3 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.

3.2.4 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.

3.2.5 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.

3.3 DEMOLITION REQUIREMENTS

3.3.1 General

The Contractor shall remove, complete, the existing control panels located at LS-1AA (one panel)and LS-4A (one panel), two floor-mounted panels total. Demolition shall include removal of conduit and conductors in accordance with the requirements of Electrical General Notes, provided in the drawings.

3.3.2 Equipment Salvage

The Contractor shall deliver remove and deliver the PLC and any other electrical components so designated by the Contracting Officer to the Government. The remaining electrical components, wires, and enclosure shall be suitably handled in accordance with Section 02 41 00 DEMOLITION AND DECONSTRUCTION.

3.4 EQUIPMENT INSTALLATION REQUIREMENTS

3.4.1 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.

3.4.1.1 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.

3.4.1.2 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.

3.5 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.

3.5.1 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.

3.5.2 Process Analytical Instrumentation

3.5.2.1 Water Quality Analyzer

Locate analyzer as shown on the drawings and install in accordance with the manufacturer's installation requirements.

3.5.3 Electric Power Devices

3.5.3.1 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.

3.5.3.2 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.

3.5.3.3 Transducers

Transducers shall be wired in accordance with the manufacturer's instructions, and installed in enclosures.

3.5.4 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.

3.5.5 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.

3.5.6 Transformers

Transformers for control voltages 120 V ac 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.

3.6 WIRE, CABLE AND CONNECTING HARDWARE

3.6.1 Metering and Sensor Wiring

3.6.1.1 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.

3.6.1.2 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.

3.7 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.

3.8 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.

3.8.1 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 set points, 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.

3.8.2 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 shall include field verification of the W1 Pump Station flow meter accuracy, specifically for flows from the specified minimum to a rate where the flow velocity through the meter is 1 fps or greater. Verify the accuracy installed in the field as indicated on the drawings. Verification under other conditions will not acceptable. The means for verifying the meter accuracy shall have a combined uncertainty, as calculated using root mean square, of 0.2 percent of measured flow or better. Demonstrate the flow accuracy at the specified minimum flow and 25, 50, 75, and 100 percent of the flow range from the specified minimum to the flow rate associated with a velocity of 1 fps or greater.

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.

## 3.9 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.

## 3.10 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.

### 3.10.1 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.

3.10.2 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.

3.10.3 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.

3.11 ATTACHMENTS

3.11.1 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 set point values. Maintain set point at values entered before power loss.

Maintain all ALARM and FAIL conditions until the alarming event has cleared and the condition is manually RESET.

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.

The starter has a fail or fault condition.

3.11.1.1 Volume 5 - W1 Pump Station Replacement

W1 PUMP STATION BOOSTER PUMP CONTROL UNIT PROCESS 10

Overview:

Provide a Proportional, Integral, Derivative (PID) control for the pump station to maintain an operator adjustable discharge pressure.

Use Adjustable Speed Motor Control common function.

PLC Special Functions:

Operator Interface:

Provide a PID control interface.

Provide a LOCAL/REMOTE selector switch for the PID control.

Provide LEAD metering pump selection or AUTOMATIC alternation of lead.

For each pump, provide the following:

Selector switch (START/STOP/REMOTE).
Status Indication (ON/OFF/Remote/Bypass).
Manual Loading Station - Motor Speed.
Analog Meter - Motor Speed.

Control Functions:

Use one PID loop to vary the speed of all booster pumps. The process variable shall be distribution pressure. The PID output variable shall be the common speed signal to each pump VFD. The set point variable shall be adjustable within a range from 70 to

75 psig. Vary the output variable minimum limit based upon an adaptation of the pump affinity laws, as follows:

$$N_{min} = N_{max} * SQRT\{((SP - P_{suct})/P_{TDH}\} + C_{OFF-SET}$$

Where

$N_{min}$ = Calculated minimum pump speed
$N_{max}$ = Maximum pump speed (initially 1775 RPM)
SP = Set Point Value (ft WC)
$P_{suct.}$ = Suction Pressure (ft WC)
$P_{TDH}$ = Representative TDH value @ $N_{max}$ (initially 107 ft WC)
$C_{OFF-SET}$ = Constant off set value (initially 10 RPM)

Operate the booster pump in a LEAD/LAG fashion. Include enabled pumps only in the alternating sequence.

START the LEAD pump whenever the measured demand flow rate (20FIT-1) exceeds an operator-entered value (initially 500 gpm) and the difference between the discharge pressure set point and the suction header pressure (10PIT-1) is greater than an operator-entered value (initially 24 ft Water Column).

START the next pump in the sequence whenever the PID output variable exceeds an operator-entered value (initially set at 95 percent) for an operator adjustable period.

STOP the pump with the longest operating time for two or more operating pumps in this operational sequence (First In, First Out) whenever the PID output variable is less than an operator-entered value (initially set at 65 percent) for an operator adjustable period.

STOP all pumps whenever either of the following conditions are true:

Demand flow is less than an operator-entered value (initially 350 gpm).

Demand flow is within an operator adjustable range (initially 350 to 1,000 gpm) and discharge pressure is an operator-entered value (initially 2 psig) greater than the pressure set point.

When LEAD/STANDBY/ALTERNATE selector is in ALTERNATE position, alternate the LEAD pump selection whenever all pumps are off. Assign LEAD, 1st LAG based upon total run time, least to highest.

When LEAD/STANDBY/ALTERNATE selector is in the LEAD position, assign the 1st and Standby as follows:

| **Lead** | **1st Lag** | **Standby** |
|---|---|---|
| 1 | 2 | 3 |
| 2 | 3 | 1 |

| Lead | 1st Lag | Standby |
|---|---|---|
| 3 | 1 | 2 |

Immediately assign the 1st LAG pump as LEAD whenever the LEAD pump is disabled.

Immediately assign the Standby pump as 1st LAG whenever the 1st LAG pump is disabled.

Pumps are disabled whenever:

The pump is FAILED.
The associated pump's ASD is FAULTed.
The pump is tagged/locked out.
The pump is in LOCAL control made.
The pump is in BYPASS mode.

Maintain elapsed run times for each individual pump.
Start the timer whenever the pump RUN status is active.
Stop the timer whenever the RUN status is inactive.

Alarms: For each pump, provide the following alarm indication and log each occurrence.

Adjustable Speed Drive FAIL.

The START/STOP status is not achieved with an adjustable delay after the START/STOP command is issued.

High motor winding temperature.

SCADA Application Display:

Operator Interface:

Provide a graphic display schematically representative of the booster pump configuration similar to that illustrated in the drawings (P&IDs).

Provide a PID control interface. The PID Set Point Variable shall be the booster pump station discharge pressure. Do not allow remote, manual adjustment of the PID Output Variable.

Display the LOCAL/REMOTE status for the PID interface.

For each pump, provide the following:

Status Indication (ON/OFF/REMOTE/BYPASS).
Elapsed Run Time Indication.

Control Functions: None.

Alarms: Display the alarms as presented above for PLC Special Functions.

Trends/Reports: Provide a minimum of two preconfigured trend screens. One shall display the suction and discharge pressures

(two pens) with respect to time. The other shall display the station flow rate (one pen) with respect to time.

WATER QUALITY MONITORING AND CONTROL UNIT PROCESSES 20 AND 30

Overview:

Monitor the following water quality parameters for the water before chemical addition:

Free Ammonia Residual.
Combined Chlorine Residual (Mono-Chloramine).
Total Chlorine Residual.

Monitor the following water quality parameters for the water after chemical addition:

Combined Chlorine Residual (Mono-Chloramine).
Total Chlorine Residual.

PLC Special Functions:

Operator Interface:

Display the instantaneous water quality parameter values.

Provide for operator-entry of the alarm set points. Alarms are as listed below:

Control Functions: None.

Alarms:

Indicate activation of the eyewash or safety shower adjacent to the chemical injection location.

Provide the following alarms whenever the associated water quality parameter exceeds or falls below the operator-entered set point value:

Pre-Chemical Addition:

Combined Chlorine Residual: HIGH and LOW.
Total Chlorine Residual: HIGH and LOW.

Post-Chemical Addition:

Combined Chlorine Residual: HIGH and LOW.
Total Chlorine Residual: HIGH and LOW.

SCADA Application Display:

Operator Interface:

Display the instantaneous water quality parameter values.

Control Functions: None.

Alarm:

Display the alarms as presented above for PLC Special Functions.

Trend/Reports:

Provide a minimum of three preconfigured trend screens. One shall display the pre-chemical addition water quality parameters (three pens) with respect to time. One shall display the post-chemical addition water quality parameters (two pens) with respect to time. And the last shall display all water quality parameters (pre- and post-chemical feed) (5 pens) with respect to time.

SODIUM HYPOCHLORITE FEED SYSTEM UNIT PROCESS 40

Overview:

Provide a flow-paced, chemical feed control loop to scavenge free ammonia residual in the supply water or boost the disinfectant residual. The loop shall work in conjunction with Unit Process 50 Ammonium Sulfate Feed System.

PLC Special Functions:

Operator Interface:

For each pump, provide the following:

Operator Control (ON/OFF/AUTO).
Status Indication (RUN).
Elapsed Run Time Indication.

Display the bulk chemical tank volume, both in feet and in gallons.

Display the chemical flow rate.

Provide a PID control interface for the chemical addition flow rate. The process variable shall be the measured chemical flow rate.

Provide a LOCAL/REMOTE selector switch for the PID control.

Provide for Operator selection of the following modes of operation:

Chemical Flow Rate, Operator-Entered Rate.
Flow-Paced, Operator-Entered Dose.
Total Disinfectant Residual Boost.
Ammonia Scavenging.

Provide for Operator Entry of the following:

Chemical dose rate (for use with Flow-Paced, Operator-Entered dose).

Disinfectant residual set point, and operational dead-band for the system (for use with Total Disinfectant Residual Boost).

Chlorine to Ammonia Ratio (ppm/ppm) set point, and operational dead-band for the system. Limit ratio to a range of 3 to 5.

LEAD metering pump selection or AUTOMATIC alternation of lead.

Control Functions:

Provide PID control of chemical flow rate, varying the stroke rate and number of operating metering pumps as required to achieve operator-entered flow rate value. This mode of operation is designated as 'Chemical Flow Rate, Operator-Entered Rate'.

The remaining modes of operation shall use flow-paced control of the chemical metering pump stroke rate. Pace flow based on the Finished Water Flow rate (20FIT-1).

For 'Flow-Paced, Operator-Entered Dose' mode of operation, provide operator-entry of a chemical dose rate.

For 'Total Disinfectant Residual Boost' mode of operation, provide for Operator-entry of final disinfectant residual. Calculate the dose value as difference between the operator-entered disintectant residual set point and the measured total chlorine residual value of the supplied water (20AIT-1($TCL_2$)). Provide a proportional only trim of the residual dose using the finished water total chlorine residual value (30-AIT-1) as the process variable.

For the final mode of operation, Ammonia Scavenging, calculate the dose value as the operator-entered chlorine to ammonia ratio times the free ammonia residual value of the supply water (20-AIT-1).

For all modes of operation, make adjustments to the pump stroke rate whenever the difference between the actual and calculated pump stroke rate values exceed the operator-entered operational dead-band.

Operate the metering pumps in a LEAD/LAG fashion. Include enabled pumps only in the alternating sequence.

START the LEAD pump whenever the measured demand flow rate (20FIT-1) exceeds an operator-entered value (initially 200 gpm).

START the next pump in the sequence whenever the PID output variable exceeds an operator-entered value (initially set at 90 percent) for an operator adjustable period.

STOP the pump with the longest operation time in this operational sequence (First In, First Out) whenever the PID output variable is less than an operator-entered value (initially set at 20 percent) for an operator adjustable period.

STOP all pumps whenever the measured demand flow rate (20-FIT-1) is less than an operator-entered value (initially 170 gpm).

When LEAD/STANDBY/ALTERNATE selector is in ALTERNATE position, alternate the LEAD pump selection whenever all pumps are off. Assign LEAD, 1st LAG based upon total run time, least to highest.

When LEAD/STANDBY/ALTERNATE selector is in the LEAD position, assign the 1st and Standby as follows:

| Lead | 1st Lag | Standby |
|---|---|---|
| 1 | 2 | 3 |
| 2 | 3 | 1 |
| 3 | 1 | 2 |

Immediately assign the 1st LAG pump as LEAD whenever the LEAD pump is disabled.

Immediately assign the Standby pump as 1st LAG whenever the 1st LAG pump is disabled.

Alarms:

Provide an 'Order Sodium Hypochlorite' event whenever either bulk tank volume falls below an operator-entered value.

Indicate activation of the eyewash or safety shower adjacent to the chemical feed system location.

Indicate High Level event in the chemical containment area.

SCADA Application Display:

Operator Interface:

For each pump, provide the following:

Status Indication (ON/OFF/AUTO).
Elapsed Run Time Indication.

Display the bulk chemical tank volume, both in feet and in gallons.

Display the chemical flow rate.

Display LOCAL/REMOTE status for the PID control.

Display the Operator selection of the following modes of operation:

Chemical Flow Rate, Operator-Entered Rate.
Flow-Paced, Operator-Entered Dose.
Total Disinfectant Residual Boost.
Ammonia Scavenging.

Display the following:

Operator-entered Chemical dose rate (for use with Flow-Paced, Operator-Entered dose).

Operator-entered Disinfectant residual set point, and operational dead-band for the system (for use with Total Disinfectant Residual Boost).

Operator-entered Ratio of Chlorine to Ammonia for chloramine creation.

LEAD metering pump selection or AUTOMATIC alternation of lead.

Control Functions: NA.

Alarm:

Indicate activation of the eyewash or safety shower adjacent to the chemical feed system location.

Indicate High Level event in the chemical containment area.

Trend/Reports: None.

AMMONIUM SULFATE FEED SYSTEM UNIT PROCESS 50

Overview:

Provide a flow-paced, chemical feed control loop to boost the disinfectant residual. The loop shall work in conjunction with Unit Process 40 Sodium Hypochlorite Feed System.

PLC Special Functions:

Operator Interface:

For each pump, provide the following:

Operator Control (ON/OFF/AUTO).
Status Indication (RUN).
Elapsed Run Time Indication.

Display the chemical flow rate.

Provide a PID control interface for the chemical addition flow rate. The process variable shall be the measured chemical flow rate.

Provide a LOCAL/REMOTE selector switch for the PID control.

Provide for Operator selection of the following modes of operation:

Chemical Flow Rate, Operator-Entered Rate.
Flow-Paced, Operator-Entered Dose.
Total Disinfectant Residual Boost.

Provide for Operator Entry of the following:

Chemical dose rate (for use with Flow-Paced, Operator-Entered dose).

LEAD metering pump selection or AUTOMATIC alternation of lead.

Control Functions:

Provide PID control of chemical flow rate, varying the stroke rate and number of operating metering pumps as required to achieve operator-entered flow rate value. This mode of operation is designated as 'Chemical Flow Rate, Operator-Entered Rate'.

The remaining modes of operation shall use flow-paced control of the chemical metering pump stroke rate. Pace flow based on the Finished Water Flower rate (20FIT-1).

For 'Flow-Paced, Operator-Entered Dose' mode of operation, provide Operator-entry of a chemical dose rate.

For 'Total Disinfectant Residual Boost' calculate dose value as difference between the calculated wet point value cascaded from the Sodium Hypochlorite Feed System and the incoming free ammonia residual, as follows:

$$\text{Dose}_{NH3} = \text{Dose}_{TC1} - (\text{Residual}_{NH3} - \text{Ratio})$$

Where

$\text{Dose}_{NH3}$ = Calculated dose (ppm)
$\text{Residual}_{NH3}$ = Supply Water Total Ammonia Residual (20AIT-1(NH3))
$\text{Dose}_{TC1}$ = Calculated dose (ppm) cascaded from UP 40
Ratio = Operator-entered Chlorine to Ammonia Ratio (ppm/ppm) set point

For all modes of operation, make adjustments to the pump stroke rate whenever the difference between the actual and calculated pump stroke rate values exceed the operator-entered operational dead-band.

Operate the metering pumps in a LEAD/LAG fashion. Include enabled pumps only in the alternating sequence.

START the LEAD pump whenever the measured demand flow rate (20FIT-1) exceeds an operator-entered value (initially 200 gpm).

START the next pump in the sequence whenever the PID output variable exceeds an operator-entered value (initially set at 90 percent) for an operator adjustable period.

STOP the pump with the longest operating time in this operational sequence (First In, First Out) whenever the PID output variable is less than an operator-entered value (initially set at 20 percent) for an operator adjustable period.

STOP all pumps whenever the measured demand flow rate (20-FIT-1) is less than an operator-entered value (initially 170 gpm).

When LEAD/STANDBY/ALTERNATE selector is in ALTERNATE position, alternate the LEAD pump selection whenever all pumps are off. Assign LEAD, 1ST LAG based upon total run time, least to highest.

When LEAD/STANDBY/ALTERNATE selector is in the LEAD position, assign the 1st and Standby as follows:

| **Lead** | **1st Lag** | **Standby** |
|---|---|---|
| 1 | 2 | 3 |

| Lead | 1st Lag | Standby |
|---|---|---|
| 2 | 3 | 1 |
| 3 | 1 | 2 |

Immediately assign the 1st LAG pump as LEAD whenever the LEAD pump is disabled.

Immediately assign the Standby pump as 1st LAG whenever the 1st LAG pump is disabled.

Alarms:

Indicate activation of the eyewash or safety shower adjacent to the chemical feed system location.

Indicate High Level event in the chemical containment area.

SCADA Application Display

Operator Interface:

For each pump, provide the following:

Status Indication (ON/OFF/AUTO).
Elapsed Run Time Indication.

Display the chemical flow rate.

Display LOCAL/REMOTE status for the PID control.

Display the Operator selection of the following modes of operation:

Chemical Flow Rate, Operator-Entered Rate.
Flow-Paced, Operator-Entered Dose.
Total Disinfectant Residual Boost.

Display the following:

Operator-entered Chemical dose rate (for use with Flow-Paced, Operator-Entered dose).

LEAD metering pump selection of AUTOMATIC alternation of lead.

Control Functions: NA.

Alarms:

Indicate activation of the eyewash or safety shower adjacent to the chemical feed system location.

Indicate High Level event in the chemical containment area.

Trends/Reports: None.

POWER MONITORING UNIT PROCESS 100

Overview:

Monitor the status of the control power in the FIC panel and the status of the Standby Generator. Comply with NFPA 110 Level 1 for the Standby Generator.

PLC Special Functions:

Operator Interface:

For the FIC control power, display when the FIC is on AC or Battery Power.

For the Standby Power Generator, display the alarm conditions listed below.

Control Functions: None.

Alarm Functions:

For the FIC control power, create and display an alarm event whenever the Battery requires service.

For the Standby Power Generator, create and display the following alarm conditions:

Engine Over-crank
Engine Over-speed
Low Temperature, Cooling Water
Low Level, Cooling Water
High Temperature (pre-alarm), Engine
High Temperature, Engine
Low Pressure (pre-alarm) Oil
Low Pressure, Oil
Low Level, Main Fuel Tank
Not IN AUTO, control switch
Low Voltage, Cranking
Common Alarm

These status are transmitted from the Generator control panel (OEM supplied) and the PLC using Serial Communication link.

SCADA Application Display:

Operator Interface:

For the FIC control power, display when the FIC is on AC or Battery Power.

For the Standby Power Generator, display the alarm conditions listed below.

Control Functions: None.

Alarm Functions:

For the FIC control power, create and display an alarm event whenever the Battery requires service.

For the Standby Power Generator, create and display the following alarm conditions:

Engine Over-crank
Engine Over-speed
Low Temperature, Cooling Water
Low Level, Cooling Water
High Temperature (pre-alarm), Engine
High Temperature, Engine
Low Pressure (pre-alarm) Oil
Low Pressure, Oil
Low Level, Main Fuel Tank
Not IN AUTO, control switch
Low Voltage, Cranking
Common Alarm

Trends/Reports: None.

3.11.2 Instrumentation List
Volume 1 - Water Systems

| Comp. Code | Tag No. | Component Title | Options | Inst Detail |
|---|---|---|---|---|
| A22 | 5-AE/AIT-1 | Analyzer and Transmitter, Residual Chlorine | Range: 0 to 5 mg/l | |
| | | | Mounting: As specified | |
| | | | Process Liquid: Potable Water | |
| | | | Type: Combined Chlorine Residual | |
| A22 | 6-AE/AIT-1 | Analyzer and Transmitter, Residual Chlorine | Range: 0 to 5 mg/l | |
| | | | Mounting: As specified | |
| | | | Process Liquid: Potable Water | |
| | | | Type: Combined Chlorine Residual | |
| A22 | 10-AE/AIT-1 | Analyzer and Transmitter, Residual Chlorine | Range: 0 to 5 mg/l | |
| | | | Mounting: As specified | |
| | | | Process Liquid: Potable Water | |
| | | | Type: Combined Chlorine Residual | |

| Comp. Code | Tag No. | Component Title | Options | Inst Detail |
|---|---|---|---|---|
| A22 | 17-AE/AIT-1 | Analyzer and Transmitter, Residual Chlorine | Range: 0 to 5 mg/l | |
| | | | Mounting: As specified | |
| | | | Process Liquid: Potable Water | |
| | | | Type: Combined Chlorine Residual | |

Volume 5 - W1 Pump Station Replacement

| Comp. Code | Tag No. | Component Title | Options | Inst Detail |
|---|---|---|---|---|
| P9 | 10PIT-1 | Pressure Transmitter, Electronic | Range: 0 to 150 psig | |
| | | | Indication: Yes | |
| | | | Zero: N/A | |
| | | | Mounting: Pipe Mount | |
| | | | Process Liquid: Potable Water | |
| P4 | 10-PI-1XA (X = 1-3) | Pressure Gauge | Range: 0 to 100 psig | |
| | | | Mounting: As specified | |
| | | | Dial Size: As specified | |
| | | | Case Material: As specified | |
| | | | Element Material: As specified | |
| | | | Damping: Required | |
| | | | Process Liquid: Potable Water | |

| Comp. Code | Tag No. | Component Title | Options | Inst Detail |
|---|---|---|---|---|
| F23 | 10-FSL-X (X=1=3) | Flow Element and Switch, Thermal | Operating Pressure: 35 psig max | |
| | | | Operating Temperature: Ambient | |
| | | | Set Point: 86 gpm | |
| | | | Pipe Size: 6-inch | |
| | | | Electronics Mounting: Integral | |
| | | | Process Liquid: Potable Water | |
| P4 | 10-PI-1XB (X = 1=3) | Pressure Gauge | Range: 0 to 100 psig | |
| | | | Mounting: As specified | |
| | | | Dial Size: As specified | |
| | | | Case Material: As specified | |
| | | | Element Material: As specified | |
| | | | Damping: Required | |
| | | | Process Liquid: Potable Water | |
| F4 | 20-FE/FIT-1 | Flow Element and Transmitter, Electro-magnetic | Line Size: 10-inch | |
| | | | Flow Range: 200 to 7500 gpm | |
| | | | Process Liquid: Potable Water | |
| | | | Unit Digit: 1,000 gallons | |
| P9 | 20PIT-1 | Pressure Transmitter, Electronic | Range: 0 to 150 psig | |
| | | | Indication: Yes | |
| | | | Zero: N/A | |
| | | | Mounting: Pipe Mount | |
| | | | Process Liquid: Potable Water | |

| Comp. Code | Tag No. | Component Title | Options | Inst Detail |
|---|---|---|---|---|
| A300 | 20AIT-1(UV) | UV Percent Transmission Analyzer | Process Variable & Range:<br>Free Ammonia: 0 - 5 mg/l<br>Mono-Chloramine: 0 to 5 mg/l<br>Total Chlorine: 0 to 5 mg/l<br>Option: Dual Stream<br>Mounting: As specified<br>Process Liquid: Potable Water | |
| A300 | 30AIT-1(UV) | UV Percent Transmission Analyzer | Process Variable & Range:<br>Free Ammonia: 0 = 5 mg/l<br>Mono-Chloramine: 0 to 5 mg/l<br>Total Chlorine: 0 to 5 mg/l<br>Option: Dual Stream<br>Mounting: As specified<br>Process Liquid: Potable Water | |
| L5 | 40-LE/LIT-X (X=1,2) | Level Element and Transmitter, Ultrasonic | Range: 0 to 4 feet<br>Zero: Field Adjust<br>Connection: Flanged<br>Element Material: PVDF<br>Process Liquid: Sodium Hypochlorite | |

| Comp. Code | Tag No. | Component Title | Options | Inst Detail |
|---|---|---|---|---|
| L109 | 40-LSH-1 | Level Switch, Rises on Stem | Set Point: Field Set<br>Mounting: Wall Bracket<br>Process Liquid: Dilute Sodium Hypochlorite<br>Options: | |
| L109 | 50-LSH-1 | Level Switch, Rises on Stem | Set Point: Field Set<br>Mounting: Wall Bracket<br>Process Liquid: Dilute Ammonium Sulfate<br>Options: | |

3.11.3 RTU and FIC Input/Output List

Volume 1 Water Systems Inputs/Outputs

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| **Water Quality Monitoring Stations (Z-CP-1 where Z= 5, 6, 10, & 17)** | | | | |
| Z-AIT-1 (TCL) | Analog | Input | Total Combined Chlorine Residual | |
| Z-ASL-1 (TCL) | Discrete | Input | Low Combined Chlorine Residual | |
| Z-HS-1 (INITIATE) | Discrete | Input | START Flush Cycle | |
| Z-HS-1 (OPEN) | Discrete | Output | OPEN Command, Flush Valve | |
| Z-QS-1 (FAIL) | Discrete | Input | AC FAIL | |
| Z-QS-1 (BAT LO) | Discrete | Input | Battery Low | |
| Z-QS-1 (BAT SUP) | Discrete | Input | Battery Supervision | |

Volume 2 Lift Stations Inputs/Outputs

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| **Lift Station LS-1AA I/O** | | | | |
| 100-QS-1 (FAIL) | Discrete | Input | AC FAIL | |
| 100-QS-1(BAT LO) | Discrete | Input | Battery Low | |
| 100-QS-1 (BAT SUP) | Discrete | Input | Battery Supervision | |
| 110-HS-1 (RUN) | Discrete | Output | RUN Command, Blower No. 1 | |
| 110-HS-1 (REMOTE) | Discrete | Input | REMOTE Status, Blower No. 1 | |
| 110-QS-1 (RUN) | Discrete | Input | RUN Status, Blower No. 1 | |
| 110-HS-2 (RUN) | Discrete | Input | RUN Command, Blower No. 2 | |
| 110-HS-2 (REMOTE) | Discrete | Output | REMOTE Status, Blower No. 2 | |
| 110-HS-2 (RUN) | Discrete | Output | RUN Status (Local), Blower No. 1 | |

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| 110-QS-2 (RUN) | Discrete | Input | RUN Status, Blower No. 2 | |
| 120-LIT-1 | Analog | Input | LEVEL, Wet Well | |
| 120LSH-1 | Discrete | Input | HIGH Level, Wet Well | |
| 120LSM-1 | Discrete | Input | MEDIUM Level, Wet Well | |
| 120LSL-1 | Discrete | Input | LOW Level, Wet Well | |
| 130-QA-1 (FAULT) | Discrete | Input | VFD FAULT, Transfer Pump No. 1 | |
| 130-HS-1 (RUN) | Discrete | Output | RUN Command, Transfer Pump No. 1 | |
| 130-QS-1 (RUN) | Discrete | Input | RUN Status, Transfer Pump No. 1 | |
| 130-QS-1 (REMOTE) | Discrete | Input | REMOTE Status, Transfer Pump No. 1 | |
| 130-SI-1 | Analog | Input | Speed Status, Transfer Pump No. 1 | |
| 130-SIC-1 | Analog | Output | Speed Command, Transfer Pump No. 1 | |
| 130-QA-2 (FAULT) | Discrete | Input | VFD FAULT, Transfer Pump No. 2 | |
| 130-HS-2 (RUN) | Discrete | Output | RUN Command, Transfer Pump No. 2 | |
| 130-QS-2 (RUN) | Discrete | Input | RUN Status, Transfer Pump No. 2 | |
| 130-QS-2 (REMOTE) | Discrete | Input | REMOTE Status, Transfer Pump No. 2 | |
| 130-SI-2 | Analog | Input | Speed Status, Transfer Pump No. 2 | |
| 130-SIC-2 | Analog | Output | Speed Command, Transfer Pump No. 2 | |
| 130-FIT-1 | Analog | Input | Flow Rate, Transfer Pump Station | |
| Lift Station LS-4A I/O | | | | |
| 400-QS-1 (FAIL) | Discrete | Input | AC FAIL | |
| 400-QS-1 (BAT LO) | Discrete | Input | BATTERY LOW | |
| 400-QS-1 (BAT SUP) | Discrete | Input | Battery Supervision | |

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| 410-HS-1 (RUN) | Discrete | Output | RUN Command, Blower No. 1 | |
| 410-HS-1 (REMOTE) | Discrete | Input | REMOTE Status, Blower No. 1 | |
| 410-QS-1 (RUN) | Discrete | Input | RUN Status, Blower No. 1 | |
| 410-HS-2 (RUN) | Discrete | Output | RUN Command, Blower No. 2 | |
| 410-QS-2 (RUN) | Discrete | Input | RUN Status, Blower No. 2 | |
| 410-HS-2 (REMOTE) | Discrete | Input | REMOTE Status, Blower No. 2 | |
| 410-QS-1 (RUN) | Discrete | Input | RUN Status, Blower No. 2 | |
| 410-HS-2 (RUN) | Discrete | Output | RUN Command, Blower No. 2 | |
| 430-QA-1 (FAULT) | Discrete | Input | VFD FAULT, Transfer Pump No. 1 | |
| 430-HS-1 (RUN) | Discrete | Output | RUN Command, Transfer Pump No. 1 | |
| 430-QS-1 (RUN) | Discrete | Input | RUN Status, Transfer Pump No. 1 | |
| 430-QS-1 (REMOTE) | Discrete | Input | REMOTE Status, Transfer Pump No. 1 | |
| 430-SI-1 | Analog | Input | Speed Status, Transfer Pump No. 1 | |
| 430-SIC-1 | Analog | Output | Speed Command, Transfer Pump No. 1 | |
| 430-QA-2 (FAULT) | Discrete | Input | VFD FAULT, Transfer Pump No. 2 | |
| 430-HS-2 (RUN) | Discrete | Output | RUN Command, Transfer Pump No. 2 | |
| 430-QS-2 (RUN) | Discrete | Input | RUN Status, Transfer Pump No. 2 | |
| 430-QS-2 (REMOTE) | Discrete | Input | REMOTE Status, Transfer Pump No. 2 | |
| 430-SI-2 | Analog | Input | Speed Status, Transfer Pump No. 2 | |
| 430-SIC-2 | Analog | Output | Speed Command, Transfer Pump No. 2 | |
| 420LIT-1 | Analog | Input | LEVEL, Wet Well | |
| 420 LSH-1 | Discrete | Input | HIGH Level, Wet Well | |

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| 420LSM-1 | Discrete | Input | HIGH Level, Wet Well | |
| 420LSL-1 | Discrete | Input | LOW Level, Wet Well | |
| 430FIT-1 | Analog | Input | Flow Rate, Transfer Pump Station | |
| 4A1-QS-1 | Discrete | Input | Control Power Status | |
| 4A1-QS-1 (RUN) | Discrete | Input | RUN Status, Lift Station Pump No. 1 | |
| 4A1-QS-2 (RUN) | Discrete | Input | RUN Status, Lift Station Pump No. 2 | |
| 4A1-LSHH-1 | Discrete | Input | HIGH HIGH LEVEL, Wet Well | |
| Lift Station RTU I/O (Z = Station Designation, see drawings) | | | | |
| Z-QS-1 | Discrete | Input | Control Power Status | |
| Z-QA-1 (LOCAL) | Discrete | Input | LOCAL Status, Lift Station Pump No. 1 | Future |
| Z-QS-1 (RUN) | Discrete | Input | RUN Status, Lift Station Pump No. 1 | |
| Z-HS-1 (RUN) | Discrete | Output | RUN Command, Lift Station Pump No. 1 | Future |
| Z-QA-2 (LOCAL) | Discrete | Input | LOCAL Status, Lift Station Pump No. 2 | Future |
| Z-QS-2 (RUN) | Discrete | Input | RUN Status, Lift Station Pump No. 2 | |
| Z-HS-1 (PUMP 1) | Discrete | Input | LED Pump Selection, Pump No. 1 | Future |
| Z-HS-1 (PUMP 2) | Discrete | Input | LEAD Pump Selection, Pump No. 2 | Future |
| Z-HS-1 (Alt) | Discrete | Input | LEAD Pump Selection, Alternate | Future |
| Z-LIT-1 | Analog | Input | LEVEL, Wet Well | Future |
| Z-LSHH-1 | Discrete | Input | HIGH HIGH LEVEL, Wet Well | |
| Z-LSH-1 | Discrete | Input | HIGH LEVEL, Wet Well | Future |
| Z-LSM-1 | Discrete | Input | MEDIUM LEVEL, Wet Well | Future |
| Z-LSL-1 | Discrete | Input | LOW LEVEL, Wet Well | Future |
| Z-LSLL-1 | Discrete | Input | LOW LOW LEVEL, Wet Well | |

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| Z-QS-1 (FAIL) | Discrete | Input | AC FAIL | |
| Z-QS-1 (BAT LO) | Discrete | Input | Battery Low | |
| Z-QS-1 (BAT SUP) | Discrete | Input | Battery Supervision | |

Volume 5 - W1 Pump Station Replacement Input/Outputs

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| 10-PIT-1 | Analog | Input | Pressure, Pump Station Supply | |
| 10-QS-1 (BYP) | Discrete | Input | In Bypass, High Service Pump No. 1 | |
| 10-QA-1 (ASD FAULT) | Discrete | Input | ASD FAULT, High Service Pump No. 1 | |
| 10-QA-1 (PUMP FAIL) | Discrete | Input | PUMP FAIL, High Service Pump No. 1 | |
| 10-QS-1 (RUN) | Discrete | Input | RUN Status, High Service Pump No. 1 | |
| 10-QS-1 (REMOTE) | Discrete | Input | IN REMOTE STATUS, High Service Pump No. 1 | |
| 10-SI-1 | Analog | Input | SPEED Status, High Service Pump No. 1 | |
| 10-SIC-1 | Analog | Output | SPEED Cmd, High Service Pump No. 1 | |
| 10-HS-1 (RUN) | Discrete | Output | RUN Cmd, High Service Pump No. 1 | |
| 10-QS-2 (RUN) | Discrete | Input | RUN Status, High Service Pump No. 2 | |
| 10-QS-2 (BYP) | Discrete | Input | In Bypass, High Service Pump No. 2 | |
| 10-QA-2 (ASD FAULT) | Discrete | Input | ASD FAULT, High Service Pump No. 2 | |
| 10-QA-2 (PUMP FAIL) | Discrete | Input | PUMP FAIL, High Service Pump No. 2 | |
| 10-QS-2 (REMOTE) | Discrete | Input | IN REMOTE STATUS, High Service Pump No. 2 | |
| 10-SI-2 | Analog | Input | SPEED Status, High Service Pump No. 2 | |

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| 10-SIC-2 | Analog | Output | SPEED Cmd, High Service Pump No. 2 | |
| 10-HS-2 (RUN) | Discrete | Output | RUN Cmd, High Service Pump No. 2 | |
| 10-QS-3 (BYP) | Discrete | Input | In Bypass, High Service Pump No. 3 | |
| 10-QA-3 (ASD FAULT) | Discrete | Input | ASD FAULT, High Service Pump No. 3 | |
| 10-QA-3 (PUMP FAIL) | Discrete | Input | PUMP FAIL, High Service Pump No. 3 | |
| 10-QS-3 (RUN) | Discrete | Input | RUN Status, High Service Pump No. 3 | |
| 10-QS-3 (REMOTE) | Discrete | Input | IN REMOTE STATUS, High Service Pump No. 3 | |
| 10-SI-3 | Analog | Input | SPEED Status, High Service Pump No. 3 | |
| 10-SIC-3 | Analog | Output | SPEED Cmd, High Service Pump No. 3 | |
| 10-HS-3 (RUN) | Discrete | Output | RUN Cmd, High Service Pump No. 3 | |
| 10-QS-4 (BYP) | Discrete | Input | In Bypass, High Service Pump No. 4 | |
| 10-QA-4 (ASD FAULT) | Discrete | Input | ASD FAULT, High Service Pump No. 4 | |
| 10-QA-4 (PUMP FAIL) | Discrete | Input | PUMP FAIL, High Service Pump No. 4 | |
| 10-QS-4 (RUN) | Discrete | Input | RUN Status, High Service Pump No. 4 | |
| 10-QS-4 (REMOTE) | Discrete | Input | IN REMOTE STATUS, High Service Pump No. 4 | |
| 10-SI-4 | Analog | Input | SPEED Status, High Service Pump No. 4 | |
| 10-SIC-4 | Analog | Output | SPEED Cmd, High Service Pump No. 4 | |
| 10-HS-4 (RUN) | Discrete | Output | RUN Cmd, High Service Pump No. 4 | |
| 20-FIT-1 | Analog | Input | Flow Rate, Pump Station Discharge | |
| 20-PIT-1 | Analog | Input | Pressure, Pump Station Discharge | |

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| 20-QA-1 (EES) | Discrete | Input | Eyewash/Safety Shower Active, Chemical Injection | |
| 20-AE/AIT-1 ($FNH_3$) | Analog | Input | Residual, Free Ammonia - Supply Water | |
| 20-AE-AIT-1 ($CCL_2$) | Analog | Input | Residual, Combined Chlorine (Mono-Chloramine) - Supply Water | |
| 20-AE/AIT-1 ($TCL_2$) | Analog | Input | Residual, Total Chlorine - Supply Water | |
| 30-AE/AIT-1 ($CCL_2$) | Analog | Input | Residual, Combined Chlorine (Mono-Chloramine) - Dist. Water | |
| 30-AE/AIT-1 ($TCL_2$) | Analog | Input | Residual, Total Chlorine - Dist. Water | |
| 40-LIT-1 | Analog | Input | Level, Sodium Hypochlorite Tank No. 1 | |
| 40-LIT-2 | Analog | Input | Level, Sodium Hypochlorite Tank No. 2 | |
| 40-QA-1 (EES) | Discrete | Input | Eyewash/Safety Shower Active, Sodium Hypochlorite Area | |
| 40-LAH-1 | Discrete | Input | Level HIGH, Sodium Hypochlorite Containment Area | |
| 44-QS-1 (RUN) | Discrete | Input | RUN Status, Sodium Hypochlorite Metering Pump No. 1 | |
| 44-HS-1 (RUN) | Discrete | Output | RUN Cmd, Sodium Hypochlorite Metering Pump No. 1 | |
| 44-FIC-1 | Analog | Output | SPEED Cmd, Sodium Hypochlorite Metering Pump No. 1 | |
| 44-QS-2 (RUN) | Discrete | Input | RUN Status, Sodium Hypochlorite Metering Pump No. 2 | |

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| 44-HS-2 (RUN) | Discrete | Output | RUN Cmd, Sodium Hypochlorite Metering Pump No. 2 | |
| 44-FIC-2 | Analog | Output | SPEED Cmd, Sodium Hypochlorite Metering Pump No. 2 | |
| 44-QS-3 (RUN) | Discrete | Input | RUN Status, Sodium Hypochlorite Metering Pump No. 3 | |
| 44-HS-3 (RUN) | Discrete | Output | RUN Cmd, Sodium Hypochlorite Metering Pump No. 3 | |
| 44-FIC-3 | Analog | Output | SPEED Cmd, Sodium Hypochlorite Metering Pump No. 3 | |
| 44-FIT-1 | Analog | Input | Flow Rate Status, Sodium Hypochlorite Feed Skid | |
| 50-QA-1 (EES) | Discrete | Input | Eyewash/Safety Shower Active, Ammonium Sulfate Area | |
| 50-LAH-1 | Discrete | Input | Level HIGH, Ammonium Sulfate Containment Area | |
| 54-QS-1 (RUN) | Discrete | Input | RUN Status, Ammonium Sulfate Metering Pump No. 1 | |
| 54-HS-1 (RUN) | Discrete | Output | RUN Cmd, Ammonium Sulfate Metering Pump No. 1 | |
| 54-FIC-1 | Analog | Output | SPEED Cmd, Ammonium Sulfate Metering Pump No. 1 | |
| 54-QS-2 (RUN) | Discrete | Input | RUN Status, Ammonium Sulfate Metering Pump No. 2 | |
| 54-HS-2 (RUN) | Discrete | Output | RUN Cmd, Ammonium Sulfate Metering Pump No. 2 | |
| 54-FIC-2 | Analog | Output | SPEED Cmd, Ammonium Sulfate Metering Pump No. 2 | |

| Tag Number | Type | I/O | Description | PLC Register |
|---|---|---|---|---|
| 54-QS-3 (RUN) | Discrete | Input | RUN Status, Ammonium Sulfate Metering Pump No. 3 | |
| 54-HS-3 (RUN) | Discrete | Output | RUN Cmd, Ammonium Sulfate Metering Pump No. 3 | |
| 54-FIC-3 | Analog | Output | SPEED Cmd, Ammonium Sulfate Metering Pump No. 3 | |
| 54-FIT-1 | Analog | Input | Flow Rate Status, Ammonium Sulfate Feed Skid | |
| 100-QA-1 (AC FAIL) | Discrete | Input | AC Power FAIL | |
| 100-QA-1 (BAT LOW) | Discrete | Input | Battery Power Low | |
| 100-QA-1 (BAT TROUBLE) | Discrete | Input | Battery Supervision Required | |
| 110-QS-1 (UTILITY) | Discrete | Input | ATS on Utility Power | |
| 110-QS-1 (GENERATOR) | Discrete | Input | ATS on Generator Power | |

3.11.4 Component Specifications

A. A-22 Residual Chlorine Analyzer/Transmitter:

1. General:

a. Function: Continuously measure, indicate, and transmit combined chlorine residual concentration of sample process stream.
b. Type: Amperometric/membrane.
c. Parts: Analyzer/transmitter unit, mounting hardware, sample tubing and connectors, and expendables (membranes, electrolyte, etc.).

2. Service:

a. Measurement Type: As noted.
b. Sample Flow: 7 to 15 gallons per hour.
c. Sample Supply: Continuous.
d. Sample Temperature Range: 0 to 40 degrees C.

3. Performance:

a. Range: 0 to 20 mg/l.
b. Repeatability: Plus or minus 0.01 mg/l or 0.03 percent of full scale.
c. Response Time: 90 percent change in 60 seconds or less.
d. Accuracy: Plus or minus 0.5 percent of full scale or 0.02 mg/l, whichever is greater.

4. Features:

a. Environmental:
(1) Operating Temperature: minus 20 to plus 60 degrees C.
(2) Operating Humidity: 0 to 95 percent, non-condensing.
b. Display: LCD.
c. Materials of Construction:
(1) Electrode: Gold cathode, silver anode.
(2) Measuring Cell: Acrylic.
(3) Probe Body: Noryl and stainless steel.
d. Instrument Piping Connections:
(1) Sample Line: 1/4-inch OD tube.
(2) Drain Line: 1/2-inch OD tube.

5. Signal Interface:

a. Output: Isolated 4- to 20-mA for load impedance 0 to 800 ohms, minimum, for 24 V dc supply without load adjustment.
b. Contacts: When noted, two SPDT rated 5 A resistive at 230 V ac, minimum.

6. Enclosure:

a. Electronics: NEMA 4x.
b. Instrument Mounting: Wall cabinet mounting, unless otherwise noted.

7. Power Requirements: 24 V dc (loop powered).

8. Manufacturer and Model: Analytical Technology, Incorporated; Model Q45-63 Combined Chlorine Analyzer, or approved equal.

B. A-300 Ultraviolet Absorbence Analyzer and Transmitter:

1. General:

a. Function: Online ultraviolet absorbence analysis.
b. Parts: Analyzer and transmitter.

2. Performance:

a. Wavelength: 256 nm.
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.

C. F-4 Flow Element and Transmitter, Electromagnetic:

1. General:

a. Function: Measure, indicate, and transmit the flow of a process liquid in a full pipe.
b. Type: Electromagnetic flowmeter, with operation based on Faraday's Law, using the pulsed dc type coil excitation principle with high impedance electrodes.
c. Parts: Flow element, transmitter, interconnecting cables, mounting hardware, and calibrator.

2. Service:

a. Stream Fluid: As noted.
b. Flow Stream Descriptions: As noted.

3. Performance:

a. Flow Range: As noted.
b. Accuracy: Plus or minus 1 percent of rate for all flows resulting from pipe velocities of 1 to 33 feet per second.
c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.

4. Features:

a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
b. No obstructions to flow.
c. Very low pressure loss.

5. Process Connection:

a. Meter Size: As noted.

b. Connection Type: 150-pound ANSI raised-face flanges or wafer style depending on meter size, unless otherwise noted.
c. Flange Materials: 316 stainless steel.

6. Signal Interface:

a. 4 to 20 mA dc for load impedance 0 to 800 ohms minimum for 24V dc supply.
b. Digital process variable signal superimposed on 4- to 20-mA signal; using HART® protocol.

7. Power: 170V ac, 60-Hz, unless otherwise noted.

8. Element:

a. Meter Tube Material: Carbon steel.
b. Liner Material: Teflon, unless otherwise noted.
c. Liner Protectors: Covers on each end to protect liner during shipment.
d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
e. Electrode Material: Hastelloy C.
f. Enclosure: NEMA 4X, submersible.
g. Grounding Ring/Electrode Material: 316 stainless steel, unless otherwise noted.

9. Transmitter:

a. Display: Indicating and/or totalizing as noted.
b. Mounting: Pipe stand, wall, panel, or integral as noted.
c. Enclosure: NEMA 4X, should withstand temporary submergence.
d. Zero and Span: Field adjustable.
e. Indicator: Digital 16-character display, with scale range as noted.
f. Totalizer: Digital 16-character display, with totalizer unit digit value as noted.

10. Cables:

a. Types: As recommended by manufacturer.
b. Lengths: As required to accommodate device locations.

11. Calibration System:

a. Features:
(1) Field programmable electronics.
(2) Self-diagnostics with troubleshooting codes.
(3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
(4) Initial flow tube calibration and subsequent calibration checks.
b. Equipment:
(1) Built-in electronics with each unit provided.
(2) Alternatively, one portable calibrator of each type required for the various electromagnetic flowmeters provided on the project.

12. Manufacturers:

a. Siemens Sitran F M.
b. Endress Hauser ProMag.
c. Or equal.

D. F-23 Flow Element and Switch, Thermal:

1. General:

a. Function: Monitor process fluid flow and provide contact closure when flow exceeds set point.
b. Type: Thermal dispersion flow switch using a heated active and a reference RTD temperature sensors to detect rate of flow as a function of the temperature difference between the two sensors.

2. Service:

a. Fluid: Water, unless otherwise noted.
b. Operating Pressure: As noted.
c. Operating Temperature: As noted.

3. Performance:

a. Set Point:
(1) Adjustable throughout full range.
(2) Set as noted.
b. Range: Choose range so that the noted set point is between 30 and 70 percent of the range.
c. Repeatability: Plus or minus 1 percent of full range.
d. Temperature, Operating:
(1) Sensor Element: Minus 100 to plus 350 degrees F.
(2) Electronics: Minus 40 to plus 140 degrees F.
e. Proof Pressure: To 4,000 psig.
f. Response Time: Field adjustable from 10 to 150 seconds.

4. Features:

a. Wetted Surfaces Materials: 316 stainless steel with nickel-base braze, unless otherwise noted.
b. Dry Pipe Protection: When applied to liquid process, furnish protection against the event of the liquid line going dry, unless otherwise noted.
c. Process Temperature Compensation: Furnish.

5. Process Connections:

a. Type: 3/4-inch NPT(M), unless otherwise noted.
b. Pipe Size: As noted.
c. Connection Type: Insertion.
d. Connection Material: 316 stainless steel, unless otherwise noted.
e. Conduit Connection: 1 1/4-inch NPT(F) reduced to 3/4 inch with bushing.

Element: Insertion/Body Length (From Tip of Probe to Process Connection: Determined by the supplier based upon pipe size and sensor mounting requirements, unless otherwise noted. The insertion length shall be noted on an application specific installation detail prepared and submitted for each unit.

7. Electronics:

a. Location: Integral with element, unless otherwise noted.
b. Hermetically sealed with SPDT relay.

8. Signal Interface:

a. Contact: Single-pole, double-throw (SPDT), rated 120V ac, 2 amps.
b. Connection: Screw terminal block.

9. Enclosure:

a. Type: NEMA 7BCD with watertight O-ring seal, submersible application.
b. Material: Epoxy coated, cast aluminum, unless otherwise noted.
c. Approval: Factory Mutual for hazardous area, unless otherwise noted.

10. Power: 120V ac, 60-Hz, unless otherwise noted.

a. Cable (Furnished Only When Remote Electronics is Specified).
b. Type: As required.
c. Length: As required.

11. Manufacturer:

a. Fluid Components, Inc.; Model FLT93S.
b. Delta M Corp., Model FS4100.

E. L-5 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 1/8 inch.
f. Repeatability: Less than 1/8 inch.
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 of 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. L-109 Level Switch, Miniature, Rises on Stem:

1. General:

a. Function: Actuate contact at preset liquid level.
b. Type: Direct acting; rises on stem.

2. Service: Chemical feed containment area leak detection unless otherwise noted.

3. Performance:

a. Set point as noted.
b. Switch Actuation Point: Approximately one-half distance from end of stem to mounting.
c. Operating Temperature Range: Minus 40 to plus 300 degrees F.

4. Features:

a. Wetted Parts: Polypropylene, solid.
b. Mounting: Stem Mount: 1/8 inch NPT.
c. Signal Interface:
(1) Switch Type: Magnetic reed switch.
(2) Switch Contacts.
(3) Isolated, rated at 20 VA.
(4) NO or NC (by inverting float on unit stem).
(5) Lead Wires: No. 22 AWG, 24-inch length.

5. Manufacturer and Product:

a. GEMS; Single Station Liquid Level Switch, Model LS-3.
b. Or equal.

G. P-4 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.

H. P-9 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.

B. Y-30 Communication Interface Module:

1. General:

a. Function: Serve as a network interface for control components.
b. Performance:
(1) Unit shall support network communication using EtherNet I/P protocol.
(2) Unit shall communicate with the control device using RS-232 or DF-1 Serial Communication protocols. Communication data rates shall be programmable, 2400 to 38.4 Kbaud.
(3) Ethernet communication shall be auto-detecting 10/100 base-T, half- or full-duplex.
c. Features:
(1) Communication Ports:
(a) Ethernet: RJ-45.
(b) Serial: RS232.
(2) Mounting: DIN rail.
d. Power:
(1) Voltage: 24 V dc, maximum.

(2) Current: 100 mA, maximum.

e. Environment:

(1) Temperature: minus 40 to plus 85 degrees C.

(2) Humidity: 55 to 95 percent, non-condensing.

f. Manufacturer and Model: Allen Bradley 1761-NET-ENI, or approved equal.

I. Y-40 Solar Panel and 24 V dc Power Supply with Battery Backup:

1. General:

a. Function: Converts sunlight to regulated 24 V dc power, with 24 V dc battery backup during period of complete or partial interruption of solar power. Unit serves to provide 'trickle-charge' to the battery during period when solar source is available.

b. Major Parts: Solar cells, controller, and sealed batteries.

2. Performance:

a. Capacity: Ability to convert sunlight source to regulated 24 V dc with up to 15 A continuous current. Unit shall have capacity to provide 'trickle charge' for the battery.

b. Output Power: 15 A, 24 V dc, unless otherwise noted.

c. Battery: Two 7 Ah, 12 V dc lead gel backup type, wired in series.

d. Continuous no-break power with no measurable transfer time.

e. Solar panel, measured at STC:

(1) Minimum optimum operating voltage: 30 V dc.

(2) Rated power: 175 W minimum.

(3) Short circuit current rating: 7.15 A.

(4) Performance output:

(a) Through first 10 years: no less than 90 percent.

(b) Years 11 through 25: no less than 80 percent.

f. Power Converter:

(1) Type: Pulse-width modulation, constant voltage.

(2) Operating voltage: 8 V dc, minimum.

(3) Power self-consumption: 22 mA, maximum.

(4) Maximum voltage drops:

(a) Solar to battery: 0.2 V dc.

(b) Battery to load: 0.12 V dc.

(5) High temperature shutdown: 70 degrees C, disconnect solar; 80 degrees C, disconnect load.

3. Features:

a. Solar panel:

(1) Mono-crystalline solar cells.

(2) Anodized aluminum frame.

(3) 4mm thick solar front glass, highly transparent and anti-reflective.

(4) Wind Loading: 125 MPH minimum.

b. Power Controller:

(1) Battery status LED: Color and flash to indicate battery voltage.

(2) LCD display.

(3) Environmental: minus 40 to plus 60 degrees C, 100 percent RH (non-condensing).

4. Manufacturers:

a. Solar cell: HelisUSA 6T Series, or approved equal.
b. Power controller: Morning Start, ProStar PS-15, or approved equal.

J. Y-41 Antennas, Type 1:

1. General:

a. Function: Facilitates transmission and reception of radio signals.
b. Type: Directional Yagi.
c. Parts: Antenna, mounting assembly, support pole, cabling, and accessories.

2. Performance:

a. Radio band: Spread spectrum, 902-928 Mhz.
b. Gain: 11dB.
c. Polarization: Vertical or horizontal.
d. Beam width:
(1) Horizontal: 50 degrees.
(2) Vertical: 40 degrees.
e. VSWR: Less than 1.5.

3. Features:

a. Anodized, solid aluminum elements.
b. Elements brazed to main support.
c. Wind load rating: 120 MPH, minimum.

4. Mounting Assembly:

a. Provide brackets, clamps, and kits as required for a permanent mount.

5. Cabling:

a. Length and cable size: As required.
b. Closed cell foam dielectric core.
c. Impedance: As required.
d. Jacket: Polyethylene.

6. Accessories:

a. Cable surge suppressor: Polyphasor or approval equal.
b. Connectors: As required.
c. Attenuation pads as required to reduce signal strength to within acceptable working limits of radio transceivers.

7. Manufacturer/Model:

a. ZDA Communications US, LLC. 902 to 928 MHz Yagi Antenna, or approved equal.

K. Y-42 Antennas, Type 2:

1. General:

a. Function: Facilitates transmission and reception of radio signals.
b. Type: Directional omni.
c. Parts: Antenna, mounting assembly, support pole, cabling, and accessories.

2. Performance:

a. Radio band: Spread spectrum, 870-960 MHz.
b. Gain: 6 dB.
c. Polarization: Vertical.
d. Beam width:
(1) Horizontal: 360 degrees.
(2) Vertical: 25 degrees.
e. VSWR: Less than 1.5.

3. Features:

a. Fiberglass radome construction.
b. Wind load rating: 125 MPH, minimum.

4. Mounting Assembly:

a. Provide brackets, clamps, and kits as required for a permanent mount.

5. Cabling:

a. Length and cable size: As required.
b. Closed cell foam dielectric core.
c. Impedance: As required.
d. Jacket: Polyethylene.

6. Accessories:

a. Cable surge suppressor: Polyphasor or approved equal.
b. Connectors: As required.
c. Attenuation pads as required to reduce signal strength to within acceptable working limits of radio transceivers.

7. Manufacturer/Model:

a. ZDA Communications US, LLC. 900 MHz Omni Antenna, or approved equal.

L. Y-54 Small Programmable Controller:

1. General:

a. Function: Multi-loop analog and discrete control.
b. Type: PLC shall be 'brick' type, i.e. having integral I/O and communication capability, but shall also support I/O expansion.
c. Parts: Unit shall be all-in-one. No additional parts are required unless noted (i.e. remote I/O or communication interface module).

2. Performance:

a. Memory:
(1) Unit shall have 8 kB of non-volatile, battery backed-up memory, 4kB for user program, 4 kB for data.
(2) Unit shall have capacity of up to 128 kB for data logging.
(3) Unit shall have provisions for addition of removable memory.
b. Instructions:
(1) A minimum of one PID loop.
(2) Support floating-point mathematics.
(3) Real-time clock.
(4) Support on-line, real-time editing.

3. Features:

a. Display: Unit shall have an integral LCD allowing access to monitor/adjust 48 bits and 48 integral values, as a minimum.
b. Trim Potentiometers: Unit shall provide two digital trim potentiometers.
c. Communication: Two channels.
(1) Channel 0: RS-232/RS-485 combination port; RS-232 supporting all serial communication protocols; RS-485 supporting DH-485, DF-1 half-duplex, ASCII, Modbus RTU Master/Slave.
(2) Channel 1: RJ-45, supporting EtherNet I/P messaging (peer-to-peer).

4. Power Supply: Integral to unit using 12 or 24 V dc.

5. Input/Output (I/O):

a. Integral to unit.
b. General requirements:
(1) Unit shall have integral a minimum of two isolated digital input groups, one isolated analog input group, and six isolated relay output groups. All relays shall be individually isolated.
(2) Unit shall support a maximum of 80 discrete I/O using expansion modules.
(3) Unit shall support a minimum of four expansion modules (input/output, discrete, and analog).
c. Specific requirements:
(1) Discrete input: Ten 12 or 24 V dc sink or source, four high speed (40KHz catch).
(2) Output: Six, individual, isolated, relay contacts.
(3) Analog Input: Two, 0 to 10 V dc, non-isolated, 10-bit resolution.

6. Programming Software:

Suitable for programming the PLC processor, communication interface module, and expansion I/O Modules:
a. Ladder diagram and function block diagram.
b. Provides communication configuration support for serial protocols.
c. Product:
(1) RS Logix 500 or approved equal.

7. Environmental Requirements:

a. Operating temperature: Minus 4 to plus 149 degrees F.

b. Relative humidity: 5 to 95 percent, non-condensing.

8. Manufacturer and Product:

Allen-Bradley MicroLogix 1100, or approved 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:
(1) User logic: 16 K words.
(2) Data: 24 Kbytes.
c. Scan time: Less than 1 msec per 1,000 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.
(4) 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.
(5) Enhanced operations.
(6) Four-function integer math.
(7) Word shift registers.
(8) Word compare.
(9) Word move.
(10) Two PID controllers, as a minimum.

6. Data Input/Output:

a. Discrete Input:
(1) Quantity: 16 inputs.
(2) Type: V dc, sinking.
(3) Nominal operating voltage: 48 V dc.
(4) Status indication: LED.
b. Discrete Output:
(1) Quantity: 8 outputs.
(2) Type: Relay, rated 8.0 amperes continuous at 120 V ac.
(3) Nominal operating voltage: 48V 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: 1780 V ac for 1 minute.
(c) Resolution: 12 bit, minimum.
(4) 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: 1780 V ac for 1 minute.
(4) Resolution: 12 bit, minimum.
(5) Status indication: LED.

7. Environmental Requirements:

Mount each PLC, its power supply, and I/O modules inside the specified control panels or as shown on the drawings.

a. Operating temperature: 0 to 45 degrees C.
b. Humidity Rating: 5 to 95 percent, non-condensing.

8. Power Supply:

PLC equipment shall operate on 120 V ac, plus or minus 10 percent, single-phase, 60-Hz, plus or minus 0.5-Hz power.

9. Manufacturer and Product:

Allen Bradley SLC 5/05 Processor with Series 1746 I/O System, or approved equal.

N. Y-57 Radio, Spread Spectrum:

1. General:

a. Function: Supports wireless communication between devices.
b. Type: Radio transceivers, frequency hopping spread spectrum.

2. Environmental:

a. Operating temperature range: Full performance from minus 22 to plus 140 degrees F.
b. Humidity rating: 95 percent relative humidity at 104 degrees F.
c. Enclosure: Die-cast aluminum.

3. Performance:

a. Radio band: 902-928 MHz, part 15 spread spectrum.
b. Frequency hopping range: 8 selectable zones, each containing 128 frequencies.
c. Operation: Half duplex or simplex.

4. Data Characteristics:

a. Connectivity: RS-232.
b. Communication rates: 1200, 2400, 4800, 9600, 19200 bps asynchronous.
c. RF channel data rate: Selectable between 512 and 256 kbps.
d. Average latency: less than 10 ms, typ.

5. Transmitter:

a. Carrier power output: 1 watt maximum.
b. Duty cycle: Continuous.

6. Receiver Sensitivity:

a. 256 kbps data transmission: -99 dBm with $10^{-6}$ bit error rate (BER)
b. 512 kbps data transmission: -92 dBm with $10^{-6}$ bit error rate (BER)

7. Power:

a. 24 V dc nominal.
b. Reverse polarity protection.

8. Diagnostics:

a. Received signal strength.
b. Main supply voltage.
c. Internal temperature.
d. Signal to noise ratio.
e. Radio status.
f. Radio Alarm and status indication.
(1) External LEDs.

9. Accessories:

a. Six-foot pigtail power connector.

10. Manufacturer/Model

a. California Microwave, Microwave Data Systems, Model iNet 900™, or approved equal.

O. Y-63 Operator Interface Unit (OIU):

1. General:

a. Function: Operator interface to PLC.
b. Type: Touch screen.

2. Environmental:

a. Operating temperature: 0 to 45 degrees C.
b. Humidity rating: 10 to 90 percent, non-condensing.

3. Performance:

a. CPU shall be 32 bit RISC operating at 400 MHz, as a minimum.
b. Enclosure: Rating: NEMA 4.
c. Display:
(1) Type: 256 color DSTN.
(2) Size: 10-inch.
(3) Back light: CCFT.
d. Application memory: 512 Kbyte flash, minimum.
e. Touchscreen:
(1) Type: 4-wire analog resistive.

4. External Interface:

a. Communication ports:
(1) Network: One port; Ethernet (Modbus TCP/IP).
(2) Serial: Two ports.

5. Electrical Requirements: 120 V ac, single-phase, 60-Hz.

6. Accessories: Configuration software, MS Windows compatible.

7. Manufacturer and Model: Maples Systems; HMI 5100N, or approved equal.

P. Y-76 Managed Network Switch, 8-Port, FX/FX, Single-Mode

1. General:

a. Managed Ethernet switch, operating on OSI Layer 2.
b. Serves as copper-to-optical converter, suitable for use with single-mode fiber optic, unless otherwise noted.

2. Power: 120 V ac, 60 Hz, 17 W.

3. Physical Characteristics:
a. Physical Dimensions: 10 x 5.4 x 1.75 inches.
b. Connections:
(1) Eight (8) RJ-45.
(2) One (1) 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).

4. Switch Performance:

a. Eight (8) port 10/100 Base T, Half/Full Duplex in compliance with IEEE Std 802.3 and IEEE Std 802.3u.
b. 8K MAC address table, with auto-learn
c. VLAN tagging in compliance with IEEE Std 802.1q. Port-based VLANs and overlapping VLANs
d. IEEE Std 802.1p Class of Service with 2-level priority queuing

b. Fiber:
(1) Multi-Mode 62.5/125 um.
(2) Light wave length: 1310 nm.
(3) Optic link budget: 15 dB/2 km.
c. Electric link budget: 100 m.

5. Transceiver Performance:

a. Light wave: 1300 nm.
b. Optic link budget: 11 db/4,000m.

6. Configuration and Troubleshooting:

a. Interface: Console port, Web-based GUI, Telnet, and SNMP
b. IEEE Std 802.1d Spanning Tree
c. IEEE Std 802.3x Flow Control
d. IEEE Std 802.3ad Broadcast storm filter
e. Diagnostics: Provide LED status indication for the following:
(1) Power.
(2) 100 M operation.
(3) LK/ACT
(4) FD/COL

7. Environment:

a. Enclosure: NEMA 1/IP20.
b. Temperature: 0 to 45 degrees C.
c. Humidity: 10 to 95 percent, noncondensing.

8. Manufacturer and Product:

a. Transition Network, MIL-SM801P(XX).
b. Or Equal.

Q. Y-85 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), or approved equal.

R. Y-87 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 multi-mode, unless otherwise noted.

2. Power: 12 V dc, 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 percent, 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) Multi-Mode 62.5/125 um.
(2) Light wave length: 1310 nm.
(3) Optic link budget: 15 dB/2 km.
c. Electric link budget: 100 m.

5. Manufacturer and Product:

a. Transition Network.
b. Or Equal.

-- End of Section --

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CHEMICAL FEED 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.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z400.1 | (2004) Hazardous Industrial Chemicals - Material Safety Data Sheets - Preparation |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA B300 | (2010) Hypochlorites |
| AWWA B302 | (2005) Ammonium Sulfate |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME A13.1 | (2007) Scheme for the Identification of Piping Systems |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D 1693 | (2008) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics |
| ASTM D 1785 | (2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D 638 | (2010) Standard Test Method for Tensile Properties of Plastics |
| ASTM D 790 | (2010) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| ASTM F 468 | (2010) Nonferrous Bolts, Hex Cap Screws, and Studs for General Use |
| ASTM F 476 | (1984; R 2002) Standard Test Methods for Security of Swinging Door Assemblies |

HYDRAULIC INSTITUTE (HI)

| | |
|---|---|
| HI 7.1-7.5 | (2002) Controlled Volume Metering Pumps |
| HI 9.1-9.5 | (2000) Pumps - General Guidelines for |

Types, Applications, Definitions, Sound Measurements and Documentation

NSF INTERNATIONAL (NSF)

NSF/ANSI 61 (2010a) Drinking Water System Components - Health Effects

1.2 SYSTEM DESCRIPTION

Provide a chemical feed system consisting of a chemical supply storage tank from which the chemical solution is pumped through piping or tubing, as appropriate, to the point of application. Include with each chemical feed system controlled volume pumps, tanks, gauges, back pressure regulators, strainers, pressure relief valves, sight glasses and flow metering devices, check valves, and hand valves as specified herein.

1.2.1 Design Requirements

Design and fabrication of the pumps shall be in accordance with HI 7.1-7.5 and HI 9.1-9.5 except as modified herein. Pump stands and platforms shall be adequate to support the pumping system.

1.2.2 Performance Requirements

Capacity and design of the chemical feed systems and accessories shall be suitable for 24-hour full load service in ambient, non freezing conditions.

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

Installation

Detail drawings containing complete piping, wiring, schematic, flow diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation.

SD-03 Product Data

Chemical Feed System

Manufacturer's descriptive and technical literature, catalog cuts, performance charts, and pump curves. List of materials, list of equipment, including a complete list of parts and supplies with current unit prices and source of supply. List of special tools for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly.

Material Safety Data Sheets

Material safety data sheets, as specified.

Auxiliary Equipment and Spare Parts

List of parts recommended by the manufacturer to be replaced after 1 year of service.

SD-06 Test Reports

Field Testing

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

SD-07 Certificates

Chemical Feed System Components

One copy of certification stating that each chemical feed system component that may come in contact with the liquid being handled meets NSF/ANSI 61 standards.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

Six complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Also include in the instructions as-built drawings of the piping layout, equipment layout, simplified wiring and control diagrams of the system as installed, and flow diagrams.

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Protect material and equipment delivered and placed in storage from the weather, excessive humidity, excessive temperature variation, dirt, dust, or other contaminants.

## 1.5 EXTRA MATERIALS

Concurrent with delivery and installation of the specified equipment, furnish auxiliary equipment and spare parts as follows:

a. Spare parts for each different item of material and equipment specified including all of the parts recommended by the manufacturer to be replaced after 1 year of service.

b. One extra of each part used that is made from glass, hard rubber,

or clear plastic; one extra set of solution-hose connections; one diaphragm and three springs for each back pressure regulator; one diaphragm and air valve for each pulsation dampener; one diaphragm and three springs for each pressure relief valve; one spare strainer for each strainer.

d. One set of special tools for each type of equipment including calibration devices, and instruments required for adjustment, calibration, disassembly, operation, and maintenance of the equipment.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.2 CHEMICALS

Submit Material Safety Data Sheets in conformance with ANSI Z400.1 for each chemical. Chemicals shall conform to the following:

2.2.1 Disinfecting Agents

AWWA B300 hypochlorites and AWWA B302 ammonium sulfate.

2.3 CHEMICAL METERING PUMPS

2.3.1 Hypochlorite Metering Pumps

Pumps shall be solenoid-actuated type metering pumps. Each pump shall have the capacity to deliver the chemical solution at any rate ranging between the minimum and maximum specified values and shall be suitable for continuous operation within that range.

Pump repeatability shall be within plus or minus 2 percent over a range between the minimum and maximum specified values.

Pump drive and electronics shall be totally enclosed in a chemical resistant enclosure. The drive electronics, solid-state electronic pulser, shall be fully encapsulated. Termination of control and power wiring shall be made at quick-connect terminals, minimum of 3/16 inch wide, located on the drive enclosure. The pump and pump drive electric power consumption shall be 87 watts or less under full speed and full pressure conditions.

The pump shall automatically cease operation whenever discharge pressure exceeds the pump's rated pressure by 35 percent.

Specific pump specifications are as follows:

Chemical Solution: Commercial-Grade Sodium Hypochlorite (NaOCl).
Chemical Solution Concentration: Minimum 9 percent; maximum 15 percent.
Feed/Flow Rate: Minimum 0.011 gph; maximum 1.1 gph.
Back Pressure: Maximum 100 psig.
Materials of Construction for Wetted Parts:
Pump Head: Polyvinyl Chloride (PVC)/PVDF.
Check Valve Ball: Ceramic.
Diaphragm/Tube: Fluorofilm/PTFE.
Seals: PVDF/Polyprel/PTFE.

Provide for local, manual adjustment of pump stroke-length.

Provide for local and remote adjustment of pump stroke rate. Provide an LCD display to indicate pump operation. Provide tactile keypad for operator selection of pump operational mode and local adjustment of pump stroke rate. The pump shall accept an analog signal (4 to 20 mA) representative of the desired feed/flow rate for remote adjustment of pump stroke rate. Pump response (direct or reverse) to the analog signal shall be operator selectable.

Number of metering pumps: Three installed.

Metering pumps shall be as manufactured by Prominent, Model GA1a 1005, or equal.

2.3.2 Ammonium Sulfate Metering Pumps

Pumps shall be solenoid-actuated type metering pumps. Each pump shall have capacity to deliver the chemical solution at any rate ranging between the minimum and maximum specified values and shall be suitable for continuous operation within that range.

Pump repeatability shall be within plus or minus 2 percent over a range between the minimum and maximum specified values.

Pump drive and electronics shall be totally enclosed in a chemical resistant enclosure. The drive electronics, solid-state electronic pulser, shall be fully encapsulated. Termination of control and power wiring shall be made at quick-connect terminals, minimum of 3/16 inch wide, located on the drive enclosure. The pump and pump drive electric power consumption shall be 87 watts or less under full speed and full pressure conditions.

The pump shall automatically cease operation whenever discharge pressure exceeds the pump's rated pressure by 35 percent.

Specific pump specifications are as follows:

Chemical Solution: 40 percent Ammonium Sulfate ((NH4)2SO4).
Chemical Solution Concentration: Minimum 18.5 percent; maximum 19.5 percent.
Feed/Flow Rate: Minimum 0.003 gph; maximum 0.29 gph.
Back Pressure: Maximum 100 psig.
Materials of Construction for Wetted Parts:
Pump Head: PVC/PVDF.
Check Valve Ball: Ceramic.
Diaphragm/Tube: Fluorofilm/PTFE.

Seals: PVDF/Polyproprel/PTFE.

Provide for local, manual adjustment of pump stroke-length.

Provide for local and remote adjustment of pump stroke rate. Provide an LCD display to indicate pump operation. Provide tactile keypad for operator selection of pump operational mode and local adjustment of pump stroke rate. The pump shall accept an analog signal (4 to 20 mA) representative of the desired feed/flow rate for remote adjustment of pump stroke rate. Pump response (direct or reverse) to the analog signal shall be operator selectable.

Number of metering pumps: Three installed.

Metering pumps shall be as manufactured by Prominent, Model GA1a 1601, or equal.

## 2.4 CHEMICAL METERING PUMP SKIDS

### 2.4.1 Hypochlorite Metering Pump Skid

#### 2.4.1.1 General Arrangement

The hypochlorite metering pump skid shall be a triplex skid. The hypochlorite metering pump skid shall be completely assembled and tested before delivery to the job site. All equipment shall be of materials selected specifically for use with sodium hypochlorite.

The required systems are schematically shown on the Mechanical and Instrumentation Drawings provided in the drawings. Deviations from these schematics are to be illustrated on these drawings and submitted for Contracting Officer review.

Provide for each hypochlorite metering pump the following:

One back pressure valve.
One pressure relief valve.
One flow through pulsation dampener.
One diaphragm protected pressure gauge.

Deliver the chemical metering feed systems assembled, complete, and tested by the manufacturer before delivery to the project site.

Configure each pump to facilitate their removal by disconnecting only the piping directly connected to their inlet and outlet piping/tubing connections and associated electrical connections. Disconnecting, removing, or modifying any adjacent piping or electrical equipment to facilitate pump removal is unacceptable.

Provide isolation valves and unions for all serviceable components.

All seals and gaskets shall be Teflon or Viton, suitable for sodium hypochlorite.

Provide the following clearances (minimum):

Between pumps: 12 inches.
Between parallel pipes: 6 inches.

All piping shall be Schedule 80 PVC as specified in Section 33 11 00 WATER DISTRIBUTION. All tubing shall be flexible reinforced clear PVC tubing as specified in Section 33 11 00 WATER DISTRIBUTION.

Rigidly support the pulsation dampener and calibration tube. Devices mounted unsupported directly to the piping are unacceptable.

Route electrical conduit around the ends and sides of the skid or base terminating at the terminal junction box.

Provide 3/4-inch-diameter quick-connect couplings on the pump skid suction and discharge piping for flushing and draining the pump skid piping. Provide pipe reducers as required to transition pipe diameter to 3/4-inch -diameter at the couplings if skid suction or discharge piping is a size other than 3/4-inch-diameter.

The quick-connect couplings and caps on skids with thermoplastic piping shall be polypropylene. Quick-connect couplings on the skid shall be male end couplings. Provide a padlockable female end cap with 316 stainless steel chain for each male coupling on the skid. Thermoplastic couplings shall be Evertite Part A, or equal.

The hypochlorite metering pump skid shall be manufactured by Blue Planet Environmental Systems, Inc., or equal.

2.4.1.2 Skid Design

The chemical metering skids shall be constructed from white PVC with a minimum trade thickness of 1/2 inch.

The skid shall be self-supporting with equipment and piping. Include gussets and supports in the design as needed.

All components of the chemical metering system shall be contained within the skid.

The skids shall be manufactured using continuous welding technology; bolted construction is not acceptable.

Pedestals shall be provided to elevate and mount the metering pumps above the skid base (to elevate the chemical metering above the containment structure floor).

Each pump shall be individually bolted so that it is removable independent of other pumps.

Attach the piping to the chemical metering skid with non-metallic corrosion resistant framing support system, Aikenstrut, or equal. Pipe straps shall be removable and reusable to allow for servicing of the system.

Use titanium bolts (ASTM F 468, Grade Ti1, Ti2, or Ti7), washers, and nuts ( ASTM F 476) wherever metallic fasteners are required.

Clearly label all inlet/outlet connections, valves, and pump accessories on the skid.

Weld all support channels directly to the chemical metering skid. Bolted or screwed supports are not acceptable.

The skid base shall have four lifting lugs, one at each corner, designed to lift the weight of the complete skid or base with all equipment attached to it.

A NEMA 4X terminal junction box (TJB) shall be provided on the skid back panel for termination of all wiring. A power outlet with weatherproof cover shall be provided for any metering pumps or accessories that require an outlet. The inside cover of the terminal box shall include a wiring diagram detailing the function of all terminals. A power disconnect switch or breaker shall be provided in the TJB. Surge protection shall be provided locally in the skid mounted TJB. Protection shall be provided for the main power supply as well as all analog input and output signals. Surge protection devices shall be as manufactured by EDCO Inc. of Florida. The NEMA 4X TJB shall provide the following I/O at a minimum:

Terminals for 120 VAC power (local heavy duty surge protection included).

15A Breaker for Main AC Power.

HOA Selector Switch for each pump.

Elapsed time meter for each pump.

DI = Remote On/Off for each pump.

AI = Remote Speed Reference for each pump (local surge protection included).

DO = Run Status for each pump.

DO = Fault Status for each pump.

2.4.1.3 Accessories

Calibration Columns:

Provide one calibration column for each hypochlorite metering pump. Size the column to provide fluid level observation for at least 30 seconds at pump's full stroke and maximum speed settings. The column shall have a minimum of 12 inches graduated in gallons and fractions thereof, to allow reading of the fluid contents. The graduation accuracy shall be 1 percent as a minimum. The column shall be clear PVC pipe, Schedule 80, conforming to ASTM D 1785 with Schedule 80 fittings. Provide the column with a cap to prevent accidental splashing of the chemical. The cap shall be suitable for installation of a ball valve for air venting.

Back Pressure and Pressure Relief Valves:

Provide separate back pressure and pressure relief valves on the discharge piping of each metering pump.

The valves' set point range shall be fully adjustable from 10 to 150 psi.

The valves' bodies shall be PVC, compatible with sodium hypochlorite.

Pulsation Dampeners:

Provide gas charged pulsation dampeners on the discharge of each pump. Size the pulsation dampeners for a minimum of 90 percent dampening.

Dampeners shall be PVC with a Viton bladder and include gas charge fitting and pressure gauge.

All materials shall be compatible with sodium hypochlorite.

Diaphragm-Protected Pressure Gauges:

Two-inch dial size liquid-filled pressure gauges with isolators shall be provided to indicate system pressure in the discharge piping of each metering pump. Industrial-quality liquid-filled Type 316 stainless steel gauges as manufactured by WIKA shall be used. The isolators shall have housings compatible with chemical as specified herein with a Teflon diaphragm and suitable liquid fill.

De-gassing Riser (DEGAS):

A de-gassing riser shall be provided in the suction header. The de-gassing riser shall be installed in front of any metering pump inlets. The de-gassing riser shall include an isolation ball valve and shall be piped in SCH-80 clear PVC to allow for visual inspection and shall terminate at the top of the metering skid. An FPT connection shall be provided for connection to rigid piping for "vent" return to the supply container.

2.4.1.4 Piping and Tubing

All piping shall be Schedule 80, PVC as specified in Section 33 11 00 WATER DISTRIBUTION.

All tubing shall be flexible reinforced clear PVC tubing as specified in Section 33 11 00 WATER DISTRIBUTION.

2.4.1.5 Valves

All manual valves shall be Double Union, PVC Ball Valve, with vented ball as specified in Section 33 11 00 WATER DISTRIBUTION.

2.4.2 Ammonium Sulfate Metering Pump Skid

2.4.2.1 General Arrangement

The ammonium sulfate metering pump skid shall be a triplex skid. The ammonium sulfate metering pump skid shall be completely assembled and tested before delivery to the job site. All equipment shall be of materials selected specifically for use with ammonium sulfate.

The required systems are schematically shown on the Mechanical and Instrumentation Drawings provided in the drawings. Deviations from these schematics are to be illustrated on these drawings and submitted for Contracting Officer review.

Provide for each ammonium sulfate metering pump the following:

One back pressure valve.
One pressure relief valve.
One flow through pulsation dampener.

One diaphragm protected pressure gauge.

Deliver the chemical metering feed systems assembled, complete, and tested by the manufacturer before delivery to the project site.

Configure each pump to facilitate their removal by disconnecting only the piping directly connected to their inlet and outlet piping/tubing connections and associated electrical connections. Disconnecting, removing, or modifying any adjacent piping or electrical equipment to facilitate pump removal is unacceptable.

Provide isolation valves and unions for all serviceable components.

Provide the following clearances (minimum):

Between pumps: 12 inches.
Between parallel pipes: 6 inches.

All piping shall be Schedule 80 PVC as specified in Section 33 11 00 WATER DISTRIBUTION. All tubing shall be flexible reinforced clear PVC tubing as specified in Section 33 11 00 WATER DISTRIBUTION.

Rigidly support the pulsation dampener and calibration tube. Devices mounted unsupported directly to the piping are unacceptable.

Route electrical conduit around the ends and sides of the skid or base terminating at the terminal junction box.

The ammonium sulfate metering pump skid shall be manufactured by Blue Planet Environmental Systems, Inc., or approved equal.

2.4.2.2 Skid Design

The chemical metering skids shall be constructed from white PVC with a minimum trade thickness of 1/2 inch.

The skid shall be self-supporting with equipment and piping. Include gussets and supports in the design as needed.

All components of the chemical metering system shall be contained within the skid.

The skids shall be manufactured using continuous welding technology; bolted construction is not acceptable.

Pedestals shall be provided to elevate and mount the metering pumps above the skid base (to elevate the chemical metering above the containment structure floor).

Each pump shall be individually bolted so that it is removable independent of other pumps.

Attach the piping to the chemical metering skid with non-metallic corrosion resistant framing support system, Aikenstrut, or equal. Pipe straps shall be removable and reusable to allow for servicing of the system.

Use stainless steel washers and nuts wherever metallic fasteners are required.

Clearly label all inlet/outlet connections, valves, and pump accessories on the skid.

Weld all support channels directly to the chemical metering skid. Bolted or screwed supports are not acceptable.

The skid base shall have four fitting lugs, one at each corner, designed to lift the weight of the complete skid or base with all equipment attached to it.

A NEMA 4X terminal junction box (TJB) shall be provided on the skid back panel for termination of all wiring. A power outlet with weatherproof cover shall be provided for any metering pumps or accessories that require an outlet. The inside cover of the terminal box shall include a wiring diagram detailing the function of all terminals. A power disconnect switch or breaker shall be provided in the TJB. Surge protection shall be provided locally in the skid mounted TJB. Protection shall be provided for the main power supply as well as all analog input and output signals. Surge protection devices shall be as manufactured by EDCO Inc. of Florida. The NEMA 4X TJB shall provide the following I/O at a minimum:

Terminals for 120 VAC power (local heavy duty surge protection included).

15A Breaker for Main AC Power.

HOA Selector Switch for each pump.

Elapsed time meter for each pump.

DI = Remote On/Off for each pump.

AI = Remote Speed Reference for each pump (local surge protection included).

DO = Run Status for each pump.

DO = Fault Status for each pump.

2.4.2.3 Accessories

Calibration Columns:

Provide one calibration column for each ammonium sulfate metering pump. Size the column to provide fluid level observation for at least 30 seconds at pump's full stroke and maximum speed settings. The column shall have a minimum of 12 inches graduated in gallons and fractions thereof, to allow reading of the fluid contents. The graduation accuracy shall be 1 percent as a minimum. The column shall be clear PVC pipe, Schedule 80, conforming to ASTM D 1785 with Schedule 80 fittings. Provide the column with a cap to prevent accidental splashing of the chemical. The cap shall be suitable for installation of a ball valve for air venting.

Back Pressure and Pressure Relief Valves:

Provide separate back pressure and pressure relief valves on the discharge piping of each metering pump.

The set point range of the valves shall be fully adjustable from 10 to 150 psi.

The bodies of the valves shall be PVC, compatible with ammonium sulfate.

Pulsation Dampeners:

Provide gas charge pulsation dampeners on the discharge of each pump. Size the pulsation dampeners for a minimum of 90 percent dampening.

Dampeners shall be PVC with a Viton bladder and include gas charge fitting and pressure gauge.

All materials shall be compatible with ammonium sulfate.

Diaphragm-Protected Pressure Gauges:

Provide 2-inch dial size liquid-filled pressure gauges with isolators to indicate system pressure in the discharge piping of each metering pump. Industrial-quality liquid-filled Type 316 stainless steel gauges as manufactured by WIKA shall be used. The isolators shall have housings compatible with chemical as specified herein with a Teflon diaphragm and suitable liquid fill.

2.4.2.4 Piping and Tubing

All piping shall be Schedule 80, PVC as specified in Section 33 11 00 WATER DISTRIBUTION.

All tubing shall be flexible reinforced clear PVC tubing as specified in Section 33 11 00 WATER DISTRIBUTION.

2.4.2.5 Valves

All manual valves shall be Double Union, PVC Ball Valve, with vented ball as specified in Section 33 11 00 WATER DISTRIBUTION.

2.5 CHEMICAL STORAGE TANKS

2.5.1 Sodium Hypochlorite Storage Tanks

2.5.1.1 General

Tanks shall be rotationally-molded, vertical, high density crosslinked polyethylene with an oxidation resistant liner system, one-piece seamless construction, cylindrical in cross-section and vertical with flat bottoms. Tanks shall be adequately vented. Where indicated, tanks shall be provided with ancillary mechanical fittings and accessories. Tanks shall be marked to identify that serial numbers must be permanently embossed into the tank.

The tanks shall be designed and constructed for storing sodium hypochlorite.

All components/items shall be suitable for the service application.

The nominal properties of the sodium hypochlorite tank materials shall be as follows:

| Property | Type I XLPE | ASTM Test |
|---|---|---|
| Environmental Stress Cracking Resistance, F50, hours, 10 percent Igepal | >1,000 | ASTM D 1693 |
| Tensile Strength, Ultimate psi, 2-inch /minimum | 2,830 | ASTM D 638 Type IV Specimen |
| Elongation at Break, percent, 2-inch minimum | 700 | ASTM D 638 Type IV Specimen |
| Flexural Modulus, psi | 86,780 | ASTM D 790 |

The tanks shall be molded from HDXLPE. The resin used shall be Paxon 7004 as manufactured by Exxon/Mobil Chemical. Interior of each tank shall have an oxidation resistant liner.

The plastic shall not contain any fillers. All plastic shall contain a minimum of 0.25 percent and maximum of 0.60 percent U.V. stabilizer. Pigments added shall not exceed 0.5 percent of the total weight of the tank if dry blended or 2 percent if melted compound. Tank color shall be natural and have molded-in gallonage markers on the tank wall.

The tanks shall be permanently marked to identify the serial number. Tanks shall be labeled as recommended by the Manufacturing Chemists Association.

The tank diameter shall be measured externally. Tolerance on the outside diameter including out of roundness shall be plus or minus 3 percent. Measurement shall be taken in a horizontal position.

On closed top tanks the top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall be equal to the thickness of the top of the straight sidewall. In most cases, flat areas shall be provided for attachment of large fittings on the dome of the tank.

The bottom head shall be integrally molded with the cylindrical wall. Knuckle radius shall be:

| Tank Diameter, feet | Min. Knuckle Radius, inch |
|---|---|
| Less than or equal to 6 | 1 |
| Greater than 6 | 1-1/2 |

The minimum wall thickness shall be 1/4 inch in all places. All edges cut shall be trimmed smooth. Use flexible connections at all lower sidewall fittings.

2.5.1.2 Tank Fittings

All tank fittings specified herein shall be furnished by the tank manufacturer. These tank fittings are not necessarily shown in the drawings. The Contractor shall coordinate the location of the following accessories with the drawings before submitting shop drawings for the tank:

Provide one PVC U-vent per tank located at the peak of the tank dome. Provide a non-metallic insect screen compatible with the sodium hypochlorite on each tank vent. Vents shall be sized by the tank manufacturer. Vents shall comply with OSHA standards.

Provide one Schedule 80 PVC fill dip/drop pipe per tank. Each dip/drop pipe shall discharge 6 inches above tank floor and fitted with a wear plate or baffle assembly to prevent erosion of tank surface. Each dip/drop pipe shall be furnished with a non-obtrusive (no tank, wall penetrations) pipe support system.

Pipes shall be supported at 4-foot maximum intervals.

Flexible Couplings/Connections: Provide Viton/PTPE flexible coupling/connection assemblies for connection of piping to the lower sidewall fitting of the tanks in accordance with the tank manufacturer's requirements and recommendations. Flange bolting shall be titanium.

2.5.1.3 Tank Accessories

Provide complete restraint system, including cables, turnbuckles, thimbles, clips, epoxy adhesive type anchor bolts by the Contractor, and all other necessary hardware to secure tank to concrete support pad. All items shall be 300-series stainless steel construction.

Restraint system shall be designed to meet 130 mph (minimum) wind load condition.

2.5.1.4 Sodium Hypochlorite Tank Manufacturer

Number of Tanks: Two.
Minimum Tank Capacity: 155 gallons.

The storage tanks shall be manufactured by Poly Processing Inc., or approved equal.

2.5.2 Ammonium Sulfate Storage Tanks

The ammonium sulfate solution shall be supplied by the manufacturer in 55-gallon drums.

2.6 INJECTORS

2.6.1 Sodium Hypochlorite Injectors

Sodium hypochlorite solution injectors shall be removable Hastelloy (Alloy C-276) chemical injection assemblies.

Solution tube tip shall enter into the main pipe to a minimum of one-third and a maximum of half the pipe diameter and have a 45-degree angle cut facing downstream inside the pipe main. Diffusers shall be removable/insertion type that can be removed without shutting down the main process piping. Include a locking device to prevent accidental release of the solution tube from the pressurized main. Include a stainless steel safety chain to prevent withdrawal of the solution tube past the corporation stop. Include a ball check valve to prevent backpressure from the main from entering the chemical feed system. Provide a flexible hose assembly to connect from the containment piping to the injector.

The manufacturer shall furnish and install one complete sodium hypochlorite injection assembly (injector, flexible hose, and isolation valve) at each sodium hypochlorite application location indicated in the drawings.

The manufacturer shall furnish and install one corporation stop valve with plug at each unused tap.

The manufacturer shall furnish one complete spare injector to the Contracting Officer.

Injectors with flexible hosing shall be EB-120 Series by Saf-T-Flo Industries Corporation, Anaheim, CA, or approved equal.

2.6.2 Ammonium Sulfate Injectors

Ammonium sulfate solution injectors shall be removable Hastelloy (Alloy C-276) chemical injection assemblies.

Solution tube tip shall enter into the main pipe to a minimum of one-third and a maximum of one-half the pipe diameter, and have a 45-degree angle cut facing downstream inside the pipe main. Diffusers shall be removable/insertion type that can be removed without shutting down the main process piping. Include a locking device to prevent accidental release of the solution tube from the pressurized main. Include a stainless steel safety chain to prevent withdrawal of the solution tube past the corporation stop. Include a ball check valve to prevent backpressure from the main from entering the chemical feed system. Provide a flexible hose assembly to connect from the containment piping to the injector.

The manufacturer shall furnish and install one complete injection assembly (injector, flexible hose, and isolation valve) at each ammonium sulfate application location indicated in the drawings.

The manufacturer shall furnish and install one corporation stop valve with plug at each unused tap at the ammonium sulfate application location.

The manufacturer shall furnish one complete spare injector to the Contracting Officer.

Injectors with flexible hosing shall be EB-120 Series by Saf-T-Flo Industries Corporation, Anaheim, CA, or approved equal.

2.7 SODIUM HYPOCHLORITE BAG FILTERS

Sodium hypochlorite bag filter body, bag hold-down unit, and restrainer basket shall be constructed of PVC. Cover shall be PVC with Viton O-ring. Provide the double length bag size filter housing capable of chemical flow rates of 100 gpm with clean filter bags. Inlet, outlet, and drain piping connections shall be 2-inch-diameter true union connections. Provide two 100-micron polypropylene double length filter bags for each filter unit with one serving as a spare. Filter bags shall be Hayward DURAGAF P02E, or approved equal. Bag filters shall be Hayward Filtration System Polyline Simplex Bag Filter Housing with Double Length Bag Size. Adapters shall be Evertite Part A/DC, Banjo Corporation Male Adapter/Female Thread and Cap, Murray Equipment Inc. Style A/DC, or approved equal.

PART 3 EXECUTION

## 3.1 FACTORY TESTING OF METERING PUMP SKIDS

The metering pump skid manufacturer shall do the following regarding factory testing for each skid:

Test the packaged chemical feed system in the factory and provide factory testing certificates to the Engineer. Factory tests are subject to be repeated at no additional cost to the Government until the Government or Contracting Officer are satisfied that the equipment is operating correctly.

Pressure test skid piping (except for overflow and vent piping) using water to a pressure of 150 psi for 3 hours. During this 3-hour test there shall no leakage at any pipe joint or connection to any valve or piece of equipment. Repair or replace any defective pipe joint or connection and retest.

Test each package system by using water and temporary storage tanks and interconnecting piping. Operate the control system by simulating the external control signals. Verify that the control system automatically controls the packaged system in response to the specified external control signals. Verify that metering pumps respond to the external flow-pacing signal. Verify that the metering pumps stage on and off in response to the control signal.

After successfully demonstrating that the systems function properly using water, drain and remove the water from the chemical systems. Nitrogen gas shall be used to completely dry out the piping before storing or shipping.

## 3.2 INSTALLATION

### 3.2.1 Chemical Feed Equipment

Install metering pump skids, metering pumps, and appurtenance in accordance with the manufacturer's instructions.

### 3.2.2 Pipe, Tubing, Hangers and Supports

The installation of pipes and tubes shall be in accordance with Section 33 11 00 WATER DISTRIBUTION.

## 3.3 FIELD PAINTING

Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material and shall be primed and top-coated with the manufacturer's standard factory finish provided it does not discolor in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) conditions. Equipment which did not receive a factory finish shall be painted as specified in Section 09 90 00.00 98 PAINTS AND COATINGS. Coating shall be not less than 1.75 mils thick. Piping identification shall be as specified in Section 09 90 00.00 98 PAINTS AND COATINGS. Pipe carrying materials not listed in Section 09 90 00.00 98 PAINTS AND COATINGS shall be marked in accordance with ASME A13.1.

## 3.4 FIELD TESTING

Conduct operating test on each metering pump, after installation is complete, as specified herein. Prepare and submit reports of these tests for review and comment prior to final acceptance of the installation. The

required test shall be as follows:

Metering Pump Performance

Record the pump delivery flow rate at the specified back pressure as follows:

50-percent of maximum pump stroke length; 25, 50, 75, and 100-percent of pump stroke rate.

100-percent of maximum pump stroke length; 25, 50, 75, and 100-percent of pump stroke rate.

10-percent of maximum pump stroke length; 25, 50, 75, and 100-percent of pump stroke rate.

Zero percent of pump stroke rate; 10, 50, and 100-percent of maximum pump stroke length.

Plot the recorded pump performance on manufacturer's characteristic performance curves.

Note vibration of pump during testing.

Neutralize all chemicals wasted during testing to achieve a pH value between 6.5 and 9.5 and a chlorine concentration of not more than 1 percent (10,000 mg/l). Dispose of wasted chemicals in a matter acceptable to the Contracting Officer. For bidding purposes, assume chemicals will be wasted to an onsite tank. Coordinate with the Contracting Officer regarding quantity of waste anticipated.

## 3.5 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment.

## 3.6 FIELD TRAINING

Conduct a field training course for designated operating, maintenance and supervisory staff members. Training shall be provided for a total period of 2 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the Operating and Maintenance Instructions.

-- End of Section --

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-- End of Section Table of Contents --

# SECTION 44 42 19

# POSITIVE DISPLACEMENT BLOWERS

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

Furnish all labor, materials, and incidentals required to provide positive displacement (PD) blower equipments specified in this Section and shown on the Drawings. The blowers shall be rotary, positive displacement, belt-driven, and shall be complete with all appurtenances necessary to make the equipment complete and operable in compliance with the following Specifications.

### 1.2 RELATED WORK

Section 01 33 00, SUBMITTAL PROCEDURES
Section 01 78 00, CLOSEOUT SUBMITTALS
Section 01 78 23, OPERATION AND MAINTENANCE DATA
Section 09 90 00.00 98, PAINTING AND COATING
Section 33 71 02.00 20, UNDERGROUND ELECTRICAL DISTRIBUTION
Section 40 95 00, PROCESS CONTROL SYSTEM

### 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.

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)

| | |
|---|---|
| AFBMA Specs | Bearing Life Specifications |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME PTC 9 | (1970; R 1997) Displacement Compressors, Vacuum Pumps and Blowers (for historical reference only) |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 112 | (2004) Standard Test Procedure for Polyphase Induction Motors and Generators |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG1 | (2010; Rev 1) Motors and Generators |

### 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

Shop Drawings; G

Shop drawings shall be in accordance with the paragraph entitled "DRAWINGS."

SD-03 Product Data

Motor Information; G

Complete motor nameplate data as defined by NEMA, the manufacturer, and any motor modifications. For energy-efficient motors, provide a certified copy of the test report for a similar motor tested in accordance with NEMA MG1-12.54 and IEEE 112, Test Method B, showing full-load efficiency meeting or exceeding specified values. Motors not as specified will be rejected.

1/2, 3/4, and full-load efficiencies and power factors.

Blower; G

The manufacturer shall supply an engineered blower selection showing the expected noise level of the blower without the enclosure and the attenuation rating for the enclosure in dBA.

Product Data shall including the manufacturer's descriptive literature.

SD-05 Design Data

Data Curves; G

Discharge Temperature; G

L10 Bearing Life Calculations; G

Silencers; G

Pressure Relief Valves; G

v-belt

Coupling Drive calculations; G

Exceptions; G

Provide all data in accordance with the paragraph entitled "DESIGN DATA."

SD-07 Certificates

Manufacturer's Certification; G

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA; G

1.5 DRAWINGS

Shop drawings shall show assembled packaging stating what items will be shipped to the job site assembled and those shipped loose for field assembly.

1.6 DESIGN DATA

Data submitted shall include the following information:

Data Curves: Performance data curves showing pressure, capability, horsepower demand, and speed over the entire operating range of the unit(s).

Discharge Temperature at ambient temperature and normal system operating conditions.

L10 Bearing Life Calculations for each bearing.

Silencers: An attenuation performance curve for each type of silencer.

Pressure Relief Valves: set pressure.

Coupling Drive calculations.

A list of all exceptions and an explanation of each non-compliance with the specifications. If it is impossible to conform to certain details of this Section due to different manufacturing techniques, describe completely all non-conforming aspects.

1.7 QUALITY ASSURANCE

All air blowers and appurtenances furnished under this Section shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best industry practices and methods.

Routine tests shall be performed on representative motors and shall include the information described on NEMA MG1-12.54 Report of Test Form for Routine Tests on Induction Motors. Efficiency shall be determined in accordance with IEEE 112, Method B.

Should equipment which differs from this Section be offered and determined to be the equal of that specified, such equipment will be acceptable only on the basis that any revisions in the design and/or construction of the structures, piping, appurtenant equipment, etc required to accommodate such a substitution shall be made at no additional cost to the Owner and be as approved by the Contracting Officer.

Equipment furnished under this Section may be supplied through a system packager other than the blower manufacturer only if the following conditions are complied with:

1. The blower manufacturer shall supply in writing that they have

reviewed the intended application and that the complete prepared package and all components are satisfactorily sized and arranged for the intended use and location

2. The blower manufacturer shall supply warranties on the blowers in compliance with Section 01 78 00, CLOSEOUT SUBMITTALS. Such warranties shall be in addition to warranties supplied by the system packager and shall be all-inclusive with regard to the blower equipment, including acknowledgement that the warranty applies to the units as packaged by others.

The blower system manufacturer shall be an authorized warranty service center for the bare blower provided.

Blower system suppliers must submit an authorization letter from the bare blower manufacturer of the blower proposed to be installed, to the Contracting Officer at least 10 working days before the bid opening for the system to qualify for use on the project. The letter shall state the system manufacturer is qualified to design and build blower systems for the application and is authorized to perform warranty work.

Blowers, motors, and all primary components shall be manufactured in the United States with replacements and parts available from multiple sources within the United States.

1.8 DELIVERY, STORAGE, AND HANDLING

Care must be taken during unloading and handling of equipment to ensure against undue strain to the blower and motor. Do not use lifting straps or chains under the blower or motor. Lift from under the main frame or base or use base-mounted lifting lugs (if provided).

In storage blowers must be kept clean, free of moisture, and rotated a minimum of twenty revolutions each week to maintain warranty. For storage in excess of 4 months or in a damp or corrosive environment, see the manufacturer's operation and maintenance manual.

1.9 WARRANTY

Warranties shall be in accordance with General Conditions, Supplementary Conditions, and Section 01 78 00 CLOSEOUT SUBMITTALS.

1.10 OPERATION AND MAINTENANCE MANUALS

Operations and Maintenance Manuals shall be in accordance with General Conditions, Supplementary Conditions, and Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.11 DEFINITIONS

SCFM. Standard cubic feet per minute is understood to be air at 68 degrees F, 14.7 pounds per square inch gauge (psig), and 36 percent relative humidity flowing at a rate of 1 cubic foot per minute.

ICFM. The volume of air in cubic feet per minute actually entering the blower inlet at the atmospheric condition specified.

Discharge Pressure. The pressure in psig measured at the blower discharge flange.

Overall Efficiency. The total efficiency for the motor, drive, and blower from the motor terminals to the pumped air.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

Each of the four PD blowers shall be designed for the following conditions of service: each PD blower shall be capable of delivering the volume of air when operating at an elevation of 0 feet above sea level and inlet temperatures varying from 30 degrees F to 100 degrees F. The equipment manufacturer shall indicate 100 degrees F and 85 percent relative humidity ambient air summer condition; overall efficiency at the guarantee point. Blower enclosures shall be suitable for outdoor installation.

Process performance requirements:

1. PD Blower No. 1, 2, 3, and 4:

| | |
|---|---|
| Site Elevation, FASL | 0 |
| Maximum Inlet Temperature, degrees F | 100 |
| Maximum Relative Humidity, percent | 85 |
| ICFM plus/minus 4 percent | 137 |
| Differential Pressure, psig | 8.0 |
| Maximum blower brake horse power required | 7.8 |
| RPM limit at above SCFM | 1765 |
| Motor Size, hp | 15 |
| Sound Limit Required: (at 3.28 feet in free field) | 78 |
| Installation Location | Outside as shown on the drawings |
| Hp | Nameplate greater than the brake horsepower at 10 percent above the relief valve set pressure |
| RPMs | 1800 |
| Type | TEFC |
| Power | 460-volt, 3-phase, 60-Hertz |
| Insulation | Class F with Class B rise |
| Service Factor | 1.15 at power voltage and site elevation listed above |

| | |
|---|---|
| Efficiency | "Premium efficient" in accordance with latest edition of NEMA MG1 |

2.2 ACCEPTABLE MANUFACTURER

The blower assembly package, including frame and base, shall be as manufactured by:

a. Universal Blower Pac, Inc. with Sutorbilt Model 4MQ.
b. Approved equal.

All PD blowers shall be provided by the same manufacturer.

2.3 EQUIPMENT

2.3.1 Blower Assembly Frame and Base

A common base and frame shall be supplied with each blower assembly with provisions on which to mount the blower, drive, motor, and intake silencer with filter, discharge silencer, and sound limiting enclosure. Each base shall be welded fabricated-steel construction, suitably reinforced. Bare base weight shall be greater than or equal to 50 percent of blower weight and not less than 100 pounds.

Each motor mounting base shall include all necessary provisions to permit proper blower/motor alignment. For V-belt drive unit(s), motor mounting bases shall be the adjustable two-rail type, each rail having a corresponding threaded rod to facilitate alignment and drive belt replacement/tensioning.

2.3.2 Blower

The blower shall be the two-lobe, two-impeller, belt-driven, rotary positive-displacement type, with top inlet and bottom outlet. The blower shall be frame mounted with intake silencer, blower, motor, and discharge silencer. Blower output shall be regulated by motor speed, which is controlled by interchangeable motor and blower sheaves and corresponding drive belts.

Each blower casing shall be of one-piece construction with separate headplates. Casings and head plates shall be made of close-grained cast iron suitably ribbed to prevent distortion under the specified operating conditions. Inlet and outlet connections shall be threaded and shall be an integral part of the blower casing.

The impellers shall be the straight, two-lobe type and shall operate without rubbing or liquid seals or lubrication. Impellers shall be constructed of ductile iron or close-grained cast iron, suitably ribbed internally. All impellers shall be statically and dynamically balanced and machined on all exterior surfaces for operating at close tolerances. The impellers shall be attached to forged, machined alloy-steel shafts by flanges, or shafts may be an integral part of the impeller. Shafts shall be of one-piece straight-through design or two-piece design designed to withstand all operating loads imposed.

The impellers shall be positively timed by a matched pair of timing gears. Timing gears shall be designed and manufactured for continuous service in accordance with AGMA Standards. Timing gears shall be fully machined from

alloy steel, bolted to timing hubs, and adjustable for field retiming. Timing hubs shall be splined to the shaft and locked in place by a suitable lock nut.

Each impeller and shaft assembly shall be supported at each end by double-row spherical bearings. All bearings shall have a rating life of 100,000 hours as defined by AFBMA Specs.

Lubrication to the timing gears and gear-end bearings of each blower shall be maintained by an oil bath relying on gears to splash lubricate all moving parts. The oil system shall have sufficient capacity and cooling provisions to provide adequate oil to the gears and bearings with a continuous service interval between oil changes of not less than 2,000 hours. High-temperature Viton oil seals shall be provided to prevent lubricant from leaking into the air stream or into the atmosphere. The drive end bearings shall be grease lubricated through exterior grease fittings.

Sight glasses shall be provided for oil level observation. Each sight glass shall be able to indicate that a safe oil level exists during blower operation and accurately indicate the amount of oil present when the blower is off.

## 2.4 ACCESSORIES

### 2.4.1 Lifting Lugs

Where practical or applicable, individual equipment and/or each component part over 100 pounds shall be provided with lifting lugs for easy handling.

### 2.4.2 Intake Filter

Each blower shall be furnished with a dry-type element inlet filter. The filter medium shall be paper filter media capable of filtering 2-micron solids with a 99.5 percent solids-retention efficiency with a pressure drop of less than 2 inches of water column.

### 2.4.3 Inlet Silencers

The inlet silencer shall be heavy-duty, welded-steel construction, two-chamber absorptive type. The silencers shall provide attenuation suitable for critical pitch line velocity applications.

Pressure drop through the inlet silencer shall be minimal.

The inlet silencers shall be capable of handling the process performance requirements specified in the paragraph entitled "Performance and Design Requirements" of this Section.

Silencer shall be:

a. Progentex, Inc., Series DS, RSI, DRSI.
b. Universal Silencer, Inc., Series U5, URB, RIS.
c. Burgess Manning Series CA, BMAI, BMSI.
d. Stoddard series L/C21, D13/41, D61/23.
e. Or approved equal.

Combination type inlet filter/silencers shall not be permitted.

2.4.4 Discharge Silencers

The discharge silencers shall be heavy-duty, welded-steel construction, two-chamber absorptive type. The silencers shall provide attenuation suitable for critical pitch line velocity applications.

The blower discharge silencers shall be capable of handling the conditions specified in the paragraph entitled "Performance and Design Requirements" of this Section.

Silencer shall be:

a. Progentex, Inc., Series DS, RS, DRS.
b. Universal Silencer, Inc., Series U5, URB, SD.
c. Burgess Manning Series CA, BMA, BMSS.
d. Stoddard Series L/C21, D13, D32/33.
e. Or approved equal.

Combination type discharge silencer/base frames shall not be permitted.

2.4.5 Pressure Relief Valves

The Contractor shall provide a spring or weighted discharge pressure-relief valve installed on the discharge silencer. This valve is to be set to relieve at 1 psig above the blower maximum operating pressure and shall be factory set and tested during the shop performance test. If the valve malfunctions, it shall do so in the open position to prevent blower damage.

2.4.6 Check Valve

Provide wafer, cast-iron body, disc-type check valve for mounting on blower discharge piping. Furnish a valve with 304 SS internals, 304 SS spring, and Teflon seat material.

2.4.7 Vibration Isolator Pads

Provide molded, synthetic rubber and cork, vibration-isolation pads for each blower. Vibration-isolation pads shall be sized to fit the structural steel base.

2.4.8 Discharge Pressure Gauge

The Contractor shall furnish and field-install a glycerine-filled pressure gauge at each blower discharge.

a. Range: 0-15 psi.

b. Accuracy: 2 percent of full scale, maximum.

c. Dial: 2-1/2-inch-diameter 270 degree scale; heavy-gauge aluminum with white background and black markings; 0.25-psig minor divisions.

d. Case: Stainless steel.

e. Ring: Stainless steel.

f. Movement: Stainless steel.

g. Bourdon Tube: Phosphor bronze, large bore tubing which is silver

soldered to socket and tip.

h. Connection: Forged brass 1/4-inch NPT black connection.

i. Gauges shall be WIKA Model 233.53, Ashcroft Type 1009, or approved equal.

2.4.9 Lubrication and Special Operating Supplies

Lubrication oil shall be the manufacturer's approved synthetic high-temperature-duty type (e.g., Mobil 1) as manufactured by Mobil Oil Company or approved equal.

2.5 MOTORS AND DRIVERS

2.5.1 Motors

The blowers motors shall be rated for 7.8 hp with a nominal motor speed of 1800 rpm. Motors shall operate on 460-volt, 60-Hertz, three-phase power. Motors shall be of the TEFC type with 1.15 service factor. The motor shall be premium efficiency.

The horsepower rating of all motors shall accommodate all brake horsepower conditions of blower performance without exceeding the temperature rating of the motor windings.

2.5.2 Belt Drive

Each blower shall be driven by a constant-speed v-belt drive assembly, equipped with integral electric drive motor and motor support. The drive assembly shall employ a belt transmission consisting of two pulleys connected by a V-belt. The output speed of the drive shall be capable of being changed by replacement of the pulleys. All rotating surfaces shall be enclosed by a removable guard. The drive assembly shall have a service factor of 1.14.

PART 3 EXECUTION

3.1 INSTALLATION

Blowers are recommended to be installed on a non-moving foundation with the industry standard depth of twice the blower gear diameter or a pad two times the total mass of all rotating compartments, whichever depth is greater.

If these recommendations cannot be accommodated, the following points must be followed to ensure an adequate installation:

1. The blower pad must be located on the equivalent of compacted soil substructure, which will allow the pad to remain flat, rigid, and free of resonant frequencies within the operating range of the equipment.

2. The blower must be anchored using bolts intended specifically for dynamic loading.

3. The area between the base and pad must be filled with 1 inch minimum of non-shrink grout.

4. The unit must be installed and leveled in accordance with the

manufacturer's installation instructions supplied in the O&M manual.

Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

3.2 PAINTING AND SURFACE PREPARATION

Factory surface preparation and painting shall be the manufacturer's standard.

3.3 SHOP TESTING

Each blower shall be statically and dynamically balance tested at the factory. Each blower shall receive a certified slip test in accordance with ASME PTC 9. A test report confirming capacity shall be furnished complete with data and calculations. The test consists of blanking off discharge and measuring the speed of the blower to maintain discharge pressure of 1 psig. Also recorded shall be inlet temperature, barometer, and discharge gauge pressure. Slip RPM recorded shall be corrected by formula in ASME PTC 9 to specified performance requirements.

Each blower shall be given a factory mechanical test to ensure mechanical integrity. If the test indicates that adjustments are necessary to ensure conformance with specifications, such adjustments shall be made before shipment.

3.4 FIELD TESTING

The Contractor shall provide services of a factory-authorized service representative to perform, approve, and certify the pre-startup testing and startup testing specified in this Section. The service representative shall be certified and employed by the manufacturer of the equipment specified in this Section.

1. The factory-authorized service representative shall be onsite to perform the testing services specified in this Section for one 8-hour day, excluding travel time.

2. Pre-Startup Testing:

a. Visually inspect the blowers and certify that the motor has been furnished in accordance with the Specifications in this Section as to horsepower, maximum input torque (100 percent rated load), voltage, phase, and hertz.

b. Visually inspect and verify that the incoming electrical service and controls have been installed in accordance with the manufacturer's recommendations.

c. Verify that the blower control panel has been furnished with all of the controls and alarms specified in this Section and has been installed in accordance with the manufacturer's recommendations.

d. Verify that the units have been properly installed and are in proper alignment.

e. Verify that there are no mechanical defects in any of the

parts.

3. Startup Testing:

a. The factory-authorized service representative shall perform the startup testing specified in this Section in accordance with this Section.

b. With the lift station filled to the maximum water surface elevation shown on the Contract Documents, verify:

(1) That the units operate without overheating or overloading of any parts and without objectionable vibration.

(2) That the blowers can deliver the specified pressures and air flow rates.

(3) That the controls meet the performance requirements stated in this Section.

(4) That the alarms and safety shutdowns have been installed in accordance with the Contract Documents and the manufacturer's recommendations. These features shall be checked by artificially simulating an alarm and/or safety shutdown or control condition.

4. Final acceptance depends on the satisfactory operation and performance after installation.

## 3.5 TRAINING SERVICES

The factory-authorized service representative shall be onsite to perform training services for one 8-hour day, excluding travel time.

## 3.6 MANUFACTURER'S CERTIFICATION OF COMPLIANCE

The Contractor shall furnish a Manufacturer's Certification of Compliance for the equipment specified in this Section.

The equipment manufacturer shall provide a written report covering findings and installation approval. The report shall describe all inspections and any deficiencies noted and shall be mailed directly to the Contracting Officer.

## 3.7 MAINTENANCE

### 3.7.1 Spare Parts

The Contractor shall furnish the following spare parts in clearly identified containers, labeled for easy identification without opening the packaging and suitably protected for long-term storage in a humid environment.

a. One set of drive belts for each blower supplied.

b. One interchangeable set of sheaves for each PD Blower.

c. One filter element for each inlet filter/silencer supplied.

d. One-year supply of each lubricant required. Lubricants shall include alternate references to equal products of other manufacturers, including specifications such as AGMA numbers, viscosity, etc.

e. Additional spare parts shall be provided in accordance with the recommendations of equipment manufacturers.

-- End of Section --