# ENGINEERING DESIGN STANDARDS FOR BID PACKAGE 4 – CIVIL WORKS

## RFB 6000000898

## C-43 WEST BASIN STORAGE RESERVOIR DESIGN UPDATE

## CORRECTED FINAL/RTA

## HENDRY COUNTY, FLORIDA

## PROJECT ID#: 100088

## TECHNICAL SPECIFICATIONS

## Volume 3

**(Division 8 – Division 40)**

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# SECTION 08 11 13

# 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 | (2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C591 | (2016) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM D2863 | (2013) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index) |
| ASTM E1300 | (2016) Standard Practice for Determining Load Resistance of Glass in Buildings |
| ASTM E283 | (2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |
| ASTM E90 | (2009) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements |
| ASTM E413 | (2016) Classification for Rating Sound Insulation |
| ASTM F2248 | (2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass |

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

| | |
|---|---|
| ANSI/BHMA A156.115 | (2014) Hardware Preparation in Steel Doors and Steel Frames |

INTERNATIONAL CODE COUNCIL (ICC)

| | |
|---|---|
| FBC | (2017) Florida Building Code 6th Edition including the High Velocity Hurricane Zone requirements |

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 A250.4 | (2011) Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcing |
| SDI/DOOR A250.6 | (2003; R2009) Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames |
| SDI/DOOR A250.8 | (2003; R2008) Recommended Specifications for Standard Steel Doors and Frames |
| SDI/DOOR A250.11 | (2001) Recommended Erection Instructions for Steel Frames |

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors

Frames

Accessories

Weatherstripping

Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

Schedule of doors

Schedule of frames

Submit door and frame locations.

SD-03 Product Data

Doors

Frames;

Accessories

Florida Product Approval or Miami-Dade NOA

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 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. Provide exterior glazing in accordance with ASTM F2248 and ASTM E1300.

### 2.1.1 Classification - Level, Performance, Model

#### 2.1.1.1 Heavy Duty Doors

SDI/DOOR A250.8, Level 2, physical performance Level B, Model 2, with core construction as required by the manufacturer for interior doors and 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.

## 2.2 INSULATED STEEL DOOR SYSTEMS

Insulated steel doors shall have a core of polyurethane foam and an R factor of 10.0 or more (based on a k value of 0.16); face sheets, edges, and frames of galvanized steel not lighter than 23 gage, 16 gage, and 16 gage respectively; magnetic weatherstripping; nonremovable-pin hinges; thermal-break aluminum threshold; and vinyl door bottom. Doors and frames shall receive phosphate treatment, rust-inhibitive primer, and baked acrylic enamel finish. Doors shall have been tested in accordance with SDI/DOOR

A250.4 and shall have met the requirements for Level C. Prepare doors to receive specified hardware. Doors shall be 1-3/4 inch thick.

## 2.3 DESIGN CRITERIA

Doors and their associated frames shall be designed for the loads and impact cases as prescribed in the FBC High Velocity Hurricane Zone. The nominal design pressure rating specified in the Florida Product Approval or Miami-Dade NOA shall exceed the nominal design pressure shown on the Drawings for the applicable pressure zones. Submit Florida Product Approval or Miami-Dade Notice of Acceptance (NOA) documentation for use in a High Velocity Hurricane Zone, meeting small and large missile impact requirements.

## 2.4 ACCESSORIES

### 2.4.1 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.

### 2.4.2 Moldings

Provide moldings around glass of interior and 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.

## 2.5 INSULATION CORES

Insulated cores shall be of type specified, and provide an apparent U-factor of .48 in accordance with SDI/DOOR 113 and shall conform to:

a. Rigid Cellular Polyisocyanurate Foam: ASTM C591, Type I or II, foamed-in-place or in board form, with oxygen index of not less than 22 percent when tested in accordance with ASTM D2863.

## 2.6 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, transoms, and interior glazed panels, unless otherwise indicated.

### 2.6.1 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.

2.6.2 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.

2.6.3 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.

2.6.3.1 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.

a. Masonry: Provide anchors of corrugated or perforated steel straps or 3/16 inch diameter steel wire, adjustable or T-shaped;

b. Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding.

c. Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111.

2.6.3.2 Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member.

2.7 WEATHERSTRIPPING

As specified in Section 08 71 00 DOOR HARDWARE.

2.7.1 Integral Gasket

Black synthetic rubber gasket with tabs for factory fitting into factory slotted frames, or extruded neoprene foam gasket made to fit into a continuous groove formed in the frame, may be provided in lieu of head and jamb seals specified in Section 08 71 00 DOOR HARDWARE. Insert gasket in groove after frame is finish painted. Air leakage of weatherstripped doors shall not exceed 0.5 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283.

2.8 HARDWARE PREPARATION

Provide minimum hardware reinforcing gages as specified in SDI/DOOR A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to

ANSI/BHMA A156.115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of SDI/DOOR A250.8, as applicable. Punch door frames, with the exception of frames that will have weatherstripping or gasketing, to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

## 2.9 FINISHES

### 2.9.1 Factory-Primed Finish

All surfaces of doors and frames shall be thoroughly cleaned, chemically treated and factory primed with a rust inhibiting coating as specified in SDI/DOOR A250.8.

## 2.10 FABRICATION AND WORKMANSHIP

Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable.

### 2.10.1 Grouted Frames

For frames to be installed in exterior walls and to be filled with mortar or grout, fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of stop-applied head and jamb seals.

# PART 3 EXECUTION

## 3.1 INSTALLATION

### 3.1.1 Frames

Set frames in accordance with SDI/DOOR A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction. Where frames require ceiling struts or overhead bracing, anchor frames to the struts or bracing. Backfill frames with mortar. Coat inside of frames with corrosion-inhibiting bituminous material. For frames in exterior walls, ensure that stops are filled with rigid insulation before grout is placed.

### 3.1.2 Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

## 3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

## 3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

-- End of Section --

# SECTION 08 71 00

# DOOR HARDWARE

## PART 1 GENERAL

### 1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM E283 | (2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |
| ASTM F883 | (2013) Padlocks |

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

| | |
|---|---|
| ANSI/BHMA A156.1 | (2013) Butts and Hinges |
| ANSI/BHMA A156.10 | (2011) Power Operated Pedestrian Doors |
| ANSI/BHMA A156.12 | (2013) Interconnected Locks & Latches |
| ANSI/BHMA A156.13 | (2012) Mortise Locks & Latches Series 1000 |
| ANSI/BHMA A156.14 | (2013) Sliding and Folding Door Hardware |
| ANSI/BHMA A156.15 | (2015) Release Devices Closer Holder, Electromagnetic and Electromechanical |
| ANSI/BHMA A156.16 | (2013) Auxiliary Hardware |
| ANSI/BHMA A156.17 | (2014) Self Closing Hinges & Pivots |
| ANSI/BHMA A156.18 | (2016) Materials and Finishes |
| ANSI/BHMA A156.19 | (2013) Power Assist & Low Energy Power Operated Doors |
| ANSI/BHMA A156.2 | (2011) Bored and Preassembled Locks and Latches |
| ANSI/BHMA A156.21 | (2014) Thresholds |
| ANSI/BHMA A156.22 | (2012) Door Gasketing and Edge Seal Systems |
| ANSI/BHMA A156.23 | (2010) Electromagnetic Locks |
| ANSI/BHMA A156.24 | (2012) Delayed Egress Locking Systems |

| | |
|---|---|
| ANSI/BHMA A156.25 | (2013) Electrified Locking Devices |
| ANSI/BHMA A156.26 | (2012) Continuous Hinges |
| ANSI/BHMA A156.27 | (2011) Power and Manual Operated Revolving Pedestrian Doors |
| ANSI/BHMA A156.29 | (2012) Exit Locks, Exit Alarms, Alarms for Exit Devices |
| ANSI/BHMA A156.3 | (2014) Exit Devices |
| ANSI/BHMA A156.30 | (2014) High Security Cylinders |
| ANSI/BHMA A156.31 | (2013) Electric Strikes and Frame Mounted Actuators |
| ANSI/BHMA A156.36 | (2010) Auxiliary Locks |
| ANSI/BHMA A156.4 | (2013) Door Controls - Closers |
| ANSI/BHMA A156.5 | (2014) Cylinder and Input Devices for Locks |
| ANSI/BHMA A156.6 | (2015) Architectural Door Trim |
| ANSI/BHMA A156.7 | (2016) Template Hinge Dimensions |
| ANSI/BHMA A156.8 | (2015) Door Controls - Overhead Stops and Holders |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 101 | (2015; ERTA 2015) Life Safety Code |
| NFPA 252 | (2017) Standard Methods of Fire Tests of Door Assemblies |
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |
| NFPA 72 | (2016) National Fire Alarm and Signaling Code |
| NFPA 80 | (2016) 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 |

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

| | |
|---|---|
| 36 CFR 1191 | Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines |

UNDERWRITERS LABORATORIES (UL)

UL 14C (2006; Reprint May 2013) Swinging Hardware for Standard Tin-Clad Fire Doors Mounted Singly and in Pairs

UL Bld Mat Dir (2012) Building Materials Directory

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Manufacturer's Detail Drawings

Hardware Schedule

Keying

SD-03 Product Data

Hardware Items

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance Data

Hardware Schedule Items, Data Package 1

SD-11 Closeout Submittals

Key Bitting

1.3 SHOP DRAWINGS

Submit manufacturer's detail drawings indicating all hardware assembly components and interface with adjacent construction.

1.4 HARDWARE SCHEDULE

Prepare and submit hardware schedule in the following form:

| Hardware Item | Quantity | Size | Reference Publi-cation Type No. | Finish | Mfr Name and Catalog No. | Key Control Symbols | UL Mark (If fire-rated and listed) | BHMA Finish Desig-nation |
|---|---|---|---|---|---|---|---|---|

In addition, submit hardware schedule data package 1 in accordance with Section 01 78 05 OPERATION AND MAINTENANCE INFORMATION.

## 1.5 KEY BITTING REQUIREMENTS

### 1.5.1 Requirements

Provide specified cylinders and cores and keys for future District re-keying.

## 1.6 QUALITY REQUIREMENTS

### 1.6.1 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.

### 1.6.2 Key Shop Drawings Coordination Meeting

Prior to the submission of the key shop drawing, the Construction Manager, Contractor, Door Hardware Subcontractor, using Activity and Base Locksmith must meet to discuss and coordinate key requirements for the facility.

## 1.7 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 on hardware schedule.

# PART 2 PRODUCTS

## 2.1 TEMPLATE HARDWARE

Hardware applied to metal doors must be manufactured using a template. Provide templates to door and frame manufacturers in accordance with ANSI/BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

## 2.2 HARDWARE FOR EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 101 for exit doors, and all other requirements indicated, even if such hardware is not specifically mentioned in paragraph HARDWARE SCHEDULE.

## 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 is visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover. Coordinate electrified door hardware components with corresponding components specified in Division 28 ELECTRONIC SECURITY SYSTEMS (ESS).

2.3.1 Hinges

Provide in accordance with ANSI/BHMA A156.1. Provide hinges that are 4-1/2 by 4-1/2 inch unless otherwise indicated. Construct loose pin hinges for interior doors and reverse-bevel exterior doors so that pins are non-removable when door is closed. Other anti-friction bearing hinges may be provided in lieu of ball bearing hinges.

| Hinge Sizes Chart | | |
|---|---|---|
| Thickness of Doors in inches | Width of Doors in inches | Height of Hinges (Length of Joint) in inches |
| 7/8 to 1-1/8 screen | To 36 | 3 |
| 1-3/8 | To 32 | 3-1/2 |
| 1-3/8 | Over 32 to 37 | 4 |
| 1-3/4 | To 36 | 4-1/2 |
| 1-3/4 | Over 36 to 48 | 5 Heavy Weight |
| 1-3/4 | Over 48 | 6 Heavy Weight |
| 2, 2-1/4 and 2-1/2 | To 42 | 5 Heavy Weight |
| 2, 2-1/4 and 2-1/2 | Over 42 | 6 Heavy Weight |

2.3.2 Locks and Latches

2.3.2.1 Mortise Locks and Latches

Provide in accordance with 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 fit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges. Provide levers and roses of mortise locks with screwless shanks and no exposed screws.

2.3.3 Exit Devices

Provide in accordance with 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. Provide escutcheons not less than 7 by 2-1/4 inch.

2.3.4 Cylinders and Cores

Provide cylinders and cores for new locks, including locks provided under other sections of this specification. Provide cylinders and cores with six pin tumblers. Provide cylinders from the products of one manufacturer, and provide cores from the products of one manufacturer. Rim cylinders, and

levers 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.

Provide cylinders for new locks, including locks provided under other sections of this specification. Provide fully compatible cylinders of Grade 1 products from products of one manufacturer with interchangeable cores that are removable by a special control key. Factory set the cores with six pin tumblers using the A4 system and F keyway. Submit a core code sheet with the cores. Provide master keyed cores in one system for this project. Provide construction interchangeable cores.

2.3.5 Lock Trim

Provide cast, forged, or heavy wrought construction and commercial plain design for lock trim.

2.3.5.1 Lever Handles

Provide lever handles in accordance with ANSI/BHMA A156.3 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.

2.3.5.2 Texture

Provide knurled or abrasive coated knobs or lever handles for doors which are accessible to blind persons and which lead to dangerous areas.

2.3.6 Keys

All locks, locksets and cylinders shall be registered and keyed at the factory. Contractor shall obtain written acceptance of keying schedule from the District and before placing order.

Equip all locks with manufacturer's cylinders for interchangeable-core pin tumbler inserts. Furnish only temporary inserts for the construction period, and remove these before Substantial Completion. Construction control keys and cores shall not be part of the District's permanent keying system. Permanent cores and keys shall be furnished to the District prior to Substantial Completion.

Visual Key Control shall apply and all keys shall be furnished with plain bows stamped with keying or keyed alike symbols as per the accepted Keying Schedule. Stamp the reverse side of all keybows "Do Not Duplicate." Provide manufacturer's standard restrictive keyways as required.

Key Quantity: Provide three (3) keys for each lock. Master and grandmaster locks shall have five (5) keys provided. All keying (except when matching existing keying system or when less than 10 locksets are required) shall be done at the factory unless otherwise approved by the District. A keying schedule shall be worked out between the District, the Contractor, and the hardware supplier. The Contractor shall have the hardware supplier submit a keying schedule for approval prior to placing an order for the locks and keying of cylinders.

2.3.7 Door Bolts

Provide in accordance with ANSI/BHMA A156.16. Provide dustproof strikes for bottom bolts, except at doors having metal thresholds. Provide automatic latching flush bolts in accordance with ANSI/BHMA A156.3, Type 25.

2.3.8 Closers

Provide in accordance with 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 printed recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty. The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

2.3.8.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation in locations that will be visible after installation.

2.3.9 Overhead Holders

Provide in accordance with ANSI/BHMA A156.8.

2.3.10 Door Protection Plates

Provide in accordance with ANSI/BHMA A156.6.

2.3.10.1 Sizes of Kick Plates

2 inch less than door width for single doors; 1 inch less than door width for pairs of doors. Provide 8 inch kick plates and 1 inch less than height of bottom rail for panel doors.

2.3.11 Door Stops and Silencers

Provide in accordance with ANSI/BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

2.3.12 Padlocks

Provide in accordance with ASTM F883.

2.3.13 Thresholds

Provide in accordance with ANSI/BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening out, unless specified otherwise.

2.3.14 Weatherstripping Gasketing

Provide in accordance with ANSI/BHMA A156.22. Provide the type and function designation where specified in paragraph HARDWARE SCHEDULE. Provide a set

to include head and jamb seals, sweep strips, and, for pairs of doors, astragals. Air leakage of weatherstripped doors not to exceed 1.25 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283. Provide weatherstripping with one of the following:

2.3.14.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide clear bronze anodized aluminum.

2.3.14.2 Interlocking Type

Zinc or bronze not less than 0.018 inch thick.

2.3.14.3 Spring Tension Type

Spring bronze or stainless steel not less than 0.008 inch thick.

2.3.15 Rain Drips

Provide in accordance with ANSI/BHMA A156.22. Provide extruded aluminum rain drips, not less than 0.08 inch thick, bronze anodized finish. Provide the manufacturer's full range of color choices to the Construction Manager for color selection. Provide rain drips with a 4 inch overlap on each side of each exterior door that is not protected by an awning, roof, eave or other horizontal projection. Set drips in sealant and fasten with stainless steel screws.

2.3.15.1 Door Rain Drips

Approximately 1-1/2 inch high by 5/8 inch projection. Align bottom with bottom edge of door.

2.3.15.2 Overhead Rain Drips

Approximately 1-1/2 inch high by 2-1/2 inch projection. Align bottom with door frame rabbet.

2.3.16 Auxiliary Hardware (Other than locks)

Provide in accordance with ANSI/BHMA A156.16, Grade 1.

2.3.17 Sliding and Folding Door Hardware

Provide in accordance with ANSI/BHMA A156.14, Grade 1. Finishes to match other hardware specified herein.

2.3.18 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, as required to service and adjust hardware items.

## 2.4 FASTENERS

Provide fasteners of type, quality, size, and quantity appropriate to the specific application. Fastener finish to match hardware. Provide stainless steel or nonferrous metal fasteners in locations exposed to weather. Verify metals in contact with one another are compatible and will avoid galvanic corrosion when exposed to weather.

## 2.5 FINISHES

Provide in accordance with ANSI/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 prime coat 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 HARDWARE SETS.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Provide 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 Weatherstripping Installation

Provide full contact, weathertight seals that allow operation of doors without binding the weatherstripping.

#### 3.1.1.1 Stop Applied Weatherstripping

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 Weatherstripping

Provide interlocking, self adjusting type on heads and jambs and flexible hook type at sills. Nail weatherstripping to door 1 inch on center and to heads and jambs at 4 inch on center.

#### 3.1.1.3 Spring Tension Type Weatherstripping

Provide spring tension type on heads and jambs. Provide bronze nails with bronze. Provide stainless steel nails with stainless steel. Space nails not more than 1-1/2 inch on center.

### 3.1.2 Soundproofing Installation

Provide as specified for stop applied weatherstripping.

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.

3.2 HARDWARE LOCATIONS

Provide in accordance with SDI/DOOR A250.8, unless indicated or specified otherwise.

a. Kick and Armor Plates: Push side of single-acting doors. Both sides of double-acting doors.

3.3 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 Construction Manager. 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 Construction Manager. Correct, repair, and finish, errors in cutting and fitting and damage to adjoining work.

3.4 HARDWARE SETS

| LIST OF HARDWARE SETS | |
|---|---|
| HW-1 Door 110-3 | |
| 3 Pair Hinges | A2112 by 626 by NRP |
| 2 Exit Devices w/cylinders | Type 1-05 by 630 |
| 1 Removable Mullion | Type 22 |
| 2 Closers | C02021 |
| 2 Kick Plates | J102 by 630 |
| 1 Threshold | Type 26 by insert |
| 1 Set Weatherstripping and rain drips | R0D165 |
| LIST OF HARDWARE SETS | |
| HW-2 Doors 001-1, 001-2, 001-4, 101-1, 101-2, 102-3, 103-3, 109-3, 110-4 | |
| 1-1/2 Pair Hinges | A2112 by 626 by NRP |
| 1 Exit Device W/Cylinder | Type 1-05 by 630 |

| | |
|---|---|
| LIST OF HARDWARE SETS | |
| 1 Closer | C02021 |
| 1 Kick Plate (interior) | J102 by 630 |
| 1 Threshold | Type 26 by insert |
| 1 Set Weatherstripping, and rain drips | R0D165 |
| HW-3 Door 108-1 | |
| 1-1/2 Pair Hinges | A8112 by 652 |
| 1 Lockset | F82 |
| 1 Closer | CO2011 |
| 1 Kick Plate | J102 by 630 |
| HW-4 Doors 102-2, 103-1107-1, 109-1, 109-2, 110-1 | |
| 1-1/2 Pair Hinges | A8133 by 652 |
| 1 Closer | C02011 |
| 1 Kick Plate (both sides of the door) | J102 by 630 |
| LIST OF HARDWARE SETS | |
| 1 Latch set | F75 |
| 1 Threshold | As required between flooring materials |
| HW-5 Door 105-1 | |
| 1-1/2 Pair Hinges | A8112 by 652 |
| 1 Lockset | F76 |
| 1 Closer | C02011 |
| 1 Kick Plate (both sides of the door) | J102 by 630 |
| 1 Threshold | As required between flooring materials |
| HW-6 Doors 102-1, 110-2 105-1 | |
| 1-1/2 Pair Hinges (min) | As required by manufacturer |

| LIST OF HARDWARE SETS | |
|---|---|
| 1 Panic Exit Devices (one each leaf) w/cylinder | As required by manufacturer, shall be operable from interior and locked from Pump Room |
| 1 Closer | As required by manufacturer |

-- End of Section --

# 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 550 | (2015) Test Method for High Velocity Wind Driven Rain Resistant Louvers |
| AMCA 540 | (2013) Test Method for Louvers Impacted by Wind Borne Debris |

ALUMINUM ASSOCIATION (AA)

| | |
|---|---|
| AA DAF45 | (2003; Reaffirmed 2009) Designation System for Aluminum Finishes |

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

| | |
|---|---|
| AAMA 611 | (2014) Voluntary Specification for Anodized Architectural Aluminum |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B221 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |

### 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wall louvers

SD-03 Product Data

Metal Wall Louvers

SD-04 Samples

Wall louvers

## 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 District for selection.

# PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Extruded Aluminum

ASTM B221, alloy 6063-T5.

## 2.2 METAL WALL LOUVERS

Miami-Dade qualified wind-driven rain-resistant type, with bird screens and made to withstand a wind load of not less than 30 pounds per square foot. Wall louvers shall bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 550 and AMCA 540. The rating shall show a water penetration of a maximum of 0.01 ounce per square foot of free area at a free velocity of 1,250 feet per minute. Louver shall have a maximum pressure drop (without screen) of 0.15-inch water column for exhaust and intake service at 1,000 feet per minute free area velocity. Louver shall be required to meet Florida TAS 100A, TAS 201, TAS 202 and TAS 203 testing protocols.

### 2.2.1 Extruded Aluminum Louvers

Fabricated of extruded 6063-T5 aluminum with a wall thickness of not less than 0.080 inch.

### 2.2.2 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.

### 2.2.3 Screens and Frames

For aluminum louvers, provide 1/2 inch square mesh, 14 gage aluminum or 1/4 inch square mesh, 16 gage aluminum 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. 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 anodic coating. Color shall be as indicated. Louvers for each building shall have the same finish.

#### 2.4.1.1 Anodic Coating

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish shall be:

a. Architectural Class I (0.7 mil or thicker), designation AA-M10-C22-A42, integral color anodized.

# PART 3 EXECUTION

## 3.1 INSTALLATION

### 3.1.1 Wall Louvers

Install using stops or moldings, flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with manufacturer's recommendations.

### 3.1.2 Screens and Frames

Attach frames to louvers with screws or bolts.

## 3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

### 3.2.1 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.

3.2.4 Wood

Paint wood or other absorptive materials that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

-- End of Section --

# SECTION 09 06 90

# PROTECTIVE COATINGS

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work: The Contractor shall provide coating on exterior and interior surfaces throughout the Project and which are listed in Part 2, with systems specified on "coating system" sheets at the end of this Section.

Regulatory Requirements: In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local and regional jurisdiction. Notify the District of any coating specified herein that fails to conform to the requirements for the location of the Project or location of application.

1. Lead Content: Use only coatings that are totally lead free.

2. Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.

3. Asbestos Content: Materials shall not contain asbestos.

4. Mercury Content: Materials shall not contain mercury or mercury compounds.

5. The specified maximum volatile organic compounds (VOC) content shall apply to the unthinned product.

Related Work Specified Elsewhere:

1. Section 01 33 00 SUBMITTAL PROCEDURES

### 1.2 APPLICABLE STANDARDS AND PUBLICATIONS

Standards or Codes: The edition of the publications of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. See the various paragraphs for the specified standard. In the case of a conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail.

1. American National Standards Institute (ANSI):

    a. A13.1 - Scheme for the Identification of Piping Systems

    b. Z535.1 - Safety Colors

2. American Society for Testing and Materials (ASTM):

    a. C267 - Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes

b. D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings

c. D4258 - Standard Practice for Surface Cleaning Concrete for Coating

d. D4259 - Standard Practice for Abrading Concrete

e. D4260 - Standard Practice for Acid Etching Concrete

f. D4261 - Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating

g. D5201 - Standard Practice for Calculating Formulation Physical Constants of Paints and Coatings

h. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

3. Society for Protective Coatings (SSPC) Surface Preparation Specifications:

a. SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.

b. SP2 - Hand Tool Cleaning: Removes loose mill scale, loose rust, loose paint and other loose foreign matter.

c. SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.

d. SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.

e. SP6 - Commercial Blast Cleaning: Two-thirds of each square inch free of all visible residues; remainder only light discoloration.

f. SP7 - Brush-Off Blast Cleaning: Removes only loose material, remaining surface tight and abraded to give anchor pattern.

g. SP10 - Near-White Blast Cleaning: At least 95% of each square inch shall be free of all visible residues.

h. SP11 - Power Tool Cleaning to Bare Metal

4. International Concrete Repair Institute (ICRI)

a. Guideline #03732: Surface preparation should comply with ICRI technical guideline number 03732 (selecting and specifying concrete surface preparation for sealers, coatings and polymer overlays).

5. United States Army Corps of Engineers (USACE)

a. CRD-C 48 - Standard Test Method for Water Permeability of Concrete

b. CRD C163-92 Test Method for Water Permeability of Concrete Using Triaxial Cell

## 1.3 DEFINITIONS

Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.

1. Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, hollow metal doors or equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless if done in shop or field.

2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.

3. Concealed surfaces are generally not required to have finish-coats unless otherwise specified, but prime coat should be applied and touched up prior to concealment.

4. Where equipment and materials are provided with shop-applied finished coating system, only touch-up is a part of field painting.

5. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.

6. The term "DFT" means minimum dry film thickness, with no tolerance for thinner films.

## 1.4 SUBMITTALS

Submit as specified in Section 01 33 00 SUBMITTAL PROCEDURES.

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

1. Schedule of products and paint systems to be used. Schedule shall include the following information:

    a. Surfaces for system to be applied

    b. Surface preparation method and degree of cleanliness

    c. Product Manufacturer, name, and number

    d. Method of application

    e. Dry film thickness per coat of coating to be applied

2. Color charts for selection and acceptance

3. Product information

    a. Manufacturer's data sheet for each product proposed

b. Technical and performance information that demonstrates compliance with the system performance and material requirements

c. Manufacturer's instructions and recommendations on surface preparation and application

d. Compatibility of shop and field applied coatings (where applicable)

e. Material Safety Data Sheet (MSDS) filled out completely according to the Florida Right-to-Know Law, Chapter 442, Florida Statutes, clearly identifying each product used.

4. Certification signed by coating Manufacturers stating that each coating is suitable for service intended as stated on each coating system sheet, and that the materials to be installed comply in all respects with the requirements of this Section.

5. The Contractor shall certify in writing to the District that applicators have previously applied all the systems in this Section and have the ability and equipment to prepare the surfaces and apply the coatings correctly.

6. Samples

a. Painted Wood: Eight (8) inch square samples for each color and material on hardboard.

b. Sample of each paint, finish, and other coating material on 8-1/2 inch by 11-inch sheet metal. Each sheet shall be completely coated over its entire surface with one coating material, type, or color.

c. Two (2) sets of color samples that match each color selected by the District from the Manufacturer's color charts. The color designation shall be shown on the back of the color sample.

d. Two (2) 2-foot by 2-foot concrete panels shall be constructed at the Site in an area designated by the District. On one panel, the C0NTRACTOR shall apply the coating system required for water-retaining concrete interior surfaces and the system for concrete exterior surfaces on the other panel. The Contractor shall not begin coating the structure surfaces until the District has accepted both panels. If the District does not approve either panel, at its own expense the Contractor shall erect another, coat it, and request District approval.

## 1.5 QUALITY REQUIREMENTS

### 1.5.1 Applicator Qualifications

Coating Work shall be performed by an SSPC certified Contractor having a minimum of Category QP 1 certification for Work without hazardous paint removal, and Category QP 2 certification for Work involving hazardous paint removal. The certified Contractor shall maintain in effect all required certifications for the duration of the Project. Any request for Project delay due to an expired certification will not be considered.

The applicator shall be certified in application of specified products and systems on projects of similar size and scope, as demonstrated by previous successful installations, and shall be approved by the Manufacturer in writing.

1.5.2 Manufacturer

Provide products of Manufacturer with no less than ten (10) years experience in manufacturing the materials for the required Work.

1.6 RESPONSIBILITIES

Not Used

1.7 INSPECTION COORDINATION

Pre-painting Conference:

1. Before field painting starts, representatives for the District, Contractor, coating applicator, and coating Manufacturer's technical representative shall meet with the District's personnel.

2. Agenda for the meeting will include details of surface preparations and coating systems to ensure understanding and agreement by all parties for compliance.

In the event a problem occurs with coating system, surface preparation, or application, coating applicator and coating Manufacturer's technical representative shall promptly investigate the problem and submit results to the District.

Whenever water tightness in a water-retaining structure is dependent upon Work in other sections, the Contractor shall assume full responsibility for water tightness of the integrated assembly. Prior to starting Work, Contractor shall meet with installers involved and with Manufacturers of all materials involved to review Drawings and Specifications to insure that materials are being used properly and details are correct. A written report of this meeting shall be submitted to the District. The report shall contain at least:

1. Meeting date and names and affiliations of those present and written statements from each installer and Manufacturer of their acceptance of Drawings, Specifications and conditions, and of proposed use of their materials as proper for purposes shown.

1.8 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Proprietary names and product numbers are specified in most systems for material identification from these Manufacturers.

1. PPG (Pittsburg Plate Glass Co.).
2. Carboline Company, Inc.
3. BASF Building Systems.
4. ICI Devoe Coating Company.
5. The Euclid Chemical Company.
6. Tnemec Company, Inc.
7. Xypex Chemical, Ltd.
8. Kryton International.
9. Sika Corporation.
10. GML Coatings, LLC.
11. Wasser Corporation.
12. Polyval, Inc.
13. Benjamin Moore & Company.
14. Sherwin-Williams.
15. PPC Coatings.
16. International Fire Resistant Systems, Inc.
17. Penetron.
18. Belzona Inc.
19. Alocit & Enviropeel USA.

2.2 GENERAL

Materials furnished for each coating system must be compatible with the substrate.

Single Manufacturer: All materials in each coating system shall be by the same coating Manufacturer to assure compatibility of coatings.

Compatibility: When shop-painted surfaces are to be field coated, the Contractor shall ascertain whether finish materials will be compatible with shop coating. Coatings of uncertain composition shall be removed completely before applying new coatings.

Colors

1. Color of finish coatings shall match accepted color samples.
2. When second and finish coats of a system are of same type, Contractor shall tint or use an easy distinguishable alternate color on second

coat to enable visual coverage inspection of the third coat. When first and second coats only are specified and are of same or different types, tint or use an easy distinguishable alternate color on first coat to enable visual coverage inspection of the second coat.

Include on label of material containers:

1. Manufacturer's name, product name, and number

2. Type of paint and generic name

3. Color name and number

4. Storage and temperature limits

5. Mixing and application instructions, including requirements for precautions which must be taken

6. Drying, recoat, or curing time

2.3 COATING SYSTEMS

Specified on the "Coating System" sheets at the end of this Section.

2.4 SURFACES TO BE COATED

Interior Surfaces: The coating system specified on interior surfaces will be applied as shown regardless of the regional classifications mentioned above.

| Generic Description | Specific Surfaces | System |
|---|---|---|
| Steel, mild exposure, non-immersion, Interior hidden from view. | 1. Miscellaneous steel.<br>2. Exposed piping where specified. | S-1 |
| Steel including non-immersed steel piping, Severe Exposure, Non-Immersion, Exterior or Interior, where only marginal cleaning can be performed. | 1. Miscellaneous exposed steel surfaces.<br>2. Hollow metal doors and frames.<br>3. Other piping where specified. | S-2 |

| Generic Description | Specific Surfaces | System |
|---|---|---|
| Steel equipment, prime coated, severe exposure, non-immersion, interior and exterior. | 1. Trash Rake System non stainless steel components.<br>2. Other carbon steel equipment. | S-3 |
| Steel and non-ferrous metal, severe exposure, buried and immersed, interior of tank, and piping and equipment immersed in tank or basin. | 1. Steel Sheet Piling (includes Wingwalls and Cutoff walls).<br>2. Steel discharge piping (RPD) except where it is otherwise specified.<br>3. Buried propane gas piping (LP).<br>4. Miscellaneous piping where specified.<br>5. Pump platform | S-4 |
| Steel, surface temperatures between 350 and 1000 degrees F continuous. | 1. Exhaust piping and silencer. | S-5 |
| Steel tank exterior, severe UV exposure. | 1. Steel Tanks. | S-6 |
| Steel, severe Exposure, Non-Immersion. Exterior or Interior. DTM Acrylic. Safety Yellow. | 1. Bollards, guard posts.<br>2. Exposed propane gas lines (LP). | S-7 |
| Concrete and concrete masonry units (CMU), mild exposure, non-immersion, interior and exterior. | 1. Precast Concrete Walls.<br>2. Control building. | C-1 |

| Generic Description | Specific Surfaces | System |
|---|---|---|
| Concrete and concrete masonry units, severe exposure, non-immersion, interior. | 1. Miscellaneous concrete walls. | C-2 |
| Water-retaining concrete structures, interior and exterior (waterproofing) , non-immersion, defined as above 1.0 foot above the HWL. | 1. Intake & Discharge Bays.<br>2. Channel walls. | C-4 |
| Gypsum board, mild exposure, interior. | 1. Interior walls. | W-1 |
| Exterior wood. | 1. Sign posts. | W-2 |
| Plywood. | Not used. | W-3 |
| Aluminum in contact with concrete or any other metal except galvanized steel. | 1. Conduits, pipes, and plates. | A-1 |

2.5 SURFACES NOT TO BE COATED

Factory finished equipment, except for touch-up or noted otherwise

Metal surfaces of stainless steel, bronze, aluminum, and fiberglass

Concrete, unless listed on specific surfaces above

Machined surfaces

Grease fittings

Glass

Equipment nameplates

Platform gratings, stair treads, door thresholds, and other walking surfaces unless listed on specific surfaces above

Concrete Floors unless listed above

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

Manufacturer recommendations: Unless this specification requires otherwise, Contractor shall strictly follow the Manufacturer's printed recommendations and instructions for storing and handling coating system materials.

Delivery of Materials

1. Deliver in sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information.

2. Contractor shall allow sufficient time for testing, if required.

Storage of Materials: Contractor shall store under conditions recommended by the Material Safety Data Sheets:

1. All protective coating materials shall be used within the Manufacturer s recommended shelf life.

2. Store only acceptable materials on Project Site.

3. Store tightly sealed materials off ground and away from moisture, direct sunlight, extreme heat, and freezing temperatures. Provide separate area and suitable containers for storage of coatings and related coating equipment.

4. Dispose of used or leftover containers, thinners, rags, brushes, and rollers in accordance with applicable regulations.

3.2 PREPARATION FOR COATING

General: All surfaces to receive protective coatings shall be clean prior to application of coatings. The Contractor shall examine all surfaces to be coated, and shall correct all surface defects before application of any coating material. All marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any coating application. Surfaces to be coated shall be dry and free of visible dust.

Protection of surfaces not to be coated: Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

Hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked, or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

Care shall be exercised not to damage adjacent work during blast cleaning operations. Spray painting shall be conducted under carefully controlled conditions. The Contractor shall be fully responsible for and shall promptly repair any and all damage to adjacent work or adjoining property occurring from blast cleaning or coating operations.

Protection of painted surfaces: Cleaning and coating shall be coordinated so that dust and other contaminants from the cleaning process will not fall on wet, newly coated surfaces.

## 3.3 SURFACE PREPARATION

### 3.3.1 General

1. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation specifications listed.

    a. If grease or oils are present, SSPC-SP1 must precede any other method specified.

    b. Remove surface irregularities such as weld spatter, burrs, or sharp edges, prior to specified surface preparation.

2. Depth of profile shall be as specified for each system, but in no instance shall it exceed one-third of the total dry-film thickness of complete system.

3. Prepare only those areas which will receive the first coat of the system on the same day.

### 3.3.2 Metals

1. The minimum abrasive blasting surface preparation shall be as indicated in the coating system sheets included at the end of this Section. Where there is a conflict between these specifications and the coating Manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

2. All sharp edges shall be rounded or chamfered, and all burrs, surface defects, and weld splatter shall be ground smooth prior to blast cleaning.

3. The type and size of abrasive shall be selected to produce a surface profile that meets the system sheet requirements for the particular coating and service conditions. Abrasives for submerged and severe service coating systems shall be clean, hard, sharp cutting crushed slag. Automated blasting systems shall not be used for surfaces that will be in submerged service. Metal shot or grit shall not be used for surfaces that will be in submerged service, even if subsequent abrasive blasting is planned to be one with hard, sharp cutting crushed slag.

4. Abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.

5. The Contractor shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

6. Compressed air for air blast cleaning shall be supplied at adequate pressure from well-maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.

7. Surfaces shall be cleaned of all dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another method prior to painting.

8. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.

9. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

10. If the required abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP2 or SSPC SP3 may be used.

11. Shop applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP1 before the abrasive blast cleaning work is started.

12. Shop primed equipment shall be solvent cleaned in the field before finish coats are applied.

3.3.3 Concrete and Concrete Masonry Units

1. Surface preparation shall not begin until at least 30 days after the concrete or masonry has been placed.

2. All oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC SP1 before abrasive blast cleaning.

3. Concrete, concrete block masonry surfaces and deteriorated concrete surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, deteriorated concrete, and to roughen the surface equivalent to the surface of the No. 80 grit flint sandpaper, if required by the coating application instructions.

4. If acid etching is required by the coating application instructions, the treatment shall be made after abrasive blasting. After etching, Contractor shall rinse surfaces with water and test the pH. The pH shall be between neutral and eight (8).

5. Surfaces shall be clean and as recommended by the coating Manufacturer before coating is started.

6. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as Delmhorst Model BD, or equal.

## 3.4 APPLICATION

Contractor shall apply coatings in accordance with coating Manufacturer's recommendations. Materials shall be thoroughly stirred, strained, and kept at uniform consistency during application. Coatings from different Manufacturers shall not be mixed together.

Use properly designed brushes, rollers, and spray equipment for all applications.

On unprimed surfaces apply first coat of the system the same day as surface preparation.

Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The Contractor shall schedule such inspection with the District in advance.

Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working day.

Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe painting for these areas.

Dry-film thickness of each system shall be at least as thick as the minimum specified. Maximum dry-film thickness shall not exceed the minimum more than 20 percent or coating Manufacturer's requirements, whichever is less. Where a dry-film thickness range is specified, the thickness shall not be shall not be outside the range.

Shop and field painting shall not be applied within three (3) inches of unprepared surface of any substrate such as areas to be welded or bolted.

Environmental Conditions:

1. Atmospheric temperature must be 50 degrees Fahrenheit or higher during application, unless approved in writing by coating Manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur during the curing time interval.

2. Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating Manufacturer s limits.

3. Relative humidity must be less than 85% and the temperature of the surface to be painted must be at least five (5) degrees above the dew point.

4. Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the Manufacturer's Material Safety Data Sheets for the specific coatings being applied.

Recoat Time: In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the previously applied coating in accordance with Manufacturer's recommendations.

Protection:

1. Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.

2. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.

3. Provide cover or shields to prevent surface preparation media and coatings from entering orifices in electrical or mechanical equipment. Where ventilation systems must be kept in operation at time of surface preparation, take precautions to shield intakes and exhausts to prevent the materials from entering system or being dispersed.

4. Provide signs to indicate fresh paint areas.

5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, and thinners. Dispose of leftover containers, thinners, rags, brushes, and rollers that cannot be reused in accordance with applicable regulations.

6. Do not remove or paint over equipment data plates, code stamps on piping, or UL fire-rating labels.

## 3.5 INSPECTION

Contractor shall provide and use a wet-film gauge to check each application approximately every fifteen (15) minutes in order to immediately correct film thickness under or over that specified.

On ferrous surfaces, measurements shall be made with one of the thickness gauges listed below. The gauge shall be calibrated on metal practically identical in composition and surface preparation to that being coated and be of substantially the same thickness, except that for measurements on metal thicker than 1/4 inch, the instrument may be calibrated on metal with a minimum thickness of 1/4 inch. When calibrating any of the gauges for making film measurements of over three (3) mils, the calibrating thickness standards (shims) shall be of non-metallic composition. Where only one thickness criterion is specified, the calibrating shim thickness shall closely approximate the specified thickness, but where both thicknesses are specified, the shim's thickness shall closely approximate an average of the two. Calibrating instructions, thickness standards and, in the case of the Mikrotest gauge, a calibrating tool, should obtained from the Manufacturer or supplier of the gauge. Authorized thickness gauges are:

1. General Electric, Type B, General Electric Company

2. Mikrotest, Elektrophysik - Koln

3. Elcometer, Elcometer Instruments, Ltd.

4. Inspector Gage, Elcometer Instruments, Ltd.

5. Minitector, Elcometer Instruments, Ltd.

Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.

Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.

Check temperature of the substrate at regular intervals to be certain surface is five (5) degrees Fahrenheit or more above the dew point.

## 3.6 CLEANING AND REPAIRS

Remove spilled, dripped, or splattered paint from surfaces.

Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified.

-- End of Section --

**Section 09 06 90**
**SCHEDULES FOR PAINTING AND COATING**
**Article 3.6, CLEANING AND REPAIR Tables**

| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, FL 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System S-1** |
|---|---|

| | |
|---|---|
| **SERVICE:** | Steel, Mild Exposure, Non-Immersion, Interior |
| **Surface Preparation:** | Field: SSPC-SP1 and SP6. Clean and dry. |
| **First Coat:** | High solids polyamine or polyamide epoxy with minimum 67% solids by volume. Spray Applications; apply at 5.0 - 8.0 mils DFT. Brush applications, apply at 4.0 mils DFT. |
| **Second Coat:** | Same as first coat.<br>Note: Second coat required only for brush applications. |
| **Third Coat (Exterior):** | Not required. |
| **System Total:** | Minimum 8.0 mils dry film thickness. |
| **Volatile Organic Content:** | Maximum 3.5 lbs/gal (425 g/l). |

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | |
|---|---|---|
| | **FIRST COAT** | **SECOND COAT** |
| PPG | Amerlock 2/400 | Same as first coat |
| Carboline | Carboguard 890 | Same as first coat |
| ICI Devoe | Devran 224HS | Same as first coat |
| Tnemec | Hi-Build Epoxoline II N69 | Same as first coat |
| Sherwin-Williams | Macropoxy 646 FC(5-8mils DFT) | Same as first coat |

| | |
|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System S-2** |

| | |
|---|---|
| **SERVICE:** | Steel, including non-immersed steel piping, Severe Exposure, Non-Immersion, Exterior and Interior (where not noted otherwise), where only marginal cleaning can be performed |
| **Surface Preparation:** | Field: SSPC-SP1 and SP3. Clean and dry. |
| **First (prime) Coat:** | Polyamidoamine epoxy with wetting and penetrating properties and with 98% solids by volume. Apply at 1.5 to 2.0 mils dry film thickness. |
| **Second Coat:** | High build polyamide epoxy with minimum 65% solids by volume. Apply at 5.0 mils dry film thickness. |
| **Third Coat (Exterior):** | High solids aliphatic or acrylic polyurethane gloss enamel with minimum 65% solids by volume. Apply at 2.0 mils dry film thickness. |
| **System Total:** | Minimum 8.5 mils dry film thickness, Exterior. Minimum 6.5 mils dry film thickness, Interior. |
| **Volatile Organic Content:** | Maximum 2.8 lbs/gal (340 g/l). |

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | | |
|---|---|---|---|
| | **FIRST COAT** | **SECOND COAT** | **THIRD COAT** |
| Carboline | Carboguard 890 | Same as first coat | Carbothane 133HB |
| ICI Devoe | Bar-Rust 231 | Devran 224HS | Devthane 379H |
| Tnemec | Chembuild 135 (4 to 6 mil) | Not Applicable | Endura-Shield 1074 |
| PPG | Amerlock 2/400 | Amerlock 2/400 | Amercoat 450H |
| Sherwin-Williams | Macropoxy 646 FC | Same as first coat | Acrolon 218 HS Polyurethane |

| | |
|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System S-3** |

| | |
|---|---|
| **SERVICE:** | Equipment, Factory Coated, Severe Exposure, Non-Immersion, Exterior or Interior |
| **Surface Preparation:** | Field or Shop (if applicable) First Coat: SSPC-SP1 and SP6. Clean and dry. |
| **First Coat: (Field)** | Modified vinyl-alkyd or epoxy-mastic, compatible with existing and new finish. Apply at 1.5 to 2.0 mils dry film thickness. |
| **Second Coat Interior:** | High build polyamide epoxy with minimum 50% solids by volume. Apply at 5.0 mils dry film thickness. |
| **Second Coat Exterior:** | High solids aliphatic or acrylic polyurethane gloss enamel with minimum 52% solids by volume. Apply at 2.0 mils dry film thickness. |
| **System Total:** | Interior: 6.5 mils dry film thickness in addition to existing coating. Exterior: 3.5 mils dry film thickness in addition to existing coating. Check for voids with holiday or pinhole detector. |
| **Volatile Organic Content:** | Maximum 3.5 lbs/gal (425 g/l). |

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | | |
|---|---|---|---|
| | **FIRST COAT** | **SECOND COAT (INT)** | **SECOND COAT (EXT)** |
| PPG | Amercoat 385 or 2/400 | Same as first coat | Amercoat 450H |
| Carboline | Carbomastic 15 | Carboguard 890 | Carbothane 134 HG |
| ICI Devoe | Bar-Rust 231 | Devran 224 HS | Devthane 379H |
| Tnemec | Omnithane 1 | Hi-Build Epoxoline II N69 | Endura-Shield 1074 |
| Sherwin-Williams | Kem Kromik Primer | Macropoxy 646C | Acrolon 218 HS Polyurethane |

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|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System S-4** |

| | |
|---|---|
| **SERVICE:** | Steel and Non-Ferrous Metals, Severe Exposure. Buried and Immersed, Interior of Tank, Piping, or Equipment Immersed in Tank or Basin. |
| **Surface Preparation:** | SSPC-1 to remove all grease and oils, soluble salt removal (if necessary)<br>SSPC-5 (white metal) to achieve a surface profile of 1.0 – 2.0 mils |
| **First Coat:** | Moisture Cured Urethane Zinc Primer without MIO, minimum 80% Zinc |
| **Second Coat:** | Moisture Cured Urethane Coal Tar |
| **Third Coat:** | Same as second coat. |
| **System Total:** | Minimum 15.00 mils dry film thickness. Check for voids with holiday or pinhole detector. |
| **Volatile Organic Content:** | Maximum 2.8 lbs/gal (340 g/l). |

| COATING MANUFACTURER | PRODUCT DESIGNATION | | |
|---|---|---|---|
| | **FIRST COAT** | **SECOND COAT** | **THIRD COAT** |
| Wasser Coatings | MC-Zinc 100 | MC-Tar 100 | Same as second coat |
| Tnemec | Series 1 Omnithane | Series 446 Perma-Shield MCU | Same as second coat |
| Polyval (Xymax) | Mono Zinc | Mono Guard | Same as second coat |

| | |
|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System S-5** |

| | |
|---|---|
| **SERVICE:** | Steel, Surface Temperatures 350 to 1000 degrees F, Continuous |
| **Surface Preparation:** | Shop or Field First Coat: SSPC-1, SP10, and profile depth 1 mil.<br>Field Touch-Up: SSPC-6 and profile depth 1 mil. |
| **First Coat:** | Silicone aluminum. Aluminum or grey color. Apply at 1.0 to 1.5 mils dry film thickness, or greater as required by manufacturer. |
| **Second Coat:** | Same as first coat. |
| **Third Coat:** | Not required. |
| **System Total:** | Minimum 2.0 mils dry film thickness. |
| **Volatile Organic Content:** | Maximum 5.2 lbs/gal (623 g/l). |

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | |
|---|---|---|
| | **FIRST COAT** | **SECOND COAT** |
| PPG | Amercoat 878 | Amercoat 878 |
| Carboline | Carbozinc 11 | Thermaline 4700 Aluminum |
| Sherwin-Williams | Heat Flex Hi Temp 1000 | Same as first coat |

| | |
|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | PROTECTIVE COATING SYSTEM<br><br>**System S-6** |

| | |
|---|---|
| **SERVICE:** | Steel tank exterior, severe UV exposure |
| **Surface Preparation:** | SSPC-SP-6, commercial blast clean |
| **First Coat:** | single component, zinc rich moisture cure urethane, 4 mils |
| **Second Coat:** | single component moisture cure urethane, 4 mils |
| **Third Coat:** | single component moisture cure urethane, gloss, 2 mils |
| **System Total:** | 10 mils |
| **Volatile Organic Content:** | 2.8 lb per gal (340 g/L) |

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | | |
|---|---|---|---|
| | **FIRST COAT** | **SECOND COAT** | **THIRD COAT** |
| Wasser Coatings | MC-Zinc 100 | MC-CR 100 | MC-Shieldcoat 100 |
| Sherwin Williams | Corothane I Zinc Primer Aliphatic | Corothane I Ironox B | Corothane I HS |
| PPG | Durathane MCZ | Amerlock 2/400 | Amercoat 450H |

| | |
|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System S-7** |

| | |
|---|---|
| **SERVICE:** | Steel; Severe Exposure, Non-Immersion. Exterior or Interior. DTM Acrylic. Safety Yellow. |
| **Surface Preparation:** | SSPC-SP1 and SP6. Clean and dry. |
| **First Coat:** | Direct to Metal Acrylic Safety Yellow. Apply a minimum of 2.5 mils dry film thickness, or greater as required by MANUFACTURER. |
| **Second Coat:** | Same as first coat. |
| **Third Coat:** | Not required. |
| **System Total:** | 5.0 mils dry film thickness. |
| **Volatile Organic Content:** | Maximum 2.08 lb per gal (< 250 g/L) |

| COATING MANUFACTURER | PRODUCT DESIGNATION | |
|---|---|---|
| | **FIRST COAT** | **SECOND COAT** |
| Benjamin Moore & Co. | DTM Acrylic Gloss Enamel P28-15 | Same as 1st coat |
| Sherwin-Williams | B66Y37 DTM Acrylic Gloss | Same as 1st coat |

| | |
|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System C-1** |

| | |
|---|---|
| **SERVICE:** | Concrete walls (interior), CMU walls (interior & exterior), and precast walls with a finned or textured concrete surface (exterior), Mild Exposure, Non-Immersion, |
| **Surface Preparation:** | Concrete: No sooner than 30 days after pouring, start coating. ASTM D 4258, clean and dry, free from grease, oil, and any other contamination. Remove protrusions. Fill pits in concrete with patching compound as recommended by coating MANUFACTURER.<br>CMU: ASTM D 4261, clean and dry, free from grease, oil, and any other contamination. Remove protrusions. |
| **First Coat:** | Acrylic Latex block filler with minimum 44% solids by volume. Apply at approximately 800 square feet per gallon on concrete and as required to fill pores on CMU. |
| **Second Coat:** | Water reducible acrylic coating with minimum 34% solids by volume, gloss finish. Apply at 2.0 mils dry film thickness. |
| **Third Coat:** | Same as second coat. |
| **System Total:** | Minimum 4.0 mils dry film thickness in addition to filler. |
| **Volatile Organic Content:** | Maximum 2.8 lbs/gal (340 g/l). |

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | | |
|---|---|---|---|
| | **FIRST COAT** | **SECOND COAT** | **THIRD COAT** |
| PPG | See Note* below. | PittTech 90-374 Series | PittTech 90-374 Series |
| Carboline | Sanitile 120 | Carbocrylic 3359 | Same as second coat |
| Tnemec | Envirofill 130 | Tneme-Cryl 6 | Same as second coat |
| Sika Corporation | Sikagard 62 | Sikagard 62 | Same as second coat |
| Sherwin-Williams | CementPlex 875 | DTM Primer Finish | Same as second coat |
| | Notes<br>*Use Amerlock Sealer for concrete, and Permacrete 4-100 for masonry units | | |

| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System C-2** |
|---|---|

| | |
|---|---|
| **SERVICE:** | Concrete and Concrete Masonry Units, Severe Exposure, Non-Immersion, Interior |
| **Surface Preparation:** | Concrete: ASTM D4258, clean and dry, free from grease, oil, and any other contamination. Remove protrusions. Fill pits in concrete with patching compound as recommended by coating MANUFACTURER.<br><br>CMU: ASTM D 4261, clean and dry, free from grease, oil, and any other contamination. Remove protrusions. |
| **First Coat:** | Sealer and primer as recommended by manufacturer |
| **Second Coat:** | Concrete: High solids epoxy with minimum 75% solids by volume. Apply at 5.0 to 8.0 mils dry film thickness.<br>CMU: High solids epoxy block filler with minimum 60% solids by volume. Apply at 10.0 to 20.0 mils dry film thickness and as required to fill pores. |
| **Third Coat:** | Concrete & CMU: High solids epoxy with minimum 75% solids by volume. Apply at 5.0 to 8.0 mils dry film thickness. Semi-gloss or gloss finish. |
| **System Total:** | Concrete: Minimum 10.0 mils dry film thickness.<br>CMU: Minimum 15.0 mils dry film thickness. |
| **Volatile Organic Content:** | Maximum 3.5 lbs/gal (425 g/l). |

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | | |
|---|---|---|---|
| | **FIRST COAT** | **SECOND COAT** | **THIRD COAT** |
| PPG | See * note below | Amerlock 2/400 | same as second coat |
| Carboline | Carboguard 1340 | Carboguard 890 | Carboguard 890 |
| ICI Devoe | Pre-Prime 167 | Devran 224 HS | Devran 224 HS |
| Tnemec | HS Epoxy 104 | HS Epoxy 104 | HS Epoxy 104 |
| Sika Corporation | Sikagard 62 | Sikagard 62 | Same as second coat |
| Wasser Coatings | MC-CR 100^ | MC-CR 100 | MC-Luster 2.8(semi-gloss) |
| Sherwin-Williams | Corobond 100** | (80%) Kem Cati Coat | Macropoxy HS Epoxy |

Notes:
*Use Amerlock Sealer for concrete, and Permacrete 4-100 for masonry units
**Epoxy Primer
^ thinned 20%

| | |
|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM** |
| | **System C-4** |

| | |
|---|---|
| **SERVICE:** | Water -Retaining Concrete Structures, Interior and Exterior (waterproofing), Non-immersion |
| **Surface Preparation:** | After concrete has cured a minimum of 28 days per MANUFACTURER recommendations (sandblasting, pressure washing at 4,000 psi cementitious resurfacer, pressure wash film on build up). Heat with indirect heat at 200 degrees. |
| **First Coat:** | Apply at 10 mils dry film thickness or as recommended by manufacturer. |
| **Second Coat:** | 125 mils |
| **Third Coat:** | As necessary to provide a 125 mil DFT. |
| **System Total:** | Minimum 125 mils dry film thickness. |
| **Volatile Organic Content:** | None |

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | | |
|---|---|---|---|
| | **FIRST COAT** | **SECOND COAT** | **THIRD COAT** |
| PPG | Amerlock Sealer | Amercoat 100A (125 mils) | None |
| GML Coatings, LLC | Green Monster Primer | Green Monster Extreme | Same as second coat (if needed) |
| Euclid Chemical Co. | Duralkote 500 | Same as first coat | Same as second coat (if needed) |
| Sika Corporation | SikaGard 62 | Same as first coat | Same as second coat (if needed) |
| Tnemec Company, Inc. | Series 434 & 436 | Same as first coat | Same as second coat (if needed) |
| PPC Coatings | Prime coat | Intermediate coat | Final Coat |

| | |
|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System W-1** |

| | |
|---|---|
| **SERVICE:** | Gypsum Board and Plaster, Mild Exposure, Interior Walls |
| **Surface Preparation:** | Clean and dry. Fill all nail holes and finish all taped joints. |
| **First Coat:** | Acrylic Sealer. Apply at 1.5 to 2.0 mils dry film thickness. |
| **Second Coat:** | Water reducible acrylic coating with minimum 34% solids by volume, flat finish for walls and semi-gloss finish for doors and trim. Apply at 1.5 mils dry film thickness. |
| **Third Coat:** | Same as second coat |
| **System Total:** | Minimum 4.5 mils dry film thickness. |
| **Volatile Organic Content:** | Maximum 2.8 lbs/gal (340 g/l). |

| COATING MANUFACTURER | PRODUCT DESIGNATION | | |
|---|---|---|---|
| | **FIRST COAT** | **SECOND COAT** | **THIRD COAT** |
| PPG | PittTech | PittTech | n/a |
| Carboline | Sanitile 120 | Carbocrylic 3359 | Same as second coat |
| Tnemec | PVA Sealer 51 | H.B. Tneme-Tufcoat 113 | Same as second coat |

| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System W-2** |
|---|---|

**SERVICE:** Exterior Wood

**Surface Preparation:** Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.

a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, and casework.
c. If transparent finish is required, back-prime with non-yellowing varnish.
d. Back-prime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.
e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
f. Surface must be prepared per paint MANUFACTURER's recommendations.

**First Coat:** Exterior Wood Primer: Factory-formulated alkyd wood primer for exterior application:
1. Applied at a dry film thickness of not less than 1.3 mils per coat.

**Second Coat:** Exterior Finish Coats:
1. Exterior Low-Luster Acrylic Paint: Factory-formulated low-sheen (eggshell) acrylic-latex paint for exterior application. (2.3 mils per coat min)

**Third Coat**: Same as Second Coat.

**System Total:** 3.6 to 5.0 mils minimum, depending on primer and number of paint coats.

**Volatile Organic Content:** Maximum 2.72 lbs/gal (326 g/l).

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | |
|---|---|---|
| | **FIRST COAT** | **SECOND COAT** |
| Sherwin-Williams | Wood Primer: A-100 Exterior Oil, Stain Blocking Primer (Y24W20). | A-100 Exterior Latex Satin, (A82 Series) |

| South Florida Water Management District<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | PROTECTIVE COATING SYSTEM<br><br>System W-3 |
|---|---|

| | |
|---|---|
| SERVICE: | Wood: Plywood Back Boards, Interior |
| Surface Preparation: | ASTM E84, clean and dry, free from grease, oil, and any other contamination.<br>Apply per MANUFACTURER's recommendation |
| First Coat: | Primer as required / approve by MANUFACTURER |
| Second Coat: | Intumescent Paint. Apply at 2.5 mils dry film thickness or as recommended by manufacturer. |
| Third Coat: | Same as second coat. Where indicated. |
| System Total: | Minimum 5.0 mils dry film thickness. |
| Volatile Organic Content: | Maximum 50 g/l (untinted) |

| COATING MANUFACTURER | PRODUCT DESIGNATION | | |
|---|---|---|---|
| | **FIRST COAT** | **SECOND COAT** | **THIRD COAT** |
| Benjamin Moore & Co. | Fresh Start Alkyd Primer | P59-01 | P59-01 |
| International Fire Resistant Systems, Inc. | Mfgr. Approved Primer | Fire Free 88 | Alkyd Enamel |

| | |
|---|---|
| **South Florida Water Management District**<br>3301 Gun Club Road<br>West Palm Beach, Florida 33406 | **PROTECTIVE COATING SYSTEM**<br><br>**System A-1** |

| | |
|---|---|
| **SERVICE:** | Aluminum in contact with concrete or any other metal except galvanized steel |
| **Surface Preparation:** | Field: SSPC-SP1. Clean and dry |
| **First Coat:** | High solids polyamine or polyamide epoxy with minimum 67 % solids by volume. Brush apply to surfaces to be in contact at 4.0 mils DFT |
| **Second Coat:** | Same as first coat |
| **Third Coat:** | Not required |
| **System Total:** | Minimum 8 mils DFT |
| **Volatile Organic Content:** | Maximum 3.5 lbs/gal (425 g/l) |

| **COATING MANUFACTURER** | **PRODUCT DESIGNATION** | |
|---|---|---|
| | **FIRST COAT** | **SECOND COAT** |
| PPG | Amerlock 2/400 | Same as first coat |
| Carboline | Carboguard 890 | Same as first coat |
| ICI Devoe | Devran 224HS | Same as first coat |
| Tnemec | Hi-Build Epoxoline II N69 | Same as first coat |
| Sherwin-Williams | Macropoxy 646 FC Epoxy | Same as first coat |
| Wasser Corporation | MC-Prepbond 100 | Same as first coat |

# SECTION 10 14 00.10

# EXTERIOR SIGNAGE

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all labor, equipment and materials for the construction of the exterior monument sign to be placed at the entrance to the project (Congen Road/SR-80 intersection).

### 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 WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A653/A653M | (2015; E 2016) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A924/A924M | (2017) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |

### 1.3 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.4 GENERAL REQUIRMENTS

The exterior monument sign must be of the design, detail, size, type, and message content shown on the drawings. It must conform to the requirements specified and must be provided at the location indicated.

#### 1.4.1 Wind Load Requirements

Exterior signage must be designed to withstand 150 mph windload. Submit design analysis and supporting calculations performed in support of specified signage.

### 1.4.2 Character Proportions and Heights

Letters and numbers on the sign must have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on the indicated signs must be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper-case letter "X". Lower case characters are permitted.

## 1.5 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Drawings

SD-05 Design Data

Design Calculations

SD-10 Operation and Maintenance Data

Protection and Cleaning

## 1.6 QUALIFICATIONS

Dimensional letters, numbers and symbols must be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items of equipment must essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

## 1.7 SUBMITTAL REQUIREMENTS

Submit detailed drawings of the sign showing the dimensions, materials, graphics, letters and symbols, colors and the finishes of the sign. The drawings should include foundation details and connection details of the sign to the foundation. The drawings shall show elevations of the sign; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction. The drawings shall include a site plan showing the proposed sign location and the proposed landscaping associated with the sign. The drawing shall demonstrate that the monument sign is outside of the SR-80 FDOT right-of-way at its intersection with Congen Road. See Section 01 35 26 SAFETY REQUIREMENTS and Section 01 35 40 ENVIRONMENTAL PROTECTION for any additional requirements related to exterior signage.

Submit design calculations for the sign including but not limited to the foundation and framing components.

## 1.8 DELIVERY AND STORAGE

If the monument sign is constructed on site the sign letters, numbers and symbols must be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area with

the manufacturer's instructions until they are needed in the sign assembly and construction.

1.9 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 FOUNDATION

The sign foundation shall be reinforced concrete as specified in Section 03 31 01.00 10 CAST IN PLACE CONCRETE FOR CIVIL WORKS.

2.2 FRAMING

Framing members may be wood, aluminum or steel. Wood must be pressure treated.

2.3 EXTERIOR SIGN PANELS

Provide panel(s) to sizes shown on drawings. Panels may be fabricated using exterior plywood (minimum 3/4 inch thick), pressure treated lumber (minimum 1-1/2 inch thick), aluminum or steel (minimum 0.090 inch thick) or fiberglass reinforced plastic (FRP) minimum 0.125 inch thick).

2.4 FINISHES

Sign base finish and sign system finishes must be as indicated.

2.5 ANCHORS AND FASTENERS

Exposed anchor and fastener materials must be compatible with metal to which applied and must match in color and finish and must be non-rusting, non-corroding, and non-staining. Exposed fasteners must be tamper-proof.

2.6 SHOP FABRICATION AND MANUFACTURE

2.6.1 Factory Workmanship

Work must be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled must be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws must be drilled or punched. Drilling and punching must produce clean, true lines and surfaces. Welding to or on structural steel must be in accordance with AWS D1.1/D1.1M. Welding must be continuous along the entire area of contact. Exposed welds must be ground smooth. Exposed surfaces of work must have a smooth finish and exposed riveting must be flush. Fastenings must be concealed where practical. Items specified to be galvanized must be by hot-dip process after fabrication if practical. Galvanization must be in accordance with ASTM A123/A123M and ASTM A653/A653M, as applicable. Other metallic coatings of steel sheet must be in accordance with ASTM A924/A924M. Joints exposed to the weather must be formed to exclude water. Drainage and weep holes must be included as required to prevent condensation buildup.

### 2.6.2 Dissimilar Materials

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces must be protected with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.

### 2.6.3 Shop Painting

Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel, and zinc-coated work, must be given one coat of zinc-molybdate primer or an approved rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice. Surfaces of items to be embedded in concrete must not be painted. Upon completion of work, damaged surfaces must be recoated.

## 2.7 COLOR, FINISH, AND CONTRAST

Color must be as indicated on the drawings. Characters and symbols must contrast with their background - either light characters on a dark background or dark characters on a light background.

# PART 3 EXECUTION

## 3.1 DESIGN

The drawings and specifications provide the criteria and performance expectations of the exterior monument sign. The Contractor shall prepare the detailed design and installation plan for the sign. As previously noted the Contractor must submit for review and approval detailed drawings of the sign prepared by a Florida registered professional engineer.

## 3.2 INSTALLATION

Signs, plaques, or dimensional letters must be installed in accordance with approved manufacturer's instructions at the location shown on the approved detail drawings. The sign must be installed plumb and true and by method shown or specified.

### 3.2.1 Protection and Cleaning

The work must be protected against damage during construction. Until the sign is completed, inspected and accepted, cover the sign so as not to mislead the public. Covering must be maintained until instructed to be removed by the District or until the facility is to be opened for business. Submit 2 copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions must include simplified diagrams for the equipment as installed. Signs must be cleaned, as required, at time of cover removal. Submit instructions for protection and cleaning.

## 3.3 FIELD PAINTED FINISH

Miscellaneous metals and frames must be field painted in accordance with Section 09 06 90 PROTECTIVE COATINGS. Anodized metals, masonry, and glass

must be protected from paint. Finish must be free of scratches or other blemishes.

-- End of Section --

# SECTION 10 14 00.20

# INTERIOR SIGNAGE

## 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.

OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA)

| | |
|---|---|
| Subpart S | Electrical |

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

| | |
|---|---|
| 36 CFR 1191 | Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines |

### 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Installation

Warranty

SD-04 Samples

Interior Signage

SD-10 Operation and Maintenance Data

Approved Manufacturer's Instructions

Protection and Cleaning

### 1.3 QUALITY REQUIREMENTS

#### 1.3.1 Samples

Submit interior signage samples of each of the following sign types showing typical quality, workmanship and color: Directional sign, Standard Room

sign, Changeable message strip sign. The samples may be installed in the work, provided each sample is identified and location recorded.

1.3.2 Detail Drawings

Submit detail drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, mounting height, shape and thickness of materials, and details of construction. Include a schedule showing the location, each sign type, and message.

1.4 DELIVERY, STORAGE, AND HANDLING

Materials shall be packaged to prevent damage and deterioration during shipment, handling, storage and installation. Product shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

1.5 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Signs, plaques, directories, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of such products that essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening. Obtain signage from a single manufacturer with edges and corners of finished letterforms and graphics true and clean.

2.2 ROOM IDENTIFICATION/DIRECTIONAL SIGNAGE SYSTEM

2.2.1 Standard Room Signs

Signs shall consist of laminated thermosetting Type MP plastic (three-ply melamine plastic laminate with phenolic core) and shall conform to the following:

a. Units shall be frameless. Corners of signs shall be rounded to 3/8 inch radius.

2.2.2 Type of Mounting For Signs

Provide extruded aluminum brackets for hanging, projecting, and double-sided signs. Surface mounted signs shall be mounted with 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam fabricated from materials that are not corrosive to sign material and mounting surface.

2.2.3 Graphics

Signage graphics for modular signs shall conform to the following:

2.2.3.1 Surface Applied Photopolymer

Integral graphics and Braille achieved by photomechanical stratification processes. Photopolymer used for ADA compliant graphics shall be of the type that has a minimum durometer reading of 90. Tactile graphics shall be raised 1/32 inch from the first surface of plaque by photomechanical stratification process.

2.2.4 Character Proportions and Heights

Letters and numbers on signs conform to 36 CFR 1191.

2.2.5 Tactile Letters, Symbols and Braille

Raised letters and numbers on signs shall conform to 36 CFR 1191.

2.3 BUILDING DIRECTORIES

Building directories shall be lobby directories or floor directories, and shall be provided with a changeable directory listing consisting of the areas, offices and personnel located within the facility. Dimensions, details, and materials of sign and message content shall be as shown on the drawings.

2.4 TYPEFACE

ADA-ABA compliant font for Room Signs.

PART 3 EXECUTION

3.1 INSTALLATION

Signs shall be installed plumb and true and in accordance with approved manufacturer's instructions at locations as directed by Owner. Submit six copies of operating instructions outlining the step-by-step procedures required for system operation. The instructions shall include simplified diagrams for the system as installed, the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the facility, name of the Contractor, and contract number. Mounting height and mounting location shall conform to 36 CFR 1191. Required blocking shall be installed. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed.

3.1.1 Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish.

a. Signs mounted to painted gypsum board surfaces shall be removable for painting maintenance.

b. Mount signs mounted to lay-in ceiling grids with clip connections to ceiling tees.

c. Install signs mounted on metal surfaces with magnetic tape.

d. Install signs mounted on fabric surfaces with hook and loop tape or pin mount.

### 3.1.2 Protection and Cleaning

Protect the work against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned at completion of sign installation in accordance with the manufacturer's approved instructions and the requirements of Section 01 78 05 OPERATION AND MAINTENANCE INFORMATION, Package 1. Submit six copies of maintenance instructions listing routine procedures, repairs, and guides.

-- End of Section --

# SECTION 10 18 00

# INFORMATIONAL KIOSK

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish the design and all labor, materials, and equipment necessary for construction of kiosks in accordance with the design criteria and applicable codes and as specified herein.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.3 REFERENCES

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

| | |
|---|---|
| AITC108 | Standard for Heavy Timber Construction |
| AITC112 | Standard for Tongue-and-Groove Heavy Timber Roof Decking |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A36/A36M | (2014) Standard Specification for Carbon Structural Steel |
| ASTM A185/A185M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete |
| ASTM A325 | (2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A615/A615M | (2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM D143 | Standard Test Methods for Small Clear Specimens of Timber |
| ASTM D198 | (2015) Standard Test Methods of Static Tests of Lumber in Structural Sizes |
| ASTM D570 | (1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics |
| ASTM D1761 | Standard Test Methods for Mechanical Fasteners in Wood |

| | |
|---|---|
| ASTM D6109 | (2013) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber and Related Products |
| ASTM D6111 | (2013a) Standard Test Method for Bulk Density and Specific Gravity of Plastic Lumber and Shapes by Displacement |
| ASTM D6117 | (2016) Standard Test Methods for Mechanical Fasteners in Plastic Lumber and Shapes |
| ASTM D6341 | (2016) Standard Test Method for Determination of the Linear Coefficient of Thermal Expansion of Plastic Lumber and Plastic Lumber Shapes Between -30 and 140°F (-34.4 and 60°C) |

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

| | |
|---|---|
| AWPA T1 | (2017) Use Category System: Processing and Treatment Standard |
| AWPA U1 | (2017) Use Category System: User Specification for Treated Wood |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Paint 20 | (2002; E 2004) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic) |

## 1.4 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

- Reinforced Concrete Slab
- Kiosk Structure
- Roof Framing System
- Bench
- Information Sign Framing
- Steel Shapes and Plates

SD-03 Product Data

- Steel Connection Plates
- Composite Lumber

SD-04 Samples

Composite Lumber

SD-07 Certificates

Certificates of Compliance

Steel Connection Plates

Composite Lumber

Zinc Coating

1.5 QUALITY CONTROL

Submit certificates of compliance in accordance with the applicable reference standards and descriptions of this section for the following:

a. Steel connection plates

b. Composite lumber

c. Zinc coating

Dimensional Tolerances: Comply with Southern Pine Inspection Bureau Tolerance Tables.

Minimum 5 years' experience in producing fiberglass reinforced (composite plastic) thermoplastic lumber.

1.6 DELIVERY AND STORAGE

Deliver materials to site in undamaged condition. Store materials off the ground. Cover materials to prevent damage from rain.

Refer to manufacture's instruction for Product Storage and Handling Requirements.

Follow manufacturer's instructions.

Handle composite lumber material with gloves; refer to MSDS.

Manufacturer shall maintain a program to permit return of scrap materials.

1.7 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 GENERAL

Coordinate with the Drawings to verify which of the following products is used in the Work.

## 2.2 CONCRETE

Submit for review and approval shop drawings of the reinforced concrete slab.

Concrete: 4,000 psi at 28 days per Section 03 31 01.00 10 CAST-IN-PLACE CONCRETE FOR CIVIL WORKS.

Reinforcing Bars: ASTM A615/A615M, Grade 60

Welded Wire Fabric: ASTM A185/A185M

## 2.3 STEEL

Submit for review and approval shop drawings of the steel shapes and plates. Submit product data for the steel connection plates.

Galvanized Steel Plate: Steel Plate ASTM A36/A36M

Fasteners: High-Strength Bolts and Nuts, ASTM A325.

Refer to Section 05 50 14 STRUCTURAL METAL FABRICATIONS for steel shapes-plates and bolted fasteners, respectively.

Galvanize shapes after fabrication. Make field repairs to galvanizing with high Zinc Dust content paint, complying with SSPC Paint 20.

## 2.4 WOOD

Submit for review and approval shop drawings of the kiosk structure. Submit for review and approval shop drawings of the information sign framing.

Comply with AITC108.

For solid wood decking, comply with AITC112.

Species: Douglas Fir, Hem-Fir, or Southern Yellow Pine

Preservative Treatment: Pressure Treat Fabricated Members with Waterborne Solution for above ground use, complying with AWPA U1, and AWPA T1.

## 2.5 COMPOSITE (PLASTIC) LUMBER

a. Acceptable Manufacturers:

   1. Trimax Building Products

   2. District approved equal

b. General: Heat-formed extruded shapes of fiberglass reinforced foamed polyolefin manufactured from approximately 80 percent recycled domestic and industrial plastics with reactive compatibilizers to stabilize the plastic/fiber matrix. The composite lumber shall be constructed from high-density polyethylene (HDPE), colorants (pigments) and UV inhibitors.

c. Decking Surface: Shall be slip resistant with embossed texture similar to natural wood grain.

d. Allowable Design Stresses: Not less than the following as determined by rational engineering analysis, and demonstrated by comprehensive testing performed by an independent testing laboratory.

Structural Composite Lumber:

| **Mechanical Properties at 70 deg F** | **Test Method** | **Average Value** |
|---|---|---|
| Density, lbs/cu. In. | ASTM D6111 | .027 - .030 |
| Modulus of rupture (ultimate) | ASTM D198<br>ASTM D6109 | 2,900 psi<br>2,900 psi |
| Modulus of elasticity | ASTM D198<br>ASTM D6109 | 420,000 psi<br>325,000 psi |
| Compression parallel to grain (ultimate) | ASTM D198 | 1,740 psi |
| Shear parallel to grain | ASTM D143 | 730 psi |
| Tension parallel to grain (ultimate) | ASTM D198 | 1,250 psi |
| Screw withdrawal (lb/in of depth) | ASTM D1761 | 380 lbs/in |
| Coefficient thermal expansion in/in/deg. F | ASTM D6341 | 0.000034 |
| Coefficient of friction | Tribometer (dry) | 0.61 |

Composite Decking:

| **Mechanical Properties at 70 deg. F** | **Test Method** | **Average Value** |
|---|---|---|
| Density, lbs/cu. In. | ASTM D6111 | .027 - .030 |
| Modulus of rupture (ultimate) | ASTM D198<br>ASTM D6109 | 2,900 psi<br>2,900 psi |
| Modulus of elasticity | ASTM D6109 | 2,300 psi |
| Allowable flexural stress | ASTM D6109 | 1,200 psi |
| Screw withdrawal #10, 1-1/2" | ASTM D6117 | 90 lbs |
| Coefficient thermal expansion in/in/deg. F | ASTM D6341 | 0.00003 |
| Water absorption, 11 weeks | ASTM D570 | <0.1% |

| Structural Allowable Live Load (psf), Multiple Span, at 120 deg. F or less | | | |
|---|---|---|---|
| **Deflection Limit** | **12" Span** | **16" Span** | **24" Span** |
| L/360 | 2,198 | 927 | 275 |
| L/240 | 3,000* | 1,391 | 412 |
| L/180 | 3,000* | 1,618* | 550 |
| * Load limited by allowable stress of 1000 psi. | | | |

Total deflection in all members shall not exceed L/240.

Submit for review and approval shop drawings of the bench. Submit product data including the Material Safety Data Sheet (MSDS) for the composite lumber.

Submit 12-inch long by 4-inch wide sample pieces of integral colored composite lumber (plastic) showing full range of available colors, five colors minimum.

2.6 ROOF

Submit for review and approval shop drawings of the roof framing system.

Roof shall be in accordance with Section 07 61 13 STANDING SEAM SHEET METAL ROOFING.

PART 3 EXECUTION

Not Used

-- End of Section --

# SECTION 10 21 12

# PRECAST RESTROOM TOILET

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all labor, equipment and materials for the construction and installation of a fully accessible (ADA compliant) precast concrete double vault restroom with a chase.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A185/A185M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete |
| ASTM A615/A615M | (2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM C33/C33M | (2016) Standard Specification for Concrete Aggregates |
| ASTM C39/C39M | (2017b) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C94/C94M | (2017a) Standard Specification for Ready-Mixed Concrete |
| ASTM C150/C150M | (2017) Standard Specification for Portland Cement |
| ASTM C172/C172M | (2014a) Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C231/C231M | (2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C260/C260M | (2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete |

| | |
|---|---|
| ASTM C309 | (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C494/C494M | (2017) Standard Specification for Chemical Admixtures for Concrete |
| ASTM D698 | (2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.)) |
| ASTM C979/C979M | (2016) Standard Specification for Pigments for Integrally Colored Concrete |
| ASTM C1611/C1611M | (2014) Standard Test Method for Slump Flow of Self-Consolidating Concrete |

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 211.1 | (1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete |

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

| | |
|---|---|
| ANSI/BHMA 156 | Series Standards |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-272 | (Rev B; Notice 1) Caulking Compounds |

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

| | |
|---|---|
| PCI MNL-116 | (1999) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 4th Edition |

FLORIDA BUILDING CODE

| | |
|---|---|
| FBC | (2017) Florida Building Code |

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

Installation Plan

SD-03 Product Data

Wall Texture

Roof Texture

SD-06 Test Reports

Factory Testing

SD-07 Certificates

Manufacturer's Certification

SD-09 Manufacturer's Field Reports

Manufacturer's Field Report

Manufacturer's Certification

SD-10 Operation and Maintenance Data

Manuals

## 1.5 DELIVERY, STORAGE, AND HANDLING

Deliver the precast toilet building to the site in an undamaged condition. Manufacturer is responsible for delivery, unloading and final placement of the precast toilet building.

## 1.6 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

## 1.7 PERMITS

The Contractor shall apply for and obtain all building permits associated with the precast restroom(s).

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

Submit detail drawings, signed and sealed by a professional engineer registered in the state of Florida, of the precast building, equipment and accessories to be provided. Detail drawings shall include floor plans, building elevations, interior and exterior elevations and sections and a listing of the selected options.

### 2.1.1 Design

The precast double vault restroom shall be fully accessible and ADA compliant. The concrete waste vaults shall hold a minimum of 1,000 gallons each. The collected waste shall be removed by pumping. The floor, roof and walls are to be designed and fabricated to meet all local and state building codes. The building shall be prefabricated and delivered, complete and ready to use, including plumbing and electrical where applicable. The toilet shall be designed and constructed so that liquids can enter the vault only through the waste ports. Materials and joints in the toilet shall be impermeable to liquids and not subject to biological, chemical, or physical

corrosion. All features of the design and prefabrication must meet the requirements of the current Florida Building Code.

2.1.2 Performance

2.1.2.1 Factory Testing

Submit factory testing results attesting to manufacturing quality control of the proposed system, at least 30 days before the District approves or disapproves the toilet proposed for installation. Document 4 installations of toilets, essentially identical to the toilet installed under this specification, and that those installations have at least 2 consecutive years of operating experience. Include available operating data for each of the installations, along with the names, addresses, and telephone numbers of personnel at the installations that will furnish information upon request regarding questions of interest to the District.

The toilet shall prevent the entry of insects in the user compartment and surrounding area. Certify that the toilet is installed properly and demonstrate that it will operate properly.

2.2 JOINT SEALANTS

Joint sealants shall be resistant to water and biological decomposition in conformance with CID A-A-272.

2.3 DESIGN LOADS

a. Roof not less than 350 pounds per square foot.

b. Floor not less than 400 pounds per square foot.

c. Wind not less than 150 miles per hour (3 second gust).

d. Seismic category E earthquake.

2.4 ADDITIONAL DESIGN STANDARDS

a. Minimum roof pitch shall be 3/12.

b. Minimum 4 inch wall, 4 1/2 inch roof, and 5 inch floor thicknesses.

c. The floor shall be a one piece unit. All wall to floor interior surface seams shall have a minimum 1 inch radius coving made of high strength grout.

2.5 MATERIALS

2.5.1 Concrete - General

a. The concrete mix design meet ACI 211.1 requirements.

b. Concrete shall contain a minimum of 675 pounds of cementitious material per yard. Cement shall be low alkali type I/II or III conforming to ASTM C150/C150M.

c. Coarse aggregates shall conform to ASTM C33/C33M with the designated size of coarse aggregate #67.

d. Maximum water/cement ratio shall not exceed .45.

e. Air-entraining admixtures shall conform to ASTM C260/C260M. Water reducing admixtures shall conform to ASTM C494/C494M, Type A.

f. If Self Compacting Concrete (SCC) is used, it must conform to ASTM C1611/C1611M.

g. The temperature of the concrete shall not exceed 90 F at the time of placement. When the ambient reaches 90 F the concrete shall be protected with moist covering.

2.5.2 Concrete - Colored

a. Color additives shall conform to ASTM C979/C979M.

b. The following components shall contain colored concrete:

1. Toilet building roof panels.

2. Building walls.

3. Screen panels.

c. The same brand and type of color additive shall be used throughout the manufacturing process.

d. Weigh and mix all ingredients to ensure uniform dispersion of the color.

2.5.3 Concrete Reinforcement

a. All reinforcing steel shall conform to ASTM A615/A615M. All welded wire fabric shall conform to ASTM A185/A185M.

b. All reinforcement shall be new, free of dirt, oil, paint, grease, loose mill scale and loose or thick rust when placed.

c. Steel reinforcement shall be centered in the cross-sectional area of the walls and shall have a minimum of 1 3/4 inch of cover on the under surface of the floor.

d. The maximum allowable variation for center-center spacing of reinforcing steel shall be 1/2 inch.

e. Use full lengths of reinforcing steel used when possible. When splices are necessary on long runs, alternate the splices from opposite sides of the components for adjacent steel bars.

f. Lap bars under #4 a minimum of 12 inch bar diameters.

g. Lap bars larger than #4 a minimum of 24 inch bar diameters.

h. Cold bend all reinforcing bars.

2.5.4 Caulking, Grout, Adhesive and Sealer

a. Interior and exterior joints shall be caulked with a paintable polyurethane sealant.

b. Grout shall be a non-shrink type and painted to match the color of surrounding concrete as nearly as possible.

c. Cement base coating shall be formulated with a very fine aggregate system and a built-in bonding agent

2.5.5 Dead Bolt

The dead bolt shall be certified ANSI/BHMA 156.5-2001 Grade 1, heavy duty tamper resistant, with a 2 3/4 inch backset and a U.S. 26D finish.

2.5.6 Doors - Steel

a. Doors shall be flush panel type 1 3/4 inch thick, minimum 16-gauge galvanized steel, top painted with DTM ALKYD.

b. Door frames shall be knockdown or welded type, single rabbet, minimum 16-gauge prime coated steel top painted with DTM ALKYD, width to suit wall thickness.

c. Provide the following with each door:

1. Three (3) rubber door silencers shall on latch side of frame.

2. Three (3) hinges per door with dull chrome plating 4 1/2 inch x 4 1/2 inch, adjustable tension, and automatic closing for each door.

3. Dome style stop meeting ANSI/BHMA 156.16.

4. Door sweep at the bottom of door with an adjustable brush.

5. A 16-gauge, type 304 stainless steel double coat hook in each restroom. The hook shall be formed construction with a satin finish and have 3/16 inch x 7/8 inch nail in anchor, upper hook extending at least 2 1/2 inches from the wall and the lower hook extending at least 1 1/4 inch from the wall.

2.5.7 Grab Bars

Provide one (1) 18-gauge, type 304 stainless steel grab bar per restroom with 1 1/2 minimum clearance. The bar and installation shall be capable of withstanding a 300 pound top loading.

2.5.8 Lock Set

a. The cylindrical lockset for exterior door shall meet ANSI/BHMA 156.2 Series 4000, Grade 1.

b. Each lock set shall meet the following requirements:

1. Lever handle both inside and out.

2. Either handle operates latch unless outside handle is locked by inside push-button.

3. Push-button will automatically release when inside lever handle is turned or door is closed.

4. Emergency slot on exterior so door can be unlocked from the outside with a coin, screwdriver, etc.

5. Inside lever always active.

6. U.S. 26D finish.

2.5.9 Paint

a. Provide and apply paint per the following:

1. Paints will not contain more than .06% by weight of lead.

2. Type of paints for toilets.

i. Inside concrete surfaces.

a) Interior floors - chemical resistant urethane. Color shall be gray.

b) Interior walls and ceilings - modified acrylic, water repellent penetrating stain. The color shall be white followed by a clear acrylic anti-graffiti sealer.

ii. Exterior concrete surfaces.

a) Exterior slab - clear sealer.

b) Exterior walls and roof - water repellent penetrating stain in the same color as the walls or roof followed by a clear acrylic anti-graffiti sealer

3. Metal surfaces (both inside and out).

i. DTM ALKYD.

2.5.10 Riser

The toilet riser shall be accessible and meet all ADA standards and requirements. It shall be a molded one-piece HDPE polyethylene with a smooth surface and have high impact resistance at extremely cold temperatures.

2.5.11 Sealers and Curing Compounds

a. Curing compounds, if used, shall be colorless, complying with ASTM C309, type I or 1-D.

b. Weatherproofing sealer for exterior of building shall be a clear, water repellent penetrating sealer.

2.5.12 Signs

a. Signs shall have raised pictograms, letters, and braille to meet ADA.

b. Interior of each bathroom shall have a "No Trash in Vault" sign.

c. All signs shall be inset a minimum of 3/4 inch into wall with 45-degree bevel.

d. All signs to be anchored into concrete with 1/4 inch x 1/4 inch concrete anchor nails.

2.5.13 Toilet Paper Dispenser

a. Dispenser shall be constructed of 1/4 inch thick, type 304 stainless steel.

b. Holds three (3) standard rolls of toilet paper.

c. Fastening system shall be capable of withstanding a 300 pound top loading.

2.5.14 Vault Liner

a. Shall be made of a Roto molded 8460 polyethylene.

b. Each vault shall hold up to 1,000 gallons of waste or 15,000 uses per vault.

c. Minimum liner thickness .100.

d. Molded dovetail embeds shall attach the liner to the concrete walls of the vault.

e. Attach the liner to the bottom of the vault with two (2) C-channels.

2.5.15 Vent Stack

Provide and install a 12 inch diameter (minimum) vent stack a minimum of 3 feet higher than the roof peak.

2.5.16 Wall Vent

a. Vent cover shall be 14-gauge, type 304 stainless steel painted with DTM and anchored into the concrete wall with high strength anti-rust tap con fasteners.

b. Vent louver frame and louvers shall be non-vision, .1 inch extruded, aluminum jet coat finish.

c. Provide insect screen with vent.

d. Cover to be recessed a minimum 3/4 inch on exterior walls with a 45-degree bevel. Interior to be flush mounted. Wall vent will not protrude from the wall.

2.5.17 Windows and Vault Cleanout Cover

a. Windows and cleanout cover frames shall be constructed from steel.

b. Window glazing shall be 3/16 inch thick translucent pebble finished mar-resistant Lexan.

c. Plate for vault cleanout cover shall be 1/4 inch thick diamond plate steel.

d. The lid shall be hinged and configured so that it can be locked with a padlock. Provide a gasket around the entire perimeter of the lid to provide an airtight seal.

e. Windows shall have 3/4 inch recess with 45-degree bevel.

f. Windows frames shall have vandal resistant fasteners.

PART 3 EXECUTION

3.1 CONCRETE

3.1.1 Mixing and Delivery of Concrete

Mixing and delivery of concrete are in accordance with ASTM C94/C94M, Section 12.6 through 12.9.

3.1.2 Placing and Consolidating Concrete

Except for the self-compacting concrete, concrete shall be consolidated by the use of mechanical vibrators. Vibrate mix to accomplish compaction but not to the point that segregation occurs.

3.1.3 Finishing Concrete

a. Submit product data for the wall texture and the roof texture prior to placing the order for the precast restroom(s).

b. Float and trowel all interior floor and exterior slabs.

c. All exterior building walls and exterior screen walls shall be textured with split faced block texture.

d. All exterior surfaces of the roof panels shall be cast to simulate rib metal, hunter green roof. The underside of the overhang shall have a smooth finish.

3.1.4 Cracks and Patching

a. Reject all cracks in concrete components which are judged to affect the structural integrity of the building.

b. Patch small holes, depressions, and air voids with a suitable material. The patch shall match the finish and texture of the surrounding surface.

c. Patching will not be allowed on defective areas if the structural integrity of the building is affected.

3.1.5 Curing and Hardening Concrete

Concrete surfaces will not be allowed to dry out from exposure to hot, dry weather during initial curing period.

3.2 FINISHING AND FABRICATION

3.2.1 Structural Joints

a. Join wall components with two (2) welded plate pairs at each joint.

b. Each weld plate shall be 6 inches long. Locate one (1) pair in the top quarter and one (1) pair in the bottom quarter of the seam.

c. Anchor weld plates into the concrete panel. The weld panels shall be welded together with a continuous weld.

d. Inside seams shall be paintable caulk.

e. Caulk the outside seams with a coordinating building color or clear.

f. Join walls and roof together with weld plates, 3 inches x 6 inches at each building corner.

g. The joint between the floor slab and walls shall be joined with a grout mixture on the inside, a matching colored caulk on the outside and two (2) weld plates 6 inch long per wall.

3.2.2 Painting/Staining

a. Apply paint only after the concrete is cured.

b. Where acid etching is required apply a 30% solution of hydrochloric acid, flush with water, and allow to thoroughly air dry.

c. Painting will not be done outside in cold, frosty, or damp weather.

d. Fill all surface voids prior to painting.

3.2.3 Schedule Of Finishes

a. Inside concrete surfaces.

1. Inside floors - one (1) coat of 1-part water based chemical resistant urethane.

2. Interior walls and ceilings - two (2) coats of a modified acrylic, water repellent penetrating stain, followed by one (1) coat of clear sealer.

b. Exterior concrete surfaces.

1. Exterior walls - two (2) coats of water repellent penetrating stain in the same color as the walls or roof followed by one (1) coat of clear acrylic anti-graffiti sealer.

c. Metal surfaces (both inside and out).

1. Two (2) coats of DTM ALKYD

3.2.4 Testing

a. Sampling shall be in accordance with ASTM C172/C172M.

b. The following tests shall be performed on concrete used in the manufacture of toilets. All testing shall be performed in PCI MNL-116 certified laboratories. Submit manufacturer's certification that the testing will be performed by a PCI certified laboratory.

1. Air content - The first batch of concrete shall be in the range of 5.0% +/- 1.5% per ASTM C231/C231M.

2. Compressive strength of the cylinders - tested to ASTM C39/C39M.

i. Test two (2) cylinders at release (minimum strength of 2500 psi).

ii. Test one (1) cylinder at seven (7) days (minimum strength of 4500 psi).

iii. Test two (2) cylinders at 28 days (minimum strength of 5000 psi).

c. Submit a copy of all test reports from the factory tests as soon as 28-day test results are available.

3.2.5 Installation

Submit an installation plan for review and approval a minimum of 30 days before anticipated delivery of the precast restroom(s). Installation includes but is not limited to excavation, backfill and placement of the precast concrete vault toilet.

a. Location - As indicated on the drawings. Provide a clear and level site free of overhang and/or underground obstructions. Provide access to the site for truck delivery and sufficient area for a crane to install and the equipment to install the restroom.

b. Excavation - Excavate for the installation of the toilet vault to a depth that will allow the structure site to be free draining after installation is completed. Allow for a 2 inch leveling course beneath the toilet vault. Stockpile topsoil in a separate pile at the site.

c. Materials - Bedding material shall be No. 57 stone. Caulking between vault and toilet floor to be 1 inch x 1 inch Butyl tape designed specifically to bond precast concrete to precast concrete.

d. Backfill and Compaction - Compact the natural ground at the bottom of the vault excavation to 95% of ASTM D698 maximum density. Install aggregate bedding material for a leveling course as needed. Grade leveling course so there are no high spots in the middle of the vault bottom. Compact leveling course with one (1) pass using a walk behind vibratory compactor. Set vault in place and check for level. Backfill around structure. Use excavated material for backfill except those rocks larger than 6 inch in maximum dimension shall not be placed within 6 inches of the exterior vault walls.

e. Finish Grading - Spread excess excavated material from the vault around structure. Intended final grade shall be 4 inches below the bathroom floor slab. Allow for placement of topsoil to reach that grade. Grade backfill to provide for positive drainage away from the structure. Spread stockpiled topsoil as final layer after rough grading is completed. Hand rake areas disturbed by excavation, backfilling and stockpiling of excavated materials. Remove all exposed rocks over 1 inch in size. Establish turf on disturbed areas around structure as indicated.

f. Exhaust Pipe Extension - Attach top pipe extension using stainless steel hardware.

g. At the completion of the installation submit a manufacturer's field report with the manufacturer's certification that the precast restroom(s) have been installed per the manufacturer's recommendation and the approved installation plan.

### 3.2.6 Closeout Activities

#### 3.2.6.1 Operation and Maintenance Manuals

Submit operation manual outlining step-by-step procedures required for system operation. Include with the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. Include with the manual diagrams for the system as installed.

#### 3.2.6.2 Training Course

Conduct a training course for the operating staff as designated by the District. The training period shall consist of a total of 4 hours of normal working time, and shall start after the system is functionally completed. The field instructions shall cover all the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Notify the District at least 14 days in advance of proposed beginning of the training course.

-- End of Section --

# SECTION 10 44 16

# FIRE EXTINGUISHERS

## PART 1 GENERAL

### 1.1 REFERENCES

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 1 | (2015; ERTA 2015) Fire Code |
| NFPA 10 | (2013) Standard for Portable Fire Extinguishers |
| NFPA 101 | (2015; ERTA 2015) Life Safety Code |

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

| | |
|---|---|
| 29 CFR 1910.157 | (2003) Portable Fire Extinguishers |

### 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Data

SD-02 Shop Drawings

Fire Extinguishers

Accessories

Wall Brackets

SD-03 Product Data

Fire Extinguishers

Accessories

Wall Brackets

Replacement Parts List

SD-04 Samples

Fire Extinguisher

Wall Brackets

Accessories

SD-07 Certificates

Fire Extinguishers

Manufacturer's Warranty with Inspection Tag

1.3 DELIVERY, STORAGE, AND HANDLING

Protect materials from weather, soil, and damage during delivery, storage, and construction.

Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

1.3.1 Samples

Provide the following samples: One of each type of fire extinguisher being installed three samples of wall brackets and accessories of each type being used.

Use approved samples for installation, with proper identification and storage.

1.4 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

Submit fabrication drawings consisting of fabrication and assembly details performed in the factory and product data for the following items: Fire Extinguishers; Accessories, Wall Brackets.

2.1 SYSTEM DESCRIPTION

2.1.1 Types

Submit certificates that show fire extinguishers comply with local codes and regulations.

Provide fire extinguishers conforming to NFPA 10. Provide quantity and placement in compliance with the applicable sections of NFPA 1, NFPA 101 and 29 CFR 1910.157.

Provide stored-pressure water type fire extinguishers.

Provide foam type fire extinguishers.

Submit manufacturer's data for each type of Fire Extinguisher required, detailing all related Wall Mounting and Accessories information, complete with manufacturer's warranty with inspection tag.

2.1.2 Material

Provide corrosion-resistant steel extinguisher shell.

2.1.3 Size

10 pounds extinguishers.

2.1.4 Accessories

Forged brass valve

Safety release

Pressure gage

PART 3 EXECUTION

3.1 INSTALLATION

Fire Extinguishers where indicated on the drawings. Verify exact locations prior to installation.

Provide extinguishers which are fully charged and ready for operation upon installation. Provide extinguishers complete with Manufacturer's Warranty with Inspection Tag attached.

Comply with the manufacturer's recommendations for all installations.

3.2 PROTECTION

3.2.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the District.

Submit replacement parts list indicating specified items replacement part, replacement cost, and name, address and contact for replacement parts distributor.

3.2.2 Cleaning

Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

-- End of Section --

# SECTION 13 34 23.10

# PRECAST CONCRETE BUILDINGS

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work: The Work of this Section shall consist of furnishing all labor, materials, and equipment necessary for the installation of modular precast concrete Control buildings as shown on the Drawings and specified herein.

Related Work Specified Elsewhere:

Section 01 33 00 SUBMITTAL PROCEDURES

### 1.2 APPLICABLE STANDARDS AND PUBLICATIONS

Standards or Codes: The edition of the standards of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. See the various paragraphs for the specified standard. In the case of a conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail.

1. American Society of Civil Engineers (ASCE)

    a. 7 - Minimum Design Loads for Buildings and Other Structures

2. American Society for Testing and Materials (ASTM)

    a. A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

    b. A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

    c. C260 Standard Specification for Air-Entraining Admixture for Concrete

3. Florida Building Code (2017 Edition) with a High Velocity Hurricane Zone requirements

4. Precast/Prestressed Concrete Institute (PCI)

    a. MNL-116 - Manual for Quality Control for Plants and Production of Structural Precast Concrete Products

    b. MNL-120 - PCI Design Handbook

5. Underwriters Laboratories (UL)

    a. 752 - Standard of Safety for Bullet Resisting Equipment

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Experience verification

SD-02 Shop Drawings

Engineering drawings

SD-03 Product Data

Sealants

Proposed coatings

Equipment Manufacturer's catalog information

Liquid Applied Roofing System

SD-04 Samples

Standard color samples

SD-05 Design Data

Engineering calculations

SD-06 Test Reports

Miami-Dade Notice of Acceptance or Florida Product Approval

SD-07 Certificates

Sealed certification by a Professional Engineer

Certification by the Manufacturer

Installer Certification

Experience Verification

## 1.4 SUBMITTAL REQUIREMENTS

A. Engineering calculations and engineering drawings signed and sealed by a Professional Engineer registered in the State of Florida shall be submitted for approval.

B. Sealed certification by a Professional Engineer registered in the State of Florida that the enclosure satisfies the requirements of the Florida Building Code for High Velocity Hurricane zones.

C. Manufacturer's catalog information on sealants and certification by the Manufacturer on the proposed material s suitability for the application.

Sealants shall conform to Section 03 11 15.00 10, Concrete Formwork and Accessories.

D. Manufacturer's catalog information on the proposed coatings including standard color samples, and certification by same on the proposed materials suitability for the application and compatibility with other systems proposed.

E. Equipment Manufacturer's catalog information.

F. Submit experience verification that the Manufacturer has no less than three (3) years' experience in the design and manufacture of similar facilities.

G. Liquid Applied Roofing System:

1. Miami-Dade Notice of Acceptance or Florida Product Approval, as applicable, with a system maximum design pressure that exceeds the uplift design pressure.

2. Installer Certification: The Contractor shall submit written certification from the Manufacturer of the roofing system certifying that the Installer is approved by the Manufacturer to install the specified roofing system and is eligible to receive the Manufacturer's warranty. Provide a copy of the certification to the District before award of the roofing Work.

1.5 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS and the requirements described below.

Liquid Applied Roofing System Warranty: Provide written warranty signed by the Manufacturer of the primary roofing materials agreeing to replace or repair defective roofing system and workmanship as required to maintain the roofing system in a watertight condition at no expense to the District for a period of fifteen (15) years after the Contractor's one (1) year warranty expires for the Project. In addition, provide a written warranty signed by the Manufacturer of the primary roofing materials agreeing to allow the District to make emergency repairs to roof without voiding the Manufacturer's warranty.

1. In conjunction with issuance of the above warranty, include instructions detailing preventive maintenance required to maintain the warranty, a list of substances which may damage the roofing system, and specifications on repair of the roofing system that may be accomplished by the District as specified above.

2. Warranty shall include coverage for damage to the building resulting from failure of roof system to resist penetration of water with no dollar limit to the value of repairs or replacements covered. The failure of the roof system includes but is not limited to:

   a. Blisters in roofing

   b. Cracks or ridging in the roofing membranes

c. Delamination, shears, or tears in the roofing membranes

d. Defects in the quality of work or materials

e. Leaks of any kind

PART 2 PRODUCTS

2.1 GENERAL

The Contractor shall provide a complete precast concrete building inclusive of doors, door hardware, louvers, ventilation, etc. Like items of materials provided hereunder shall be the end products of one Manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

2.2 DESIGN REQUIREMENTS

A. The building shall be designed to safely support the loads, with the applicable load factors, indicated on the Drawings and as specified herein.

B. Wind loads shall be calculated in accordance with ASCE 7.

C. The building shall be designed to meet the Florida Building Code and this Section.

D. The building shall be designed to be highly vandal resistant. The building envelope shall be designed and constructed to be bullet resistant to UL 752, Level 4.

E. Wall, roof, and floor panels shall be manufactured as single-component monolithic panels. No roof, floor, or wall joints are permitted, except at corners. Refer to the Drawings for wall penetration and electrical blockout locations.

F. The building shall be designed for maintenance-free use.

G. The building shall be designed to be transported and placed using standard lift points on the outside walls.

H. The building foundation shall be #57 stone compacted to 95% density surrounded by a concrete confinement.

I. The building roof and floor shall be designed for an 11 feet 4 inches clear span without the use of interior supporting of any type. The interior finished height shall be not less than 10 feet 0 inches.

J. The building shall be manufactured with a mechanism for assembly under tension at the factory.

1. All joints shall be caulked with a material selected by the Manufacturer to maintain a permanent seal under severe weather and handling conditions.

2. Leakage within one (1) year of installation shall constitute proof of noncompliance with this Section, and shall be repaired by Contractor at no additional cost to the District.

2.3 MATERIALS

A. Concrete: Steel-reinforced, 5,000 pounds per square inch (psi) minimum 28-day compressive strength, air-entrained conforming to ASTM C260.

B. Reinforcing Steel: Deformed bars of sizes shall conform to ASTM A615, Grade 60; welded wire fabric shall conform to ASTM A1064.

C. Provide concrete blocks of same strength as the concrete mix to support reinforcing bars in cast slab and curb. Do not use broken concrete bricks or stone. The precast Manufacturer may use his standard supports.

D. Like items of materials provided hereunder shall be the end products of one Manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

2.4 PRECAST CONCRETE ENCLOSURES

A. Provide a precast concrete enclosure of dimensions shown on the Drawings.

Specify 6 inch wall thickness for high security locations as directed by the District. Adjust overall building outside dimension as required to accommodate increased wall thickness.

B. The minimum wall thickness shall be four (4) inches. The minimum floor thickness shall be six (6) inches.

C. The panels shall be securely fastened with welded steel plates according to the Manufacturer's specifications.

D. Provide cast junction boxes and conduits into wall panels for electrical devices indicated on the Drawings, including future card readers for a door access control system and CCTV. Coordinate locations and sizes with the Drawings and Division 26.

E. Building Exterior:

1. Provide the exterior wall with a flat surface, smooth, and free of voids and cracks.

2. The exterior wall final coating color shall be neutral beige as selected by the District.

3. The roof exterior color shall be white as selected by District.

4. Wall coatings shall comply with Section 09 06 90 PROTECTIVE COATINGS, System C-1.

F. Roof:

1. The building roof system shall be designed to protect the equipment in the building from falling debris.

2. The minimum roof slab thickness shall be five (5) inches.

3. Roof slope shall be a pitch of 1/4 inch per foot minimum.

4. GAF TOPCOAT or DISTRICT approved equal roofing system shall be:

   a. A liquid applied acrylic based elastomeric membrane applied to the concrete deck with no insulation above the concrete deck.

   b. The roofing system products shall be applied in accordance with the Miami-Dade Notice of Acceptance or Florida Product Approval installation instructions and the Manufacturer's installation instructions.

   c. Complete system shall be installed per Manufacturer's recommendations.

G. Building Interior:

1. Interior final coating shall be white and in accordance with Section 09 06 90 PROTECTIVE COATINGS, System C-1.

H. The building shall be entirely assembled by the Manufacturer at their plant, sealed, caulked, waterproofed and tested for water-tightness. All joints shall be caulked and concrete on interior surfaces smoothed to remove projections.

2.5 HOLLOW METAL DOORS AND FRAMES

A. Comply with the requirements of Section 08 11 13 STEEL DOORS AND FRAMES

B. Provide weather seals and door sweep at all exterior doors.

C. Doors shall have a Florida Product Approval or Miami-Dade Notice of Acceptance (NOA), including missile impact rating.

2.6 FINISH HARDWARE

Comply with the requirements of Section 08 71 00 DOOR HARDWARE.

2.7 ELECTRICAL EQUIPMENT, MATERIALS, AND CONSTRUCTION

Comply with the requirements of Division 26.

Manufacturer to coordinate fan opening with fan provided by the Contractor or as specified in Section 23 00 00 AIR SUPPLY DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS and Section 08 91 00 METAL WALL LOUVERS...

2.8 LOUVERS

Provide louvers of sizes and locations as indicated on the Drawings.

Comply with the requirements of Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS.

## 2.9 TAMPER RESISTANT FASTENERS

Any exposed exterior fasteners shall be tamper resistant type.

## 2.10 PORTABLE LADDER SECURING SYSTEM

Provide a galvanized portable ladder securing system with stainless steel attachment hardware, LadderPort Type as manufactured by LadderPort, Brighton, Michigan 48116 or DISTRICT approved equal.

Locate ladder securing system where shown on the Drawings; install in accordance with Manufacturer's instructions.

# PART 3 EXECUTION

## 3.1 PRECAST CONCRETE ENCLOSURE

A. The precast concrete enclosure shall be delivered to the Site in one piece, and located on a leveled prepared surface as shown on the Drawings and in accordance with the Manufacturer's recommendations. The floor slab of the enclosure shall not vary from level or true plane more than 1/4-inch in ten (10) feet, nor more than 1/2-inch from the elevation shown on the Drawings.

B. Install all below grade conduits and piping, extending above the finished floor elevation. Control installation of conduits and piping such that the installed facilities will conform to openings in the precast enclosure.

C. Precast Concrete Floor Blockout for Conduit Penetrations.

1. Blockouts shall be filled on Site with non-shrink grout after conduit installation is completed.

D. All penetrations through the walls of the precast enclosure shall be either cast-in-place by the Manufacturer or core-drilled in the field. Nonuniform wall penetrations by use of the impact devices are not acceptable. Provide sealant around finished penetrations.

E. Manufacturer's Field Service: Manufacturer's representative shall be present at building's delivery and unloading. Set building to conform to the Manufacturer's recommendations and as indicated by the Manufacturer's representative.

F. Designer shall specify stainless steel fasteners, in accordance with Manufacturer's installation instructions to anchor building to concrete foundation where required.

## 3.2 CONDUITS AND PIPES

Shall be installed plumb and watertight.

-- End of Section --

# 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.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

| | |
|---|---|
| AMCA 201 | (2002; R 2011) Fans and Systems |
| AMCA 210 | (2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating |
| AMCA 300 | (2014) Reverberant Room Method for Sound Testing of Fans |
| AMCA 301 | (2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data |
| AMCA 500-D | (2012) Laboratory Methods of Testing Dampers for Rating |

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI Guideline D | (1996) Application and Installation of Central Station Air-Handling Units |

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 325 | (2011) Steel Construction Manual |
| AISC 360 | (2010) Specification for Structural Steel Buildings |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 62.1 | (2010) Ventilation for Acceptable Indoor Air Quality |
| ASHRAE 90.1 - IP | (2013) Energy Standard for Buildings Except Low-Rise Residential Buildings |
| ASHRAE EQUIP IP HDBK | (2012) Handbook, HVAC Systems and Equipment (IP Edition) |
| ASHRAE FUN IP | (2013; Addenda and Corrigendum 2013) Fundamentals Handbook, I-P Edition |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME A13.1 | (2015) Scheme for the Identification of Piping Systems |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A167 | (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B766 | (1986; R 2015) Standard Specification for Electrodeposited Coatings of Cadmium |
| ASTM C553 | (2013) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications |
| ASTM E2016 | (2015) Standard Specification for Industrial Woven Wire Cloth |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (2016; SUPP 2016) Motors and Generators |
| NEMA MG 10 | (2013) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors |
| NEMA MG 11 | (1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 701 | (2015) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films |
| NFPA 90A | (2015) Standard for the Installation of Air Conditioning and Ventilating Systems |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCSS CS Global Services (SCS)Indoor Advantage

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

| | |
|---|---|
| SMACNA 1966 | (2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition |
| SMACNA 1981 | (2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 4-010-01 | (2012; with Change 1) DoD Minimum Antiterrorism Standards for Buildings |

U.S. DEPARTMENT OF ENERGY (DOE)

| | |
|---|---|
| Energy Star | (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP) |

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

| | |
|---|---|
| 40 CFR 82 | Protection of Stratospheric Ozone |
| PL 109-58 | Energy Policy Act of 2005 (EPAct05) |

UL ENVIRONMENT (ULE)

ULE Greenguard UL Greenguard Certification Program

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 6 | (2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel |
| UL 705 | (2004; Reprint Mar 2016) UL Standard for Safety Power Ventilators |
| UL Bld Mat Dir | (2012) Building Materials Directory |

## 1.2 SYSTEM DESCRIPTION

Provide low-pressure systems ductwork and plenums where maximum air velocity is 2,000-feet per minute(fpm) and maximum static pressure is 2-inches water gage (wg), positive or negative.

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.

### 1.2.1 Mechanical Equipment Identification

The number of charts and diagrams shall be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.2.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

1.2.1.2 Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. provide neat mechanical drawings provided with extruded aluminum frame under 1/8-inch glass or laminated plastic, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.

1.2.2 Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Labels shall be in accordance with the typical examples below:

| SERVICE | LABEL AND TAG DESIGNATION |
|---|---|
| Air handling unit Number | AHU - _____ |
| Heat Pump Number | HP - _____ |
| Exhaust Fan Number | EF - _____ |
| Supply Fan Number | SF - _____ |

Identify similar services with different temperatures or pressures. Where pressures could exceed 125 pounds per square inch, gage, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

a. Each point of entry and exit of pipe passing through walls.

b. Each change in direction, i.e., elbows, tees.

c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 75 feet. All labels shall be visible and legible from the primary service and operating area.

| For Bare or Insulated Pipes | |
|---|---|
| for Outside Diameters of | Lettering |
| 1/2 thru 1-3/8 inch | 1/2 inch |
| 1-1/2 thru 2-3/8 inch | 3/4 inch |
| 2-1/2 inch and larger | 1-1/4 inch |

1.2.3 Color Coding

Color coding of all piping systems shall be in accordance with ASME A13.1.

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Insulated Nonmetallic Flexible Duct Runouts

Metal Ductwork

Duct Connectors

Duct Access Doors

Manual Balancing Dampers

Backdraft Dampers

Screens

Sidewall Propeller Fans

Test Procedures

Diagrams

SD-06 Test Reports

Ductwork Leak Tests

Testing, Adjusting, and Balancing

Performance Tests

Damper Acceptance Test

SD-07 Certificates

Bolts

Certification

Ozone Depleting Substances

Ductwork Materials

Manual Balancing Dampers

Backdraft Dampers

Duct Connectors

Screens

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

Manual Balancing Dampers

Backdraft Dampers

Sidewall Propeller Fans

## 1.4 QUALITY REQUIREMENTS

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.

d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or Energy Star certified product categories, equipment selected shall have as a minimum the efficiency rating identified under "Energy-Efficient Products" at http://www1.eere.energy.gov/femp/procurement.

   These specifications conform to the efficiency requirements as defined in Public Law PL 109-58, "Energy Policy Act of 2005" for federal procurement of energy-efficient products. Equipment having a lower efficiency than Energy Star or FEMP requirements may be specified if

the designer determines the equipment to be more life-cycle cost effective using the life-cycle cost analysis methodology and procedure in 10 CFR 436.

### 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. Provide written certification from the bolt Manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, and the number of each type of bolt to be furnished in the certification.

### 1.4.2 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 equipment containing refrigerants must comply with the following:

a. Do not knowingly vent or otherwise release into the environment, Class I or Class II substances used as a refrigerant.

b. Do not open appliances without meeting the requirements of 40 CFR 82 Part 82.156 Subpart F, regarding required practices for evacuation and collection of refrigerant, and 40 CFR 82 Part 82.158 Subpart F, regarding standards of recycling and recovery equipment.

c. Only persons who comply with 40 CFR 82 Part 82.161 Subpart F, regarding technician certification, can conduct Work on appliances containing refrigerant.

In addition, provide copies of all applicable certifications to the Construction Manager at least 14 calendar days prior to initiating maintenance, repair, servicing, dismantling or disposal of appliances, including:

a. Proof of Technician Certification

b. Proof of Equipment Certification for recovery or recycling equipment.

c. Proof of availability of certified recovery or recycling equipment.

### 1.4.4 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 Construction Manager. The waiver will be evaluated and dispositioned.

### 1.4.5 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the Work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

### 1.4.6 Test Procedures

Submit proposed test procedures and test schedules for the ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

## 1.5 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 5 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. Include purchaser, address of installation, service organization, and date of installation. Products having less than a 5-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.

### 2.2 STANDARD PRODUCTS

Except for the fabricated duct, plenums and casings specified in paragraphs "Metal Ductwork" and "Plenums and Casings for Field-Fabricated Units", provide components and equipment that are standard products of Manufacturers regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. This requirement applies to all equipment, including diffusers, registers, and balancing dampers.

a. Standard products are defined as components and equipment that have been in satisfactory commercial or industrial use in similar applications of similar size for at least five years before bid opening.

b. Prior to this five year period, these standard products shall have been sold on the commercial market using advertisements in Manufacturers' catalogs or brochures. These Manufacturers' catalogs, or brochures shall have been copyrighted documents or have been identified with a Manufacturer's document number.

c. Provide equipment items that are supported by a service organization. In product categories covered by Energy Star or the Federal Energy Management Program, provide equipment that is listed on the Energy Star Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

### 2.3 IDENTIFICATION PLATES

In addition to standard Manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Identification plates shall be three layers, black-white-black, engraved to show white letters on black background. Letters shall be upper case. Identification plates 1-1/2-inches high and smaller shall be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high shall be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger shall

have beveled edges. Install identification plates using a compatible adhesive.

## 2.4 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard.

## 2.5 ELECTRICAL WORK

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include Manufacturer provided controllers with the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Integral size motors shall be the premium efficiency type in accordance with NEMA MG 1.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system , and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

## 2.6 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment Manufacturer and located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

## 2.7 SEISMIC ANCHORAGE

Anchor equipment in accordance with applicable seismic criteria for the area and as defined in SMACNA 1981 and Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.

## 2.8 PAINTING

Paint equipment units in accordance with approved equipment Manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing.

## 2.9 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

## 2.10 DUCT SYSTEMS

### 2.10.1 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 ductwork materials of aluminum construction and constructed meeting the requirements for the duct system static pressure specified in APPENDIX D of Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.

c. Provide two-piece type miter elbows for angles less than 31 degrees, three-piece type for angles 31 through 60 degrees, and five-piece type for angles 61 through 90 degrees. Ensure centerline radius of elbows is 1-1/2 times fitting cross section diameter.

d. Provide ductwork that meets the requirements of Seal Class C. Limit crossbreaking to 4-feet and provide on all ducts 8-inches wide and wider. Provide bead reinforcement in lieu of crossbreaking where panel popping may occur. Where rigid insulation is applied, crossbreaking is not required.

e. Provide sealants that conform to fire hazard classification and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant.

f. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the

male portion of the slip fitting collar are not acceptable. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

g. Low pressure ductwork minimum thickness are:

| MINIMUM SHEET METAL THICKNESS | |
|---|---|
| **DUCT WIDTH INCHES** | **GAGE** |
| 0-12 | 22 |
| 13-30 | 20 |
| 31-60 | 18 |

2.10.1.1 General Service Duct Connectors

Provide a flexible duct connector approximately 12 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardant fabrics" in UL Bld Mat Dir.

Fabric for flexible connection shall be Neoprene coated glass fabric suitable for a temperature range of -20 degrees Fahrenheit to 180 degrees Fahrenheit and shall have a weight of at least 27 ounces per square yard and a thickness of 0.024 inches.

2.10.1.2 High Temperature Service Duct Connections

Provide material that is approximately 3/32 inch thick, 35 to 40-ounce per square yard weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 1200 degrees F.

2.10.1.3 Aluminum Ducts

ASTM B209, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.10.1.4 Fittings

Make divided flow fittings as separate fittings, not tap collars into duct sections, with the following construction requirements:

a. Sound, airtight, continuous welds at intersection of fitting body and tap.

b. Tap liner securely welded to inner liner, with weld spacing not to exceed 3 inches.

c. Pack insulation around the branch tap area for complete cavity filling.

d. Carefully fit branch connection to cutout openings in inner liner without spaces for air erosion of insulation and without sharp projections that cause noise and airflow disturbance.

Continuously braze seams in the pressure shell of fittings. Protect galvanized areas that have been damaged by welding with Manufacturer's standard corrosion-resistant coating.

Construct two-piece type elbows for angles through 35 degrees, three-piece type for angles 36 through 71 degrees, and five-piece type for angles 72 through 90 degrees.

2.10.1.5 Duct Hangers and Supports

For duct hangers in contact with aluminum duct surfaces, provide hot dipped galvanized steel painted with inorganic zinc and installed as indicated on drawings.

2.10.2 Insulated Nonmetallic Flexible Duct Runouts

Flexible ductwork liner shall be spunbonded non-woven nylon porous surface for sound absorption. Provide high carbon spring steel helix with zinc coating and fiberglass insulation with thermal resistance R rating of 4.2. Outer jacket shall be gray polyethylene jacket rated as UL Class 1 with 0.05 perm rating. Provide end treatment with adjustable male/female aluminum collars with stainless steel clamps to hold duct to collar. Design pressure shall be 1.5 inches positive and 0.5 inches water column negative. Flexible duct shall be rated for up to 4,000 feet per minute continuous operation and friction loss to not exceed more than 0.15 inches water column per 100 feet at 500 cubic feet per minute for 12 inch diameter duct.

2.10.3 Duct Access Doors

Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.10.4 Manual Balancing Dampers

Construct low pressure drop, high-velocity manual balancing dampers in accordance with ASHRAE EQUIP IP HDBK, ASHRAE FUN IP, and SMACNA 1966.

Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators.

Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide access doors

or panels in hard ceilings, partitions and walls for access to all concealed damper operators and damper locking setscrews. Coordinate location of doors or panels with other affected contractors.

Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Stand-off mounting items shall be integral with the operator or standard accessory of the damper Manufacturer.

2.10.4.1 Square or Rectangular Dampers

2.10.4.1.1 Duct Height 12 inches and Less

2.10.4.1.1.1 Frames

| Width | Height | Aluminum Thickness | Length |
|---|---|---|---|
| Maximum 19 inches | Maximum 12 inches | Minimum 20 gauge | Minimum 3 inches |
| More than 19 inches | Maximum 12 inches | Minimum 16 gauge | Minimum 3 inches |

2.10.4.1.1.2 Single Leaf Blades

| Width | Height | Aluminum Thickness | Length |
|---|---|---|---|
| Maximum 19 inches | Maximum 12 inches | Minimum 20 gauge | Minimum 3 inches |
| More than 19 inches | Maximum 12 inches | Minimum 16 gauge | Minimum 3 inches |

2.10.4.1.1.3 Blade Axles

To support the blades of round dampers, provide aluminum shafts supporting the blade the entire duct diameter frame-to-frame. Axle shafts shall extend through standoff bracket and hand quadrant.

| Width | Height | Material | Square Shaft |
|---|---|---|---|
| Maximum 19 inches | Maximum 12 inches | Aluminum | Minimum 3/8 inch |
| More than 19 inches | Maximum 12 inches | Aluminum | Minimum 1/2 inch |

2.10.4.1.1.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings. Shaft bearings configuration shall be a pressed fit to provide a tight joint between blade shaft and damper frame.

| Width | Height | Material |
|---|---|---|
| Maximum 19 inches | Maximum 12 inches | solid nylon, or equivalent solid plastic, or oil-impregnated bronze |
| More than 19 inches | Maximum 12 inches | oil-impregnated bronze |

2.10.4.1.1.5 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Stand-off distance shall be a minimum of 2 inches off the metal duct surface. Stand-off mounting items shall be integral with the operator or standard accessory of the damper Manufacturer.

2.10.4.1.1.6 Finish

Mill aluminum

2.10.4.1.2 Duct Height Greater than 12 inches

2.10.4.1.2.1 Dampers

Provide dampers with multi-leaf opposed-type blades.

2.10.4.1.2.2 Frames

Maximum 48 inches in height; maximum 48 inches in width; minimum of 16 gauge aluminum, minimum of 5 inches long.

2.10.4.1.2.3 Blades

Minimum of 16 gauge aluminum; 6 inch nominal width.

2.10.4.1.2.4 Blade Axles

To support the blades of round dampers, provide aluminum square steel shafts supporting the blade the entire duct diameter frame-to-frame. Axle shafts shall extend through standoff bracket and hand quadrant.

2.10.4.1.2.5 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, or solid nylon, or a solid plastic equivalent to nylon. Shaft bearings configuration shall be a pressed fit to provide a tight joint between blade shaft and damper frame.

2.10.4.1.2.6 Blade Actuator Linkage

Mill aluminum bar and crank plate with stainless steel pivots.

2.10.4.1.2.7 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Stand-off distance shall be a minimum of 2 inches off the metal duct surface. Stand-off mounting items shall be integral with the operator or standard accessory of the damper Manufacturer.

2.10.4.1.2.8 Finish

Mill aluminum.

2.10.5 Backdraft dampers

Where outdoor air supply and exhaust air dampers are required they shall have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - IP or UFC 4-010-01, including maximum Damper Leakage for:

a. Climate Zones 1,2,6,7,8 the maximum damper leakage at 1.0 inch w.g. for motorized dampers is 4 cfm per square foot of damper area and non-motorized dampers are not allowed.

b. All other Climate Zones the maximum damper leakage at 1.0 inch w.g. is 10 cfm per square foot and for non-motorized dampers is 20 cfm per square foot of damper area.

Dampers smaller than 24 inches in either direction may have leakage of 40 cfm per square foot.

Provide low pressure opening at 0.01 inches water column in rectangular ducts or wall mounting for spot air velocities up to 2,500 feet per minute; weather resistant for exhaust applications.

2.10.5.1 Frames

Frame to be 2.25 inches deep, and have a minimum thickness of 0.125 inches. To be constructed of 6063T5 aluminum with insect screen and water stop.

2.10.5.2 Blades

Blades to be a minimum thickness of 0.070 inches and constructed of 6063T5 aluminum with Zytel bearings, elastomer edge seals, and aluminum tie-bar.

Blades to require no more than 4.25 inches clearance beyond frame when fully open.

2.10.5.3 Counterbalance

Counterbalance to be zinc plated bar on blades and adjustable down to 0.01 inch water column opening.

2.10.5.4 Finish

Finish to be Kynar in Manufacturer's standard colors to be selected by the District.

2.10.5.5 Damper Operators

Provide manual damper operator for each damper furnished.

2.10.5.5.1 Manual Operators

Gears or mechanical, to operate damper manually with a force not exceeding 20 pounds.

Provide manual operators with locking quadrant.

Provide 3/8 inch, or larger, square double-ended drive shaft adequate for required damper torque.

Provide sufficient number of operators for torque required to operate damper.

2.10.6 Plenums and Casings for Field-Fabricated Units

2.10.6.1 Plenum and Casings

Fabricate and erect plenums and casings as shown in SMACNA 1966, as applicable. Construct system casing of not less than 16 gauge galvanized sheet steel. Furnish cooling coil drain pans with 1 inch threaded outlet to collect condensation from the cooling coils. Fabricate drain pans from not lighter than 16 gauge steel, galvanized after fabrication or of 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304, welded and stiffened. Thermally insulate drain pans exposed to the atmosphere to prevent condensation. Coat insulation with a flame resistant waterproofing material. Provide separate drain pans for each vertical coil section, and a separate drain line for each pan. Size pans to ensure capture of entrained moisture on the downstream-air side of the coil. Seal openings in the casing, such as for piping connections, to prevent air leakage. Size the water seal for the drain to maintain a pressure of at least 2 inch water gauge greater than the maximum negative pressure in the coil space.

2.10.6.2 Casing

Terminate casings at the curb line and bolt each to the curb using galvanized angle, as indicated in SMACNA 1966.

2.10.6.3 Access Doors

Provide access doors in each section of the casing. Weld doorframes in place, gasket each door with neoprene, hinge with minimum of two brass hinges, and fasten with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, make doors 36 by 18 inches and locate them 18 inches above the floor. Where the space available does not accommodate doors of this size, use doors as large as the space accommodates. Swing doors so that fan suction or pressure holds doors in closed position, airtight. Provide a push-button station, located inside the casing, to stop the supply.

2.10.6.4 Factory-Fabricated Insulated Sheet Metal Panels

Factory-fabricated components are allowed for field-assembled units, provided all requirements specified for field-fabricated plenums and casings are met. Provide panels of modular design, pretested for structural strength, thermal control, condensation control, and acoustical control. Seal and insulate panel joints. Provide and gasket access doors to prevent air leakage. Provide panel construction that is not less than 20 gauge galvanized sheet steel, assembled with fasteners treated against corrosion. Provide standard length panels that deflect not more than 1/2 inch under operation. Construct details, including joint sealing, not specifically covered, as indicated in SMACNA 1966. Construct the plenums and casings to withstand the specified internal pressure of the air systems.

2.10.6.5 Duct Liner

Unless otherwise specified, duct liner is not permitted.

2.10.7 Louvers

Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section 08 91 00 METAL WALL LOUVERS.

2.10.8 Screens and Frames

Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.11 AIR SYSTEMS EQUIPMENT

2.11.1 Fans

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans shall not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than 150 percent of the connected driving capacity. Provide variable pitch motor sheaves for 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide

fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

#### 2.11.1.1 Sidewall Propeller Fans

Provide wall-mounted, low noise propeller type. The fans shall be licensed to bear the AMCA certified ratings seal and listed in AMCA 261. Provide Manufacturer's constant speed performance curves for the rpm of the fans furnished indicating brake horsepower and cfm at all static pressures along the fan curve. Fan is to be statically and dynamically balanced propeller with aluminum blades, unless noted otherwise. Provide permanently lubricated motor, selected to avoid running in service factor. Provide motor and fan side OSHA guards. Provide wall mount collar when necessary as indicated in drawings. Provide dampers with damper guards when scheduled. Provide bird screen if no screen is listed in schedule. Provide a complete heavy duty assembly including a corrosive resistant housing and/or frame, gravity backdraft damper, suitable gaskets, closure pieces, and mounting holes. Coat fan, housing, and accessories with polyester finish. Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have totally enclosed enclosures. Provide junction box and disconnect switch as required for electrical connection. Coordinate location and size of fan openings with other affected contractors.

### 2.11.2 Air Filters

Filters to be 2 inches deep and washable aluminum mesh type.

#### 2.11.2.1 Holding Frames

Fabricate frames from not lighter than 16 gauge sheet aluminum with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

## PART 3 EXECUTION

### 3.1 EXAMINATION

After becoming familiar with all details of the Work, verify all dimensions in the field, and advise the Construction Manager of any discrepancy before performing the Work.

### 3.2 INSTALLATION

a. Install materials and equipment in accordance with the requirements of the contract drawings and approved Manufacturer's installation instructions. Accomplish installation by workers skilled in this type of Work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors

that clears a minimum of 3 feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related Work practices)and an additional 3 feet.

c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

### 3.2.1 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, fans, coils, dampers, and other similar items requiring supports. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment Manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 31 01.00 10 CAST-IN-PLACE CONCRETE.

### 3.2.2 Access Panels

Construct access door in accordance with SMACNA 1966, except that sliding doors may be used only for special conditions upon prior approval. Provide double-panel type doors.

Install access doors and panels in ductwork upstream from coils at controls or at any item requiring periodic inspection, adjustment, maintenance, or cleaning where indicated, and every 20-feet for indoor air quality housekeeping purposes.

Minimum access opening size is 12 by 18-inches, unless precluded by duct dimensions or otherwise indicated.

Make airtight access doors that leak by adding or replacing hinges and latches or by construction of new doors adequately reinforced, hinged, and latched.

### 3.2.3 Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the Manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct Manufacturer and set at the intervals recommended.

### 3.2.4 Metal Ductwork

Provide sheet metal construction in accordance with the recommendations for best practices in ASHRAE EQUIP IP HDBK, ASHRAE FUN IP, SMACNA 1966, and NFPA 90A.

Design and fabricate supplementary steel in accordance with AISC 360 and AISC 325.

Where construction methods for certain items are not described in the referenced standards or herein, perform the Work in accordance with recommendations for best practice defined in ASHRAE EQUIP IP HDBK.

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

### 3.2.5 Jointing

Enclose dampers located behind architectural intake or exhaust louvers by a rigid sheet metal collar and sealed to building construction with elastomers for complete air tightness.

Provide outside air-intake ducts and plenums made from sheet metal with soldered watertight joints.

### 3.2.6 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.

### 3.2.7 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment. Externally insulate outdoor air intake ducts and plenums up to the point where the outdoor air reaches the conditioning unit or up to the point where the outdoor air mixes with the return air stream.

### 3.2.8 Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

### 3.2.9 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings

to within 50 percent of Manufacturer's maximum allowable range of misalignment.

3.2.10 Duct Transitions

Where the shape of a duct changes, ensure the angle of the side of the transition piece does not exceed 15 degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, ensure the angle of the side of the transition piece from the straight run of duct connected thereto does not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.2.11 Fans

Furnish all labor, materials and equipment necessary to make a complete installation as indicated on the Drawings and specified.

Do not install equipment or material until compliance submittals are approved.

Provide all necessary supports, brackets or foundations for properly installing all equipment.

Coordinate with the other trades before installation of materials. No extra charges shall be approved for interferences due to lack of coordination.

All equipment shall be properly aligned, adjusted and lubricated before final acceptance.

Be responsible for all added expenses due to choice of equipment.

Install all material at times necessary to avoid delays in construction.

Provide sleeves and flashings for all piping and ductwork penetrating walls. Provide all required openings in walls

Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

Form tight joints with exposed connections accurately located and secured.

Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective work. Return items that cannot be refinished in the field to the shop, make required alterations, and refinish entire unit, or provide new units.

Protect galvanized and nonferrous metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

Install concealed gaskets, flashings, joint fillers, and insulation, as equipment installation progresses, where required to make all joints weathertight.

## 3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 3-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of 28 calendar days before being loaded.

## 3.4 CUTTING AND PATCHING

Install Work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

## 3.5 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the Work area is in an occupied space such as office, laboratory or warehouse protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction Work that leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

## 3.6 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

### 3.6.1 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.

### 3.6.2 Framed Prepared Openings

Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

### 3.6.3 Insulation

Provide duct insulation through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

### 3.6.4 Closure Collars

Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.

## 3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat. Additional requirements for field painting of items and surfaces not specifically noted otherwise, are specified in Section 09 06 90 PAINTS AND COATINGS.

### 3.7.1 Temperatures less than 120 degrees F

Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat to metal surfaces subject to temperatures less than 120 degrees F.

### 3.7.2 Temperatures between 120 and 400 degrees F

Apply two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of two mils to metal surfaces subject to temperatures between 120 and 400 degrees F.

### 3.7.3 Temperatures greater than 400 degrees F

Apply two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of two mils to metal surfaces subject to temperatures greater than 400 degrees F.

### 3.7.4 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 06 90 PAINTS AND COATINGS.

### 3.7.5 Color Coding Scheme for Locating Hidden Utility Components

Use scheme in buildings having suspended grid ceilings. Provide color coding scheme that identifies points of access for maintenance and operation of components and equipment that are not visible from the finished space and are accessible from the ceiling grid, consisting of a color code board and colored metal disks. Make each colored metal disk approximately 3/8 inch diameter and secure to removable ceiling panels with fasteners. Insert each fastener into the ceiling panel so as to be concealed from view. Provide fasteners that are manually removable without the use of tools and that do not separate from the ceiling panels when the panels are dropped from ceiling height. Make installation of colored metal disks follow completion of the finished surface on which the disks are to be fastened. Provide color code board that is approximately 3 foot wide, 30 inches high, and 1/2 inches thick. Make the board of wood fiberboard and frame under glass or 1/16 inch transparent plastic cover. Make the color code symbols approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. Mount the color code board where indicated.

## 3.8 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

## 3.9 DUCTWORK LEAK TESTS

The requirements for ductwork leak tests are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

## 3.10 DAMPER ACCEPTANCE TEST

Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Test each fire damper equipped with fusible link by having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.

## 3.11 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

## 3.12 PERFORMANCE TESTS

After testing, adjusting, and balancing is complete as specified, test each system as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Record the testing during the applicable season. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Conduct capacity tests and general operating tests by an experienced engineer. Make coincidental chart recordings at points indicated on the drawings for the duration of the time period and record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

Submit test reports for the ductwork leak test, and performance tests in booklet form, upon completion of testing. Document phases of tests performed including initial test summary, repairs/adjustments made, and final test results in the reports.

## 3.13 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and install new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the Manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the Manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

## 3.14 OPERATION AND MAINTENANCE

### 3.14.1 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 05 OPERATION AND MAINTENANCE INFORMATION.

### 3.14.2 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Construction Manager. Make the training period consist of a total of 8 hours of normal working time and start it after all Work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

# SECTION 23 03 00.00 20

# BASIC MECHANICAL 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 within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B117 | (2016) Standard Practice for Operating Salt Spray (Fog) Apparatus |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C2 | (2017; Errata 1 2017) National Electrical Safety Code |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (2016; SUPP 2016) Motors and Generators |
| NEMA MG 10 | (2013) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors |
| NEMA MG 11 | (1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |

### 1.2 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 21, FIRE SUPPRESSION; 22, PLUMBING; and 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

### 1.3 QUALITY REQUIREMENTS

#### 1.3.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of Manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, Manufacturers' catalogs, or brochures during the 2 year period.

1.3.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the Manufacturer's factory or laboratory tests, can be shown.

1.3.3 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Manufacturer's Nameplate

For each item of equipment, provide 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.

1.3.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" 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 Construction Manager

1.3.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Construction Manager." For District owned property, references to the "owner" must be interpreted to mean the "District." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.3.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the District to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Construction Manager as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the Manufacturer's

recommendations, and as approved by the Construction Manager. Replace damaged or defective items.

## 1.5 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

## 1.6 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations must conform to IEEE C2, NFPA 70, and requirements specified herein.

### 1.6.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters (except starters/controllers which are indicated as part of a motor control center), control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not to be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, the motor control equipment forming a part of motor control centers, and the electrical power circuits must be provided under Division 26, except internal wiring for components of package equipment must be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the Work for the section specifying that motor or equipment.

### 1.6.2 High Efficiency Motors

#### 1.6.2.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors must be high efficiency types corresponding to the applications listed in NEMA MG 11.

#### 1.6.2.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors must be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with

continuous ratings must meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

### 1.6.3 Three-Phase Motor Protection

Provide controllers for motors rated one 1 horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

## 1.7 ACCESSIBILITY

Install all Work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

# PART 2 PRODUCTS

Not Used

# PART 3 EXECUTION

## 3.1 PAINTING OF NEW EQUIPMENT

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

### 3.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If Manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system must be designed for the temperature service.

### 3.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and

retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of 1 mil; and two coats of enamel applied to a minimum dry film thickness of 1 mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F must receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F must receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

-- End of Section --

# SECTION 23 05 48.00 40

# VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

## PART 1 GENERAL

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to Work specified in this section to the extent applicable.

### 1.1 REFERENCES

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

ACOUSTICAL SOCIETY OF AMERICA (ASA)

| | |
|---|---|
| ASA S2.71 | (1983; R 2006) Guide to the Evaluation of Human Exposure to Vibration in Buildings |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE HVAC APP IP HDBK | (2016) HVAC Applications Handbook, I-P Edition |

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

| | |
|---|---|
| NEBB PROCEDURAL STANDARDS | (2005) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems |

### 1.2 ADMINISTRATIVE REQUIREMENTS

Within ten working days of Contract Award, submit equipment and performance data for vibration isolator systems including equipment base design; inertia-block mass relative to support equipment weight; spring loads and free, operating, and solid heights of spring; spring diameters; nonmetallic isolator loading and deflection; disturbing frequency; natural frequency of mounts; deflection of working member; and anticipated amount of physical movement at the reference points.

Ensure the data includes information on the following:

a. Mountings

b. Bases

c. Isolators

d. Floor-Mounted Piping

e. Vertical Piping

Five working days prior to commencement of installation, submit installation drawings for vibration isolator systems including equipment and performance requirements.

Indicate within outline drawings for vibration isolator systems, overall physical features, dimensions, ratings, service requirements, and weights of equipment.

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings

Outline Drawings

SD-03 Product Data

Equipment and Performance Data, including isolators

SD-06 Test Reports

Type of Isolator

Type of Base

Allowable Deflection

Measured Deflection

Tests and Reports

1.4 QUALITY REQUIREMENTS

Ensure all vibration-control apparatus is the product of a single manufacturing source, where possible. Human exposure levels should be considered using ASA S2.71 and NEBB PROCEDURAL STANDARDS.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Scheduled isolation mounting is in inches and is a minimum static deflection.

Spans referred to in paragraph EQUIPMENT, means longest bay dimension.

Determine exact mounting sizes and number of isolators by the isolator Manufacturer based on equipment that will be installed. Check equipment revolutions per minute (rpm) and spring deflections to verify that resonance cannot occur.

2.1.1 Design Requirements

Design for vibration isolation using NEBB PROCEDURAL STANDARDS and ASHRAE HVAC APP IP HDBK as applicable to the following sections.

2.1.1.1 Mountings

Provide the following mountings:

Type A: Composite pad, with 0.25-inch thick elastomer top and bottom layers, molded to contain a pattern with nonslip characteristics in all horizontal directions. Elastomer loading is not to exceed 40 pounds per square inch (psi). Ensure minimum overall thickness is 1 inch. Maximum deflections up to 0.25-inch are allowed.

Type B: Double elastomer-in-shear with molded-in steel reinforcement in top and bottom. Maximum deflections up to 0.50-inch are allowed.

Type C: Free-standing laterally stable open-spring type for deflections over 0.50-inch, with built-in bearing and leveling provisions, 0.25-inch thick Type A base elastomer pads, and accessories. Ensure outside diameter of each spring is equal to or greater than 0.9 times the operating height of the spring under rated load.

Type D: Partially housed type, containing one or more vertically restrained springs with at least 0.50-inch clearance maintained around springs, with adjustable limit stops, 0.25-inch thick Type A base elastomer pads, and accessories.

2.1.1.2 Bases

Provide the following bases:

Type U: Unit isolators without rails, structural-steel bases, or inertia blocks.

Type R: Rails, disconnected mill-rolled structural steel, of sufficient dimension to preclude deflection at midpoint of unsupported span in excess of 1/1,440th of the span between isolators, power transmission, component misalignment, and any overhung weight. Where Type R bases are specified and the equipment proposed requires additional base support, use a Type S base.

Type S: Structural-steel bases common to a supported assembly, made from welded-joint mill-rolled structural steel with closed-perimeter configuration, isolators attached to outrigger supports.

Ensure height of steel members is sufficient to provide stiffness required to maintain equipment Manufacturer's recommended alignment and duty efficiency of power-transmission components. Ensure height of steel member does not result in member deflection at midpoint of unsupported span of more than 1/1,440th of the span between isolators. Minimum height is 5-inches.

## 2.2 EQUIPMENT

Vibration isolation design per NEBB PROCEDURAL STANDARDS and ASHRAE HVAC APP IP HDBK.

### 2.2.1 Floor-Mounted Piping

Type K: Provide isolators with springs mounted on floor-supported columns or directly on the floor. Load devices by supported system during operating conditions to produce a minimum spring static deflection of 1-inch.

### 2.2.2 Vertical Piping

Type L: Provide isolators which are pipe base-support devices with one or more contained steel springs. Load devices by supported system during operating conditions to produce a minimum static deflection of 1-inch. Equip devices with precompression and vertical-limit features, as well as a minimum 1/4-inch thick elastomer sound pad and isolation washers, for mounting to floor.

Type M: Provide isolators which are elastomer mounted baseplate and riser pipe-guide devices, with contained double acting elastomer elements which under rated load have a minimum static deflection of 3/8-inch. Size isolator to accommodate thermal insulation within the stationary guide ring.

## 2.3 MATERIALS

Ensure rubber is natural rubber and elastomer is chloroprene. Shore A durometer measurement of both materials and range between 40 and 60.

Inorganic materials such as precompressed, high-density, fibrous glass encased in a resilient moisture-impervious membrane may be used in lieu of specified natural rubber and elastomers. Where this substitution is made, ensure specified deflections are modified by the manufacturing source to accommodate physical characteristics of inorganic materials and to provide equal or better vibration isolation.

Ensure weather-exposed metal vibration-isolator parts are corrosion protected. Chloroprene coat springs.

## 2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit test reports for testing vibration isolation for each type of isolator and each type of base. Meet referenced standards contained within this section. Include in test reports allowable deflection and measured deflection also meeting referenced standards within this section.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Install equipment in accordance with Manufacturer's recommendations.

Ensure rails, structural steel bases, and concrete inertia blocks are raised not less than 1-inch above the floor and are level when equipment supported is under operating load.

Ensure vibration-isolation installation and deflection testing after equipment start-up is directed by a competent representative of the Manufacturer.

## 3.2 FIELD QUALITY CONTROL

### 3.2.1 Tests and Reports

Ensure vibration-isolation devices are deflection tested. Submit test reports substantiating that all equipment has been isolated as specified and that minimum specified deflections have been met. Make all measurements in the presence of the Construction Manager.

-- End of Section --

# SECTION 23 05 93

# TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 GENERAL

### 1.1 REFERENCES

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

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

| | |
|---|---|
| AMCA 203 | (1990; R 2011) Field Performance Measurements of Fan Systems |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 62.1 | (2010) Ventilation for Acceptable Indoor Air Quality |

ASSOCIATED AIR BALANCE COUNCIL (AABC)

| | |
|---|---|
| AABC MN-1 | (2002; 6th ed) National Standards for Total System Balance |
| AABC MN-4 | (1996) Test and Balance Procedures |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

| | |
|---|---|
| RCBEA GUIDE | (2004) NASA Reliability Centered Building and Equipment Acceptance Guide |

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

| | |
|---|---|
| NEBB MASV | (2006) Procedural Standards for Measurements and Assessment of Sound and Vibration |
| NEBB PROCEDURAL STANDARDS | (2005) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems |

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

| | |
|---|---|
| SMACNA 1780 | (2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition |
| SMACNA 1858 | (2004) HVAC Sound And Vibration Manual - First Edition |
| SMACNA 1972 CD | (2012) HVAC Air Duct Leakage Test Manual - 2nd Edition |

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

40 CFR 82 Protection of Stratospheric Ozone

1.2 DEFINITIONS

a. AABC: Associated Air Balance Council

b. COTR: Construction Manager's Technical Representative

c. DALT: Duct air leakage test

d. DALT'd: Duct air leakage tested

e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling

f. NEBB: National Environmental Balancing Bureau

g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means "a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction and sealant class.""a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING." When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."

h. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.

i. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.

j. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.

k. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

l. TAB: Testing, adjusting, and balancing (of HVAC systems)

m. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed

n. TAB Agency: TAB Firm

o. TAB team field leader: TAB team field leader

p. TAB team supervisor: TAB team engineer

q. TAB team technicians: TAB team assistants

o. TAB team field leader: TAB team field leader

p. TAB team supervisor: TAB team engineer

q. TAB team technicians: TAB team assistants

r. TABB: Testing Adjusting and Balancing Bureau

1.2.1 Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

| **SIMILAR TERMS** | | | |
|---|---|---|---|
| **Contract Term** | **AABC Term** | **NEBB Term** | **TABB Term** |
| TAB Standard | National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems | Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems | International Standards for Environmental Systems Balance |
| TAB Specialist | TAB Engineer | TAB Supervisor | TAB Supervisor |
| Systems Readiness Check | Construction Phase Inspection | Field Readiness Check & Preliminary Field Procedures | Field Readiness Check & Prelim. Field Procedures |

1.3 WORK DESCRIPTION

The Work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings, including records of existing conditions.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

1.3.1 Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Construction Manager's written approval before applying insulation to exterior of air distribution systems as specified.

1.3.2 TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.

2. Air quantities at air terminals.

3. Air quantities and temperatures in air handling unit schedules.

4. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications: http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf

The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Construction Manager of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation. The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Construction Manager of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

Submit three copies of the TAB Schematic Drawings and Report Forms to the Construction Manager, no later than 21 days prior to the start of TAB field measurements.

1.3.3 Related Requirements

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to Work specified in this section.

Specific requirements relating to Reliability Centered Maintenance (RCM) principals and Predictive Testing and Inspection (PTI), by the construction Contractor to detect latent manufacturing and installation defects must be followed as part of the Contractor's Quality Control program. Refer to the paragraph SUSTAINABILITY for detailed requirements.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Records of Existing Conditions

Independent TAB Agency and Personnel Qualifications

TAB Design Review Report

TAB Firm

Prerequisite HVAC Work Checkout List

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms

SD-03 Product Data

TAB Related HVAC Submittals

A list of TAB related HVAC submittals, no later than 7 days after the approval of the TAB team engineer

TAB Procedures

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

Calibration

Systems Readiness Check

TAB Execution

TAB Verification

SD-06 Test Reports

Completed Pre-Final DALT Report

Certified Final DALT Report

Prerequisite HVAC Work Checkout List for Season 1

Prerequisite HVAC Work Checkout List for Season 2

TAB Design Review Report

TAB Report for Season 1

TAB Report for Season 2

SD-07 Certificates

Independent TAB Agency and Personnel Qualifications

DALT and TAB Submittal and Work Schedule

TAB Pre-Field Engineering Report

Instrument Calibration Certificates

DALT and TAB Procedures Summary

Completed Pre-Final DALT Work Checklist

Advance Notice of Pre-Final DALT Field Work

Advance Notice of TAB Field Work for Proportional Balancing

Advance Notice of TAB Field Work for Season 1

Advance Notice of TAB Field Work for Season 2

TAB Firm

Design Review Report

Prerequisite HVAC Work Checkout List for Season 2

## 1.5 QUALITY REQUIREMENTS

### 1.5.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Construction Manager for approval:

a. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew

Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

b. TAB Team Members: TAB team approved to accomplish Work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Construction Manager.

1.5.1.1 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument Manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the Manufacturer's recommendations.

All quality requirements provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.1.2 Qualifications

a. TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including building systems commissioning and the measuring of sound and vibration in environmental systems.

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Construction Manager and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All Work specified in this Section and in other related Sections to be performed by the TAB Firm will be

considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

b. TAB Specialist

The TAB Specialist must be either a member of AABC, an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Construction Manager and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All Work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

c. TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process.

#### 1.5.1.3 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the District. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

### 1.5.2 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

#### 1.5.2.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

(1) Contract drawings and specifications

(2) Approved submittal data for equipment

(3) Construction work schedule

(4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and Work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.

e. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Construction Manager within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

(1) HVAC system installations are fully complete.

(2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

(3) DALT field checks for all systems are completed.

(4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

i. Advance notice: Furnish to the Construction Manager with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

j. Insulation work: For required DALT work , ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed, and sealed.

1.5.2.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

1.5.2.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Pre-DALT/TAB meeting: Attend meeting with Contractor.

c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the Work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.

e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Construction Manager.

f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.

g. Prerequisite HVAC work checkout list: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

h. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of one 8 hour workday duration.

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

(1) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workday duration. Review the TAB final report data and certify the TAB final report.

(2) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workday duration. Review the TAB final report data and certify the TAB final report.

k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Construction Manager, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise Season 1 and Season 2 TAB field check.

1.5.2.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the Work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

1.5.3 Sequencing and Scheduling

1.5.3.1 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.

Submit this schedule,and TAB Schematic Drawings, adapted for this particular contract, to the Construction Manager (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

Qualify TAB Personnel: Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

Pre-DALT/TAB Meeting: Within 30 calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

Design Review Report: Within 60 calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Construction Manager in writing within 5 days after completion.

Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Construction Manager.

Submit Final DALT Report: Within 15 calendar days after completion of successful DALT Work Field Check, submit TAB report.

Pre-Field TAB Engineering Report: Within 30 calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

Prerequisite HVAC Work Checkout List and Advanced Notice for TAB Field Work: At a minimum of 115 calendar days prior to CCD, submit prerequisite HVAC work checkout list for Season 1 certified as complete, and submit advance notice of TAB field work for Season 1 commencement.

Season 1 TAB Field Work: At a minimum of 90 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work.

Submit Season 1 TAB Report: Within 15 calendar days after completion of Season 1 TAB field work, submit Season 1 TAB report.

Season 1 TAB Field Check: 30 calendar days after Season 1 TAB report is approved by the Construction Manager, conduct Season 1 field check.

Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work.

Season 1 TAB Field Work: At a minimum of 90 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work; submit Season 1 TAB report; and conduct Season 1 field check.

Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work.

Prerequisite HVAC Work Checkout List For Season 2 and Advanced Notice For Season 2 TAB Field Work: Within 150 calendar days after date of the commencement of the Season 1 TAB field work, submit the Season 2 prerequisite HVAC work checkout list certified as complete and submit advance notice of TAB field work for Season 2 commencement.

Season 2 TAB Field Work: Within 180 calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within 15 calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 TAB Field Check: 30 calendar days after the Season 2 TAB report is approved by the Construction Manager, conduct Season 2 field check.

Complete Season 2 TAB Work: Within 15 calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

Season 2 TAB Field Work: Within 180 calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work; submit Season 2 TAB report; and conduct Season 2 field check.

Complete Season 2 TAB Work: Within 15 calendar days after the completion of Season 2 field data check, complete TAB work.

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

b. Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Construction Manager in writing within 7 calendar days after completion.

1.5.3.2 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system.

Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checklist: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Construction Manager prior to the TAB team coming to the contract site.

At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

### 1.5.4 Instrument Calibration Certificates

It is the responsibility of the TAB firm to provide instrumentation that meets the minimum requirements of the standard under which the TAB Firm's qualifications are approved for use on a project. Instrumentation must be in proper operating condition and must be applied in accordance with the instrumentation's Manufacturer recommendations.

All instrumentation must bear a valid NIST traceable calibration certificate during field work and during District acceptance testing. All instrumentation must be calibrated within no later than one year of the date of TAB work or District acceptance testing field work.

### 1.5.5 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB,

including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument Manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the Manufacturer's recommendations.

All quality requirements provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.6 Sustainability

Contractor must submit the following as part of the Quality Control Plan for acceptance testing:

a. List all test equipment to be used, including its Manufacturer, model number, calibration date, and serial number.

b. Certificates of test personnel qualifications and certifications. Provide certification of compliance with 40 CFR 82.

c. Proof of equivalency if the Contractor desires to substitute a test requirement.

Perform the following PTI as an integral part of the TAB process per the most recent edition of the NASA RCBEA GUIDE:

Compressors:

a. Vibration Analysis

b. Balance Test and Measurement

c. Alignment (laser preferred)

d. Lubricating Oil Test

e. Thermodynamic Performance Test

f. Hydraulic Oil Test (optional)

Fans:

a. Vibration Analysis

b. Balance Test and Measurement

c. Alignment (laser preferred)

d. Lubricating Oil Test

e. Thermodynamic Performance Test

HVAC Ducts:

a. Operational Test

b. Ductwork Leak Testing (DALT); Pre-Final DALT report, Final DALT report

Piping Systems:

a. Vibration Analysis

b. Infrared Thermography

Valves:

a. Hydrostatic Test

b. Airborne Ultrasonic Test (optional)

c. Thermodynamic Performance Test (optional)

d. Infrared Thermography (optional)

1.5.7 Qualifications

1.5.7.1 TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems.

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Construction Manager and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All Work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

1.5.7.2 TAB Specialist

The TAB Specialist must be either a member of AABC,an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Construction Manager and submit another TAB Specialist for approval. Any individual that

has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All Work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

1.5.7.3 TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process as specified.

1.5.7.4 LIST OF TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the District. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.8 Test Reports

1.5.8.1 Data from DALT Field Work

Report the data for the Pre-final DALT Report and Certified Final DALT Report in compliance the following requirements:

a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.

b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition, provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.

c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.

d. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

1.5.8.2 Certified TAB Reports

Submit: TAB Report for Season 1 and TAB Report for Season 2 in the following manner:

a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.

b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

(1) Pump Room, Control Room, Kitchenette, Restroom, Janitor Closet, Lower Gallery. Measure and compile data on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Measure and record data only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls must be fully operational a minimum of 24 hours in advance of commencing data compilation. Include the specified data in the Season 1 and Season 2 TAB Report.

c. System Diagrams: Provide updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations. Use a key numbering system on the diagram which identifies each outlet contained in the outlet airflow report sheets.

d. Static Pressure Profiles: Report static pressure profiles for air duct systems. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. Include the following in the static pressure report data, in addition to AABC/NEBB/TABB required data:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils, and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.

e. Duct Traverses: Report duct traverses for main and branch main supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane."

f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument Manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

g. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

h. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's, and flow orifices TAB'd on the job.

## 1.6 SEQUENCING AND SCHEDULING

### 1.6.1 Projects with Phased Construction

This specification section is structured as though the HVAC construction, and thereby the TAB work, will be completed in a single phase. When the construction is completed in phases, the DALT work and TAB work must be planned, completed, and accepted for each construction phase.

#### 1.6.1.1 Phasing of Work

This specification section is structured as though the HVAC construction, and thereby the TAB work, is going to be completed in a single phase in spite of the fact that there will be two seasons. All elements of the TAB work are addressed on this premise. When a contract is to be completed in construction phases, including the TAB work, and the DALT work, the TAB work and DALT work must be planned for, completed and approved by the Construction Manager with each phase. An example of this case would be one contract that requires the rehabilitation of the HVAC in each of several separated buildings. At the completion of the final phase, compile all approved reports and submit as one document.

### 1.6.2 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.

Submit this schedule, and TAB Schematic Drawings, adapted for this particular contract, to the Construction Manager for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

1. Qualify TAB Personnel: Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

2. Pre-DALT/TAB Meeting: Within 30 calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

3. Design Review Report: Within 60 calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

4. Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Construction Manager in writing within 5 days after completion.

5. Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

6. DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

7. Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final

DALT reports may be submitted to allow phased testing from system to system.

8. DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Construction Manager.

9. Submit Final DALT Report: Within 15 calendar days after completion of successful DALT Work Field Check, submit Season 1 TAB report.

10. Pre-Field TAB Engineering Report: Within 30 calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

11. Prerequisite HVAC Work Check Out List for Season 1 and Advanced Notice for Season 1 TAB Field Work: At a minimum of 115 calendar days prior to CCD, submit Season 1 prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of Season 1 TAB field work.

12 Season 1 TAB Field Work: At a minimum of 90 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work; submit Season 1 TAB report; and conduct Season 1 field check.

13. Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work.

14. Prerequisite HVAC Work Check Out List for Season 2 and Advanced Notice for Season 2 TAB Field Work: Within 150 calendar days after date of the commencement of the Season 1 TAB field work, submit the Season 2 prerequisite HVAC work check out list certified as complete and submit advance notice of commencement of Season 2 TAB field work.

15. Season 2 TAB Field Work: Within 180 calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work; submit Season 2 TAB report; and conduct Season 2 field check.

16. Complete Season 2 TAB Work: Within 15 calendar days after the completion of Season 2 field data check, complete TAB work.

#### 1.6.2.1 TAB Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

#### 1.6.2.2 Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Construction Manager in writing within 7 calendar days after completion.

1.6.2.3 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Construction Manager prior to the TAB team coming to the contract site.

At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" must be provided for each separate system to be TAB'd.

## 1.7 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

Not Used

# PART 3 EXECUTION

## 3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section as specified in Appendix A WORK DESCRIPTIONS OF PARTICIPANTS.

## 3.2 DALT PROCEDURES

### 3.2.1 Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with Manufacturer's written procedures.

### 3.2.2 Advance Notice of Pre-Final DALT Field Work Advance Notice of Pre-Final DALT Field Work

On completion of the installation of each duct system indicated to be DALT'd, notify the Construction Manager in writing prior to the COTR's duct selection field visit.

### 3.2.3 Ductwork To Be DALT'd

From each duct system indicated as subject to DALT, the COTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

### 3.2.4 DALT Testing

Perform DALT on the HVAC duct sections of each system as selected by the COTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1972 CD.

In spite of specifications of SMACNA 1972 CD to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the COTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

### 3.2.5 Completed Pre-Final DALT Report

After completion of the DALT work, prepare a Pre-final DALT Report meeting the additional requirements specified in Appendix B REPORTS - DALT and TAB. Data required by those data report forms shall be furnished by the TAB team. Prepare the report neatly and legibly; the Pre-final DALT report shall provide the basis for the Final DALT Report.

TAB supervisor shall review, approve and sign the Pre-Final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-Final DALT Report data can commence. After completion of the DALT work, prepare a Pre-final DALT Report using the reporting forms specified. TAB team to furnish data required by those data report forms. Prepare the report neatly and legibly; the Pre-final DALT report is the basis for the Final DALT Report. TAB supervisor must review and certify the Pre-final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-final DALT Report data can commence.

### 3.2.6 Quality Requirements - COTR DALT Field Acceptance Testing

In the presence of the COTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the COTR. For each duct system, this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.

Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the presence of the COTR.

### 3.2.7 Additional COTR Field Acceptance Testing

If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the COTR.

### 3.2.8 Certified Final DALT Report

On successful completion of all field checks of the Pre-final DALT Report data for all systems, the TAB Supervisor is to assemble, review, certify and submit the Final DALT Report to the Construction Manager for approval.On successful completion of all field checks of the Pre-Final DALT Report data for all systems, the TAB Supervisor shall assemble, review, approve, sign and submit the Final DALT Report in compliance with Appendix B REPORTS - DALT and TAB to the Construction Manager for approval.

### 3.2.9 Prerequisite for TAB Field Work

Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

## 3.3 TAB PROCEDURES

### 3.3.1 TAB Field Work

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

That is, comply with the the requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, NEBB MASV, or SMACNA 1780 (TABB) and SMACNA 1858 (TABB),except as supplemented and modified by this section.

Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with Manufacturer's written procedures.

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section. The only water flow and air flow reporting which can be deferred until the Season 2 is that data which would be affected in terms of accuracy due to outside ambient conditions.

### 3.3.2 Preliminary Procedures

Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

### 3.3.3 TAB Air Distribution Systems

#### 3.3.3.1 Units With Coils

Report heating and cooling performance capacity tests for hot water, chilled water, DX and steam coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. Do not determine entering and leaving wet and dry bulb temperatures by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

   Submit part-load coil performance data from the coil Manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.3.3.2 Exhaust Fans

Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.

3.3.3.3 Cooling Units

3.3.4 TAB Work on Performance Tests Without Seasonal Limitations

3.3.4.1 Performance Tests

In addition to the TAB proportionate balancing work on the air distribution systems and the water distribution systems, accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the heating systems and cooling systems.

3.3.4.2 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3.3.4.3 Coils

Report heating and cooling performance capacity tests for DX and electric heating systems for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. Entering and leaving wet and dry bulb temperatures are not determined by single point measurement, but the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

Submit part-load coil performance data from the coil Manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units and unitary units, such as through-the-wall heat pumps:

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.3.5 Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Construction Manager for direction.

3.3.6 Deficiencies

Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph WORKMANSHIP, provide written notice as soon as possible to the Contractor and the Construction Manager describing the deficiency and recommended correction.

Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

3.3.7 TAB Reports

Additional requirements for TAB Reports are specified in Appendix B REPORTS - DALT and TAB

After completion of the TAB work, prepare a pre-final TAB report using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Construction Manager, the TAB work and the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP of this section.

Prepare the report neatly and legibly; the pre-final TAB report is the final TAB report minus the TAB supervisor's review and certification. Obtain, at the contract site, the TAB supervisor's review and certification of the TAB report.

Verbally notify the COTR that the field check of the TAB report data can commence; give this verbal notice 48 hours in advance of field check commencement. Do not schedule field check of the TAB report until the specified workmanship requirements have been met or written approval of the deviations from the requirements have been received from the Construction Manager.

3.3.8 Quality Requirements - COTR TAB Field Acceptance Testing

3.3.8.1 TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR, random selections of data (water, air quantities, air motion, sound level readings) recorded in the TAB Report. Points and areas for field

acceptance testing are to be selected by the COTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

Group 1: Air handling units.

Group 2: 25 percent of the variable refrigerant flow units and associated diffusers and registers.

Group 3: 25 percent of the supply diffusers, registers, grilles associated with air handling units.

Group 4: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.

Group 5: 25 percent of the supply fans, and exhaust fans

Further, if any data on the TAB Report for Groups 2 through 5 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

3.3.8.2 Additional COTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the COTR.

Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to to be found. This additional field testing is up and above the original 25 percent of the of reported data entries to be field tested.

If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.

3.3.8.3 Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Construction Manager approval of the TAB Report submitted.

3.4 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent

markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

## 3.5 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

## 3.6 APPENDICES

Appendix A WORK DESCRIPTIONS OF PARTICIPANTS
Appendix B REPORTS - DALT and TAB
Appendix C DALT AND TAB SUBMITTAL AND WORK SCHEDULE
Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING

## Appendix A

## WORK DESCRIPTIONS OF PARTICIPANTS

The Contractor is responsible for ensuring compliance with all requirements of this specification section. However, the following delineation of specific work items is provided to facilitate and co-ordinate execution of the various work efforts by personnel from separate organizations.

1. Contractor

   a. HVAC documentation: Provide pertinent contract documentation to the TAB Firm, to include the following: the contract drawings and specifications; copies of the approved submittal data for all HVAC equipment, air distribution devices, and air/water measuring/balancing devices; the construction work schedule; and other applicable documents requested by the TAB Firm. Provide the TAB Firm copies of contract revisions and modifications as they occur.

   b. Schedules: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

   c. Pre-DALT and TAB meeting: Arrange and conduct the Pre-DALT and TAB meeting. Ensure that a representative is present for the sheet metal contractor, the mechanical contractor, the electrical contractor, and the automatic temperature controls contractor.

   d. Coordinate Support: Provide and coordinate support personnel required by the TAB Firm in order to accomplish the DALT and TAB field work. Support personnel may include factory representatives, HVAC controls installers, HVAC equipment mechanics, sheet metal workers, pipe fitters, and insulators. Ensure support personnel are present at the work site at the times required.

   e. Correct Deficiencies: Ensure the notifications of Construction Deficiencies are provided as specified herein. Refer to the paragraph CONSTRUCTION DEFICIENCIES. Correct each deficiency as soon as practical with the Construction Manager, and submit revised schedules and other required documentation.

   f. Pre-TAB Work Checklists: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as pre-TAB work checklist items, the deficiencies pointed out by the TAB team supervisor in the design review report.

      Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's DALT and TAB Work Procedures Summary. Do not allow the TAB team to commence TAB field work until all of the following are completed.

g. Give Notice of Testing: Submit advance notice of TAB field work for proportional balancing, Season 1, and Season 2 TAB field work accompanied by completed prerequisite HVAC Work List

h. Insulation work: Ensure that no insulation is shall not be installed on ducts to be DALT'd until DALT work on the subject ducts is complete.

Ensure the duct and piping systems are properly insulated and vapor sealed upon the successful completion and acceptance of the DALT and TAB work.

2. TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Schedule: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Submittals: Provide the submittals specified herein.

d. Pre-DALT/TAB meeting: Attend meeting with Contractor. Ensure TAB personnel that will be involved in the TAB work under this contract attend the meeting.

e. Design Review Report: Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

f. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the DALT and TAB Procedures Summary, the during the DALT or TAB field work.

Ensure the Contractor is properly notified and aware of all support personnel needed to perform the TAB work. Maintain communication with the Contractor regarding support personnel throughout the duration of the TAB field work, including the TAB field acceptance testing checking.

Ensure all inspections and verifications for the Pre-Final DALT and Pre-TAB Checklists are completely and successfully conducted before DALT and TAB field work is performed.

g. Advance Notice: Monitor the completion of the duct system installations and provide the Advance Notice for Pre-Final DALT field work as specified herein.

h. Technical Assistance: Provide technical assistance to the DALT and TAB field work.

i. Deficiencies Notification: Ensure the notifications of Construction Deficiencies are provided as specified herein. Comply with requirements of the paragraph CONSTRUCTION DEFICIENCIES. Resolve each deficiency as soon as practical and submit revised schedules and other required documentation.

j. Procedures: Develop the required TAB procedures for systems or system components not covered in the TAB Standard.

3. TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC work list, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

Appendix B

REPORTS - DALT and TAB

All submitted documentation must be typed, neat, and organized. All reports must have a waterproof front and back cover, a title page, a certification page, sequentially numbered pages throughout, and a table of contents. Tables, lists, and diagrams must be titled. Generate and submit for approval the following documentation:

1. DALT and TAB Work Execution Schedule

Submit a detailed schedule indicating the anticipated calendar date for each submittal and each portion of Work required under this section. For each work entry, indicate the support personnel (such as controls provider, HVAC mechanic, etc.) that are needed to accomplish the Work. Arrange schedule entries chronologically.

2. DALT and TAB Procedures Summary

Submit a detailed narrative describing all aspects of the DALT and TAB field work to be performed. Clearly distinguish between DALT information and TAB information. Include the following:

a. A list of the intended procedural steps for the DALT and TAB field work from start to finish. Indicate how each type of data measurement will be obtained. Include what Contractor support personnel are required for each step, and the tasks they need to perform.

b. A list of the project's submittals that are needed by the TAB Firm in order to meet this Contract's requirements.

c. The schematic drawings to be used in the required reports, which may include building floor plans, mechanical room plans, duct system plans, and equipment elevations. Indicate intended TAB measurement locations, including where test ports need to be provided by the Contractor.

d. The data presentation forms to be used in the report, with the preliminary information and initial design values filled in.

e. A list of DALT and TAB instruments to be used, edited for this project, to include the instrument name and description, Manufacturer, model number, scale range, published accuracy, most recent calibration date, and what the instrument will be used for on this project.

f. A thorough checklist of the work items and inspections that need to be accomplished before DALT field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Pre-Final DALT Work Checklist before DALT field work can be accomplished.

g. A thorough checklist of the work items and inspections that need to be accomplished before the Season 1 TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Season 1 Pre-TAB Work Checklist before the Season 1 TAB field work can be accomplished.

h. A thorough checklist of the work items and inspections that need to be accomplished before the Season 2 TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Season 2 Pre-TAB Work Checklist before the Season 2 TAB field work can be accomplished.

i. The checklists specified above shall be individually developed and tailored specifically for the Work under this contract. Refer to NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under the paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" for examples of items to include in the checklists.

3. Design Review Report

Submit report containing the following information:

a. Review the contract specifications and drawings to verify that the TAB work can be successfully accomplished in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

b. Submit a typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the DALT work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. If no deficiencies are evident, state so in the report.

4. Completed Pre-Final DALT Work Checklist

Report the data for the Pre-Final DALT Report meeting the following requirements:

a. Submit a copy of the approved DALT and TAB Procedures Summary: Provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit a comprehensive report for the DALT field work data using data presentation forms equivalent to the "Air Duct Leakage Test Summary Report Forms" located in the SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Node numbers shall be included in the completed report forms to identify each duct section.

c. Calculations: Include a copy of all calculations prepared in determining the duct surface area of each duct test section. Include in the DALT reports copy(s) of the calibration curve for each of the DALT test orifices used for testing.

d. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments are to be calibrated within one year of the date of

use in the field; instrument calibration is to be traceable to the measuring standards of the National Institute of Standards and Technology.

e. TAB Supervisor Approval: Include on the submitted report the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

5. Final DALT Report

On successful completion of all COTR field checks of the Pre-final DALT Report data for all systems, the TABS Supervisor shall assemble, review, sign and submit the Final DALT Report to the Construction Manager for approval.

6. TAB Reports: Submit TAB Report for Proportional Balancing, Season 1, and Season 2 in the following manner:

a. Procedure Summary: Submit a copy of the approved DALT and TAB Procedures Summary. When applicable, provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit the completed data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed, approved and signed by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data shall be typewritten. Handwritten report forms or report data are not acceptable.

c. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

Pump Room, Control Room, Kitchenette, Restroom, Janitor Closet, Lower Gallery.

(1) Data shall be measured and compiled on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Data shall be measured/recorded only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode. Provide a detailed explanation wherever a final measurement did not achieve the required value.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, the Contractor shall temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls shall have been fully operational a minimum of 24 hours in advance of commencing data compilation. The specified data shall be included in the Season 1 and Season 2 TAB Report.

d. Air System Diagrams: Provided updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations.

e. Air Static Pressure Profiles: Report static pressure profiles for all air duct systems. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems in the Contract Drawings. The static pressure report data shall include, in addition to AABC or NEBB or TABB required data, the following:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across DX coils electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.

f. Duct Transverses: Report duct traverses for main and branch main supply, return, exhaust, relief and outside air ducts. This shall include all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency shall evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pitot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane".

g. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings shall provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument Manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

h. Performance Curves: The TAB Supervisor shall include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor shall include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturis and flow orifices TAB'd on the job.

j. Data From TAB Field Work: After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and approval signature, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms shall be furnished by the TAB team. Except as approved otherwise in writing by the Construction Manager, the TAB work and thereby the TAB report shall be considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP.

Appendix C

DALT AND TAB SUBMITTAL AND WORK SCHEDULE

Perform the following items of work in the order listed adhering to the dates schedule specified below. Include the major items listed in this schedule in the project network analysis schedule.

Submit TAB Agency and TAB Personnel Qualifications: Within 42 calendar days after date of contract award.

Submit the DALT and TAB Work Execution Schedule: within 14 days after receipt of the TAB agency and TAB personnel qualifications approval. Revise and re-submit this schedule 28 days prior to commencement of DALT work and 28 days prior to the commencement of TAB Season 1 work and TAB Season 2 work.

Submit the DALT and TAB Work Procedures Summary: within 14 days after receipt of the initial approved DALT and TAB Work Execution Schedule.

Meet with the COTR at the Pre-DALT/TAB Meeting: Within 28 calendar days after receipt of the approved initial DALT/TAB Execution Schedule.

Submit Design Review Report: Within 56 calendar days after the receipt of the approved initial DALT and TAB Work Execution Schedule.

Advance Notice of Pre-Final DALT Field Work: After the completed installation of the HVAC duct system to be DALT'd, submit to the Construction Manager an Advance Notice of Pre-Final DALT Field Work accompanied by the completed Pre-Final DALT Work Checklist for the subject duct system.

Ductwork Selected for DALT: Within 14 calendar days after receiving an acceptable completed Pre-Final DALT Work Checklist, the Construction Manager's technical representative (COTR) will select the project ductwork sections to be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected project ductwork.

Submit Pre-Final DALT Report: Within two working days after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

Quality Requirements - COTR DALT Field Checks: Upon approval of the Pre-final DALT Report, the COTR's DALT field check work shall be scheduled with the Construction Manager.

Submit Final DALT Report: Within 14 calendar days after completion of successful DALT Work Field Check, submit Season 1 TAB report.

Advance Notice of Season 1 TAB Field Work: At a minimum of 14 calendar days prior to Season 1 TAB Field Work, submit advance notice of TAB field work accompanied by completed Season 1 Pre-TAB Work Checklist.

Season 1 TAB Field Work: At a minimum of 84 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work.

Submit Season 1 TAB Report: Within 14 calendar days after completion of Season 1 TAB field work, submit initial Season 1 TAB report.

Season 1 Quality Requirements - COTR TAB Field Check: 30 calendar days after initial Season 1 TAB report is approved by the Construction Manager, conduct Season 1 field check.

Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work and submit final.

Receive the approved TAB report: Within 21 calendar days, receive the report from Construction Manager approved TAB report.

Advance Notice of Season 2 TAB Field Work: At a minimum of 126 calendar days after CCD, submit advance notice of Season 2 TAB field work accompanied by completed Season 2 Pre-TAB Work Checklist.

Season 2 TAB Field Work: Within 14 calendar days after date of advance notice of Season 2 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within 14 calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 Quality Requirements - COTR TAB Field Checks: 28 calendar days after the Season 2 TAB report is approved by the Construction Manager, conduct Season 2 field check.

Complete Season 2 TAB Work: Within 14 calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

Receive the approved TAB report: Within calendar 21 days, receive the report from Construction Manager.

| **Appendix D** | | | |
|---|---|---|---|
| **REQUIREMENTS FOR DUCT AIR LEAK TESTING** | | | |
| | | **SYSTEMS** | |
| | | **Dedicated Outside Air Unit No. 1** | **Air Handling Unit No. 3** |
| Duct System Static Pressure, in inches W.C. | for Supply | 2 | 2 |
| | for Return | 2 | 2 |
| | for Exhaust | 2 | 2 |
| | for Outside Air | 2 | 2 |
| System Oval/Round Duct and Rectangular Duct SMACNA Seal Class | for Supply | C | C |
| | for Return | C | C |
| | for Exhaust | C | C |
| | for Outside Air | C | C |

| Appendix D | | | |
|---|---|---|---|
| **REQUIREMENTS FOR DUCT AIR LEAK TESTING** | | | |
| | | **SYSTEMS** | |
| | | **Dedicated Outside Air Unit No. 1** | **Air Handling Unit No. 3** |
| System Oval/Round Duct SMACNA Leak Class | for Supply | 12 | 12 |
| | for Return | 12 | 12 |
| | for Exhaust | 12 | 12 |
| | for Outside Air | 12 | 12 |
| System Rectangular Duct SMACNA Leak Class | for Supply | N/A | 24 |
| | for Return | N/A | 24 |
| | for Exhaust | N/A | 24 |
| | for Outside Air | N/A | 24 |
| Duct Test Pressure, in inches W.C. | for Supply | 1 | 1 |
| | for Return | 1 | 1 |
| | for Exhaust | 1 | 1 |
| | for Outside Air | 1 | 1 |

-- End of Section --

# SECTION 23 09 13

# INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

## PART 1 GENERAL

### 1.1 REFERENCES

CSA GROUP (CSA)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2014) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |
| NFPA 90A | (2015) Standard for the Installation of Air Conditioning and Ventilating Systems |

UNDERWRITERS' LABORATORIES, INC. (UL)

### 1.2 DEFINITIONS

NEMA

1. Type 4X enclosure in accordance with NEMA 250.

### 1.3 SYSTEM DESCRIPTION

General requirements

1. All electrical components shall be UL listed and meet the design and installation requirements of NFPA 70.

2. Complete, functional system: Provide all necessary electrical power and control systems, components, and wiring to make a complete functioning system.

3. Submit Electrical Power and Control Diagrams as specified in the electrical specification sections.

4. System control functions to perform as described in Products.

5. Materials: New, free from defects, and of the quality specified.

6. Common manufacturer: Provide components, component accessories, and devices, as much as possible, by the same manufacturer throughout the work.

7. Mounting: Mount control components and devices in accessible locations for maintenance and as recommended by the manufacturer; provide

necessary manufacturer approved mounting and configuration hardware for mounting and operation of control components and devices.

## 1.4 SUBMITTALS

Submit as specified in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

Electrical Power and Control Diagrams

SD-03 Product Data

Thermostats

SD-07 Certificates

SD-08 Manufacturer's Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation And Maintenance Manuals

SD-11 Closeout Submittals

Manufacturer's Certificate of Source Testing

Manufacturer's Certificate of Installation and Functionality Compliance

## 1.5 QUALITY REQUIREMENTS

The control system shall be designed in accordance with UL and CSA standards.

## 1.6 DELIVERY, STORAGE, AND HANDLING

The system control products shall be stored and handled per manufacturer's recommendations.

## 1.7 SITE CONDITIONS

Elevation and ambient conditions as indicated in contract documents.

## 1.8 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 THERMOSTATS

2.1.1 General

Thermostat types: Provide 1 of the specified types that will match the controlled equipment requirements and provide a functioning system.

2.1.2 Cooling Only Thermostat, Line Voltage

1. Dry locations (no hose bibs or open water processes in room): Model A19BBC-2 in NEMA 1 enclosure.

   Wet locations (hose bibs or open water processes in room): Model A19KNC-1 in rain and dusttight enclosure.

2. Switch action: Single pole double throw, close on rising temperature.

3. Sensing element: Coiled bulb and capillary.

4. Setpoint: 30 to 110 degrees Fahrenheit with knob adjuster and visible scale.

5. Electrical ratings: 16 amps alternating current at 120 volts, 9.2 amps alternating current at 208 volts.

6. Differential range: For dry locations, 3 to 12 degrees Fahrenheit adjustable; for wet locations, 5 degrees Fahrenheit fixed.

2.2 HVAC CONTROL DESCRIPTIONS

2.2.1 General

Provide control systems that will maintain room or area comfort under changing ambient conditions and varying use; descriptions in this Section are general in nature and do not cover every mode of operation.

2.2.2 S-471 Generator Building HVAC Control Descriptions

1. Generator Room Control Sequences:

   a. Exhaust fan EF-1 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2. Control Room Sequences:

   a. Exhaust fan EF-2 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2.2.3 S-473 Generator Building HVAC Control Descriptions

1. Generator Room Control Sequences:

   a. Exhaust fan EF-3 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2. Control Room Sequences:

   a. Exhaust fan EF-4 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2.2.4 S-475 Generator Building HVAC Control Descriptions

1. Generator Room Control Sequences:

   a. Exhaust fan EF-5 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2. Control Room Sequences:

   a. Exhaust fan EF-6 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2.2.5 S-477 Generator Building HVAC Control Descriptions

1. Generator Room Control Sequences:

   a. Exhaust fan EF-7 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2. Control Room Sequences:

   a. Exhaust fan EF-8 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2.2.6 S-479 Generator Building HVAC Control Descriptions

1. Generator Room Control Sequences:

    a. Exhaust fan EF-9 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2. Control Room Sequences:

    a. Exhaust fan EF-10 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2.2.7 S-481a Generator Building HVAC Control Descriptions

1. Generator Room Control Sequences:

    a. Exhaust fan EF-11 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

2. Control Room Sequences:

    a. Exhaust fan EF-12 shall be controlled by thermostat with adjustable set points. The cooling set point shall be 85 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature falls 5 degrees below the set point, the unit will de-energize.

PART 3 EXECUTION

3.1 EXAMINATION

1. Examine and verify that Work is in condition to receive installation specified in this Section.

2. Take measurements and verify dimensions to ascertain fit of installation.

3. Ascertain structural sufficiency to support installation.

4. Ascertain that supports and openings are correctly located; cut new openings where required.

    1. Submit details of proposed cutting and patching.

3.2 PREPARATION

1. Before installation remove dust and debris from equipment and accessories.

2. During installation and until equipment is operated, protect equipment and accessories from dust and debris.

3.3 INSTALLATION

1. Install as indicated on the Drawings, in accordance with NFPA 90A, and per the manufacturer s written instructions.

2. Coordinate installation of HVAC control systems with other trades.

   a. Prior to installation, coordinate wiring and conduit requirements with electrical subcontractor.

3. Mount remote annunciator and test station on wall near smoke detector.

   a. Devices shall be easily accessible from floor level.

   b. Label annunciator and test station.

4. Provide all electrical work to support smoke detector.

   a. Coordinate with electrical subcontractor.

5. Sensor and control station mounting:

   a. Where not otherwise indicated, mount 5 feet above floor or walking level.

   b. Provide insulating back plates when mounting is on an exterior wall or a wall adjoining an unconditioned space.

   c. Shield outside thermostats or sensors from the sun; provide thermostats with remote bulb and compensated capillary.

   d. Install locking covers where indicated on the Drawings.

3.4 FIELD QUALITY CONTROL

1. Test each control system and provide written, signed, and dated test report.

   a. Test individual control components and accessories to comply with the Specifications.

   b. Test functions of each control system as a complete system to comply with the Specifications.

2. Test each control component and system as part of HVAC system testing, adjusting, and balancing as specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

3.4.1 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 05 OPERATION AND MAINTENANCE INFORMATION.

### 3.4.2 Operation and Maintenance Training

Conduct a training course for the members of the operating staff as designated by the District. Make the training period consist of a total of 8 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

## 3.5 COMMISSIONING

1. As specified in Section 01 91 00 COMMISSIONING and this Section.

2. Manufacturer(each) services for each type of strainer:

   a. Provide Manufacturer's Certificate of Source Testing.

   b. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

   c. Training and other on-site services.

| **Manufacturer Rep Onsite** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Source Testing (Witnessed or Non-witnessed** | **Training Requirements** | | **Installation Testing** | | **Functional Testing** | | **Process Operational Period** | |
| | **Maintenance (hrs per session)** | **Operation (hrs per session)** | **Trips** | **Days (each trip)** | **Trips** | **Days (each trip)** | **Trips** | **Days (each trip)** |
| Non-Witnessed | 16 | 8 | 2 | 2 | 1 | 2 | Not Required | |

-- End of Section --

# SECTION 26 00 00.00 20

# BASIC ELECTRICAL MATERIALS AND METHODS

## PART 1 GENERAL

### 1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| A36 | Standard Specification for Carbon Structural Steel |
| A193 | Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications |
| A194 | Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both |
| A307 | Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| F3125 | Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength |
| ASTM D709 | (2017) Standard Specification for Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C2 | (2017; Errata 1 2017) National Electrical Safety Code |
| IEEE C57.12.28 | (2014) Standard for Pad-Mounted Equipment - Enclosure Integrity |
| IEEE C57.12.29 | (2014) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2014) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |
| Local Building Codes and Standards | |
| MIL-PRF_907E | Antiseize Thread Compound, Hight Temperature |
| NETA | Acceptance Testing Specifications |
| NEMA 250 | Enclosures for Electrical Equipment(1,000 Volts Maximum) |

1.2 DEFINITIONS

~~a~~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.~~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.~~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.

1.3 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 23 kV primary, three phase, four wire, 60 Hz, and 120/208 volts secondary, three phase, four wire (except for service to the S-479 pump station and gate which will be 277/480 volts). Final connections to the power distribution system at the secondary spades of the pad mounted transformers shall be made by the Utility after inspection by authority having jurisdiction using local building codes and standards.

1.4 SUBMITTALS

~~A.~~ The Contractor shall furnish submittals and owner's manuals in accordance with Section 01 33 00 SUBMITTAL PROCEDURES. Shop Drawings shall be custom prepared. Drawings or data indicating "optional" or "as required" equipment are not acceptable. Options not proposed shall be crossed out or deleted from Shop Drawings. Catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material shall be allowed. Mark-out any model or part numbers of material on catalog data sheets that do not specifically apply to the project. Catalog data sheets shall be stamped to indicate the project name, applicable Section and paragraph, model number, and options. Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

SD-02 Shop Drawings

Materials and Equipment Schedules

SD-03 Product Data

Complete material lists stating manufacturer and brand name of each item or class of material

Front, side, rear elevations, and top views with dimensional data

Types of materials and finish

Nameplates

Grounding devices

SD-05 Design Data

Conduit layout plans

Location of conduit entrances and access plate

Method of anchoring

Temperature limitations, as applicable

SD-06 Test Reports

Test reports

~~B. The CONTRACTOR shall provide the following for shop drawing submittals:~~

~~1. Complete material lists stating manufacturer and brand name of each item or class of material~~

~~2. Front, side, rear elevations, and top views with dimensional data~~

~~3. Location of conduit entrances and access plates~~

~~4. Component data~~

~~5. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers~~

~~6. Method of anchoring, seismic requirements, weight~~

~~7. Types of materials and finish~~

~~8. Nameplates~~

~~9. Temperature limitations, as applicable~~

~~10. Voltage requirement, phase, and current, as applicable~~

~~11. Front and rear access requirements~~

~~12. Test reports~~

~~13. Grounding requirements~~

~~14. Catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material. Mark-out any model or part numbers of material on catalog data sheets that do not specifically apply to the project. Catalog data sheets shall be stamped to indicate the project name, applicable Section and paragraph, model number, and options.~~

~~C. Shop Drawings shall be custom prepared. Drawings or data indicating "optional" or "as required" equipment are not acceptable. Options not proposed shall be crossed out or deleted from Shop Drawings.~~

~~D. Materials and Equipment Schedules: The CONTRACTOR shall deliver to the DISTRICT within 30 days of the commencement date in the Notice to Proceed, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.~~

~~E. Owner's Manuals: Complete information in accordance with SECTION 01 33 00 SUBMITAL PROCEDURES.~~

~~F. Record Drawings: The CONTRACTOR shall show invert and top elevations and routing of all conduits in duct banks and concealed below-grade electrical installations. Buried electrical conduits shall be located by showing the horizontal distance to two fixed structures at the start of the conduit installation, the end of the conduit installation, and for every conduit change of direction. In addition, circuit schematic drawings and wiring drawings shall show all field changes. Layout drawings shall show all equipment location changes. Record drawings shall be prepared, be available to the DISTRICT, and be submitted according to SECTION 01300.~~

~~G. Where test reports are indicated, proof of design test reports for mass-produced equipment shall be submitted with the Shop Drawings, and factory performance test reports for custom-manufactured equipment shall be submitted and be approved prior to shipment. Field test reports shall be submitted for review prior to Substantial Completion.~~

~~ADDITIONAL SUBMITTALS INFORMATION~~

~~H. Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable. Conduit layout plans shall be provided as a submittal and included in the preparation phase work plan.~~

~~1.4.1I. Shop Drawings (SD-02)~~

~~Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, conduit layout plans, verified as-builts, 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.~~

~~1.4.2J. Product Data (SD-03)~~

~~Submittal shall include performance and characteristic curves. Layout plans shall be provided as a submittal and included in the preparation phase work plan.~~

1.5 QUALITY REQUIREMENTS

A. ~~1.5.1~~ 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 District. 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.

B. ~~1.5.2~~ 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 and 1 year prior to later installation. The 2-year and 1-year periods 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 and still available at 1 year prior to the installation. 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.

C. ~~1.5.2.1~~ 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.

D. ~~1.5.2.2~~ 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. Complete material lists stating manufacturer and brand name of each item or class of material should be provided.

1.6 WARRANTY

The CONTRACTOR shall warrant the WORK against defects for one (1) year from the date of Substantial Completion and~~The warranty~~ shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

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.~~A. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

~~b.~~B. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

~~c.~~C. Safety precautions.

~~d.~~D. The procedure in the event of equipment failure.

~~e.~~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.

1.8 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 D709)

**Commented [nm1]:** Tag Submittal

~~ASTM D709.~~ 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 substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding ~~600~~ 300 volts.

~~a.~~A. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

1.11 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein including methods of anchoring.

1.12 INSTRUCTION TO DISTRICT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated District 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 District 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.

1.13 RESPONSIBILITIES:

A. The CONTRACTOR shall contact the serving utility and verify compliance with requirements before construction. The CONTRACTOR shall coordinate schedules and make payments for work by all utilities.

B. Electrical service shall be as indicated and be as required by the serving utility.

C. The CONTRACTOR shall verify and provide all service conduits, fittings, transformer pad, grounding devices, and all service wires not provided by the serving utility. The CONTRACTOR shall pickup utility material and install same as directed by the utility. The CONTRACTOR shall verify with the utility the exact location of each service point and type of service and shall pay all charges levied by the serving utilities as part of the WORK.

D. Permits shall be obtained, and inspection fees shall be paid according to General Conditions.

E. The CONTRACTOR shall pay all utility construction/connection charges and turn-on service charges required by the utility company.

F. The CONTRACTOR shall be responsible for factory and field tests required by specifications in DIVISON 16 in accordance with NETA ATS and by the DISTRICT and other authorities having jurisdiction. The CONTRACTOR shall furnish necessary testing equipment and pay costs of tests, including all replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of faulty installation.

1.14 INSPECTION COORDINATION: The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The CONTRACTOR shall provide 48 hours notice of its intention to begin new WORK activities.

1.15 QUALIFICATIONS: All electrical work shall be performed by personnel employed by an Electrical CONTRACTOR licensed in the State of Florida. Actual work shall be performed by Master and or Journeyman electricians or personnel under direct on-site supervision of a Master and or a Journeyman electrician. If the work is performed under the direct on-site supervision

of a Journeyman electrician, he or she shall be certified in the county in which the work is performed or meet the reciprocity standards of Florida State Statue 489 part II. The credentials of the Electrical CONTRACTOR, Master and/or Journeyman electricians shall be supplied to the DISTRICT upon request.

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.

2.2 GENERAL:

A. The CONTRACTOR shall provide equipment and materials that shall be new, shall be listed by UL, or by an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction, and shall bear the UL label or other certification where these requirements apply. Equipment and materials shall be the products of experienced and reputable manufacturers in the industry with front, side, rear elevations, and top views with dimensional data on relative equipment submittals. Similar items in the WORK shall be products of the same MANUFACTURER. Equipment and materials shall be of heavy duty industrial grade.

B. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

C. On devices indicated to display dates, the year shall be displayed as 4 digits.

SIGNAGE:

A. Electrical Equipment - Each piece of electrical equipment shall be legibly marked to indicate its purpose unless the DISTRICT determines that its purpose is indicated by the location and arrangement.

1. Outside branch circuits and feeders - for 600 volts nominal, or less - Warning signs shall be posted in plain view where unauthorized persons might come in contact with live parts.

B. Isolating Switches - Isolating switches not interlocked with an approved circuit interrupting device shall be provided with a sign warning against opening them under load.

C. Back-up Generation - A sign shall be placed at the service entrance equipment indicating the type and location of on-site back-up generation.

2.3 AREA DESIGNATIONS:

A. General:

1. Raceway system enclosures shall comply as mentioned herein and in SECTION 16110.

2. Electric work specifically indicated in sections within any of the Specifications shall comply with those requirements.

| AREA | NEMA ENCLOSURE CLASSIFICATION | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 3R | 4X | 7 | 9 | 12 | Notes |
| Air Condition Space | ☐ | | | | | | |
| Non A/C Space Interior | | | | | | ☐ | Or as directed by Project drawings |
| Outdoor Application | | | ☐ | | | | Or as directed by Project drawings |

B. Types of Materials and Finish~~Materials Requirements~~

1. NEMA 4X enclosures shall be 316 stainless steel.
2. NEMA 7 enclosures shall be cast aluminum where used with aluminum conduit; cast iron when used with galvanized steel conduit.
3. NEMA 1, 3R, and 12 enclosures shall be steel coated with ANSI 61 grey paint. NEMA 4X, 7, and 9 enclosures shall not be painted.

2.4 MOUNTING HARDWARE:

A. Miscellaneous Hardware

1. Threaded rods for trapeze supports shall be continuous threaded, 3/8-inch diameter minimum. Utilize hot dipped galvanized steel for dry indoor non process areas and 316 stainless steel for "wet," "damp," or "corrosive" areas.
2. Strut for mounting of conduits and equipment shall be 316 stainless steel or hot dipped galvanized as specified on Project drawings. Where contact with concrete or dissimilar metals may cause galvanic corrosion, suitable non-metallic insulators shall be utilized to prevent such corrosion.
3. Wall-mounted panels that weigh more than 500 pounds shall be provided and mounted with steel support pedestals. Transformers hung from 4 inch stud walls and weighing more than 300 pounds shall have auxiliary floor supports.

B. Bolts and Anchors

1. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolt material, anchor bolts and cap screws shall be in accordance with the following.
   a. Structural connections: ASTM A307, Grade A or B, hot-dip galvanized
   b. Anchor Bolts: ASTM A307, Grade A or B, or ASTM A36, hot-dip galvanized
   c. High strength bolts where indicated: ASTM F3125

2. Corrosive Service: All bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.
   a. All buried locations
   b. All submerged locations
   c. All locations subject to seasonal or occasional flooding
   d. Inside hydraulic structures below the top of the structure
   e. Inside buried vaults, manholes, and structures which do not drain through a gravity sewer or to a sump with a pump
   f. All chemical handling areas
   g. Inside trenches, containment walls, and curbed areas
   h. Locations indicated by the Contract Documents or designated by the DISTRICT to be provided with stainless steel bolts.
3. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, class 2, conforming to ASTM A193 for bolts and to ASTM A194 for nuts. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-PRF~~A~~-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
   a. Anti-seizure lubricant shall be classified as acceptable for potable water use by the NSF.
   b. Anti-seizure lubricant shall be odorless, non-toxic, weather-proof, teflon based, with operating temperature limitations, as applicable ~~temperatures~~ up to 475 deg F.
4. Indoors Finished Areas Service:
   a. Expanding-Type Anchors: Expanding-type anchors if indicated or permitted, shall be 18-8 stainless steel split expansion ring with threaded stud bolt body and integral cone expander, nut and washer. Plated carbon steel, hot-dipped galvanized carbon steel, type 304 stainless steel or type 316 stainless steel anchor bodies, as identified in the drawings or other notations.

2.5 ELECTRICAL IDENTIFICATION:

A. Nameplates: Nameplates shall be fabricated from white-letter, black-face laminated plastic engraving stock. Each shall be fastened securely, using fasteners of brass, cadmium plated steel, or stainless steel, screwed into inserts or tapped holes, as required. Engraved characters shall be block style with no characters smaller than 1/4-inch high.

B. Conductor and Equipment Identification: Conductor and equipment identification devices shall be either imprinted plastic-coated cloth marking devices or shall be heat-shrink plastic tubing, imprinted split-sleeve markers cemented in place.

PART 3 EXECUTION

3.1 GENERAL:

A. Incidentals: The CONTRACTOR shall provide all materials and incidentals required for a complete and operable system, even if not required explicitly by the Specifications or the Drawings. Typical incidentals are terminal lugs not furnished with vendor supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor furnished equipment to connect with other equipment indicated in the Contract Documents.

B. Field Control of Location and Arrangement: The CONTRACTOR shall determine the exact locations in the field based on the physical size and arrangement of equipment, finished elevations, and other obstructions. The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Locations on the Drawings, however, shall be followed as closely as possible.

1. Where conduit development drawings or "home runs" are shown, the CONTRACTOR shall route the conduits in accordance with the indicated installation requirements. Routings shall be exposed or encased as indicated, except that conduit in finished areas shall be concealed unless specifically indicated otherwise. Conduits encased in a slab shall be sized for conduit OD to not exceed one-third of the slab thickness and be laid out and spaced to not impede concrete flow.

2. Conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms as indicated. Where the Drawings do not indicate exact locations, such locations shall be determined by the DISTRICT. Lighting fixture locations shall be adjusted slightly as necessary prior to installation to avoid obstructions and to minimize shadows.

3. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR's responsibility to provide all lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated. Wiring shall be #12 AWG minimum, and conduits shall be 3/4-inch minimum (exposed) and 1 inch minimum (encased). Where circuits are combined in the same raceway, the CONTRACTOR shall derate conductor ampacities in accordance with NEC requirements.

C. Workmanship: Materials and equipment shall be installed in strict accordance with printed recommendations of the MANUFACTURER. Installation shall be accomplished by workers skilled in the work. Installation shall be coordinated in the field with other trades to avoid interference.

3.1.4. Materials and Equipment Schedules: The Contractor shall deliver to the District within 30 days of the commencement date in the Notice to Proceed, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items. Include wiring diagrams and installation details of equipment indicating proposed location,

layout and arrangement, conduit layout plans with locations of conduit entrances and access plates and included in the preparation phase work plan, verified as-builts, 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.

D. Protection of Equipment and Materials: The CONTRACTOR shall fully protect materials and equipment against damage from any cause. Materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. Moving parts shall be kept clean and dry. The CONTRACTOR shall replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections as part of the WORK.

E. Incoming utility power equipment shall be provided in conformance with the utility's requirements.

F. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 FR 1926, as applicable), state building standards, and applicable local codes and regulations.

3.1.8 Record Drawings: The Contractor shall show invert and top elevations and routing of all conduits in duct banks and concealed below-grade electrical installations. Buried electrical conduits shall be located by showing the horizontal distance to two fixed structures at the start of the conduit installation, the end of the conduit installation, and for every conduit change of direction. In addition, circuit schematic drawings and wiring drawings shall show all field changes. Layout drawings shall show all equipment location changes. Record drawings shall be prepared, be available to the District, and be submitted according to Section 01 33 00 SUBMITTAL PROCEDURES.

3.2 CORE DRILLING: The CONTRACTOR shall perform core drilling required for installation of raceways through concrete walls and floors. Locations of floor penetrations, as may be required, shall be based on field conditions. Verify all core drilling locations based on equipment actually furnished as well as exact field placement. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the DISTRICT prior to any core drilling activities.

3.3 CONCRETE HOUSEKEEPING PADS:

A. Concrete housekeeping pads shall be provided for indoor floor standing electrical equipment. Housekeeping pads for equipment, including future units, shall be 4 inches nominal above surrounding finished floor or grade and 4 inches larger in both dimensions than the equipment, unless otherwise indicated.

B. Concrete housekeeping curbs shall be provided for all conduit stub-ups in indoor locations that are not concealed by equipment enclosures. Such curbing shall be 4 inches nominal above finished floor or grade.

3.4 EQUIPMENT IDENTIFICATION:

A. General: Equipment and devices shall be identified as follows:

1. Nameplates shall be provided for all panelboards, control and instrumentation panels, starters, switches, and pushbutton stations. In addition to nameplates, control devices shall be equipped with standard collar-type legend plates.
2. Control devices within enclosures shall be identified as indicated. Identification shall be similar to the subparagraph above.
3. Toggle switches which control loads out of sight of switch and all multi-switch locations of more than two (2) switches shall have inscribed finish plates clearly indicating the load.
4. Where shown on the drawings, name tags shall be inscribed with the equipment name and tag number.
5. The CONTRACTOR shall furnish typewritten circuit directories for panelboards; circuit directory shall accurately reflect the devices/equipment connected to each circuit breaker.

3.5 CLEANING: The CONTRACTOR shall thoroughly clean the electrical WORK before final acceptance. Exposed parts shall be thoroughly clean of cement, plaster, and other materials. Oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped, and all cracks and corners scraped out. Touch-up paint shall be applied to scratches on panels and cabinets. Electrical cabinets or enclosures shall be vacuum-cleaned.

~~FIELD APPLIED PAINTING~~

~~PAINT ELECTRICAL EQUIPMENT AS REQUIRED TO MATCH FINISH OF ADJACENT SURFACES OR TO MEET THE INDICATED OR SPECIFIED SAFETY CRITERIA. PAINTING SHALL BE AS SPECIFIED IN SECTION 09 06 90 PROTECTIVE COATINGS AND THE SECTION SPECIFYING THE ASSOCIATED ELECTRICAL EQUIPMENT.~~

~~3.2 FIELD FABRICATED NAMEPLATE MOUNTING~~

~~PROVIDE NUMBER, LOCATION, AND LETTER DESIGNATION OF NAMEPLATES AS INDICATED. FASTEN NAMEPLATES TO THE DEVICE WITH A MINIMUM OF TWO SHEET-METAL SCREWS OR TWO RIVETS.~~

~~3.3 WARNING SIGN MOUNTING~~

~~PROVIDE THE NUMBER OF SIGNS REQUIRED TO BE READABLE FROM EACH ACCESSIBLE SIDE, BUT SPACE THE SIGNS A MAXIMUM OF 30 FEET APART.~~

-- End of Section --

# SECTION 26 05 19.10 10

# INSULATED WIRE AND 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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 1202 | (2006; R 2012; CORR 1 2012) Flame-Propagation Testing of Wire and Cable |

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

| | |
|---|---|
| ICEA S-58-679 | (2014) Control, Instrumentation and Thermocouple Extension Conductor Identification |
| ICEA T-30-520 | (1986) Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 70,000 B.T.U./Hour |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI/NEMA WC 71/ICEA S-96-659 | (2014) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy |
| NEMA WC 57 | (2014) Standard for Control, Thermocouple Extension, and Instrumentation Cables |
| NEMA WC 70 | (2009) Power Cable Rated 2000 V or Less for the Distribution of Electrical Energy--S95-658 |
| NEMA WC 74/ICEA S-93-639 | (2012) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1685 | (2015) UL Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables |

| | |
|---|---|
| UL 2556 | (2015) UL Standard for Safety Wire and Cable Test Methods |
| UL 83 | (2014) Thermoplastic-Insulated Wires and Cables |

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wire and Cable

Conductors

Cable Manufacturing Data

SD-06 Test Reports

Test Report(s), Inspection Report(s), and Verification Report(s)

1.3 DELIVERY, STORAGE, AND HANDLING

Furnish cables on reels or coils. Each cable and the outside of each reel or coil, must be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel of cable must contain only one continuous cable without splices. Reels must remain the property of the District.

1.4 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Wire and Cable

Furnish wire and cable in accordance with the detailed requirements specified herein.

2.1.2 Rated Circuit Voltages

All power wire and cable must have minimum rated circuit voltages in accordance with NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Power wire and cable for circuit voltages rated 0-600 volts must be rated not less than 600 volts. Control wire and cable must have minimum rated circuit voltages in accordance with NEMA WC 57, but must be rated 600 volts if routed in raceway with other conductors that are rated 600 volts.

### 2.1.3 Conductors

#### 2.1.3.1 Material for Conductors

Conductors must conform to all the applicable requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Copper conductors must be annealed copper material and they may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used.

#### 2.1.3.2 Size

Minimum wire size must be No. 12 AWG for power and lighting circuits; No. 10 AWG for current transformer secondary circuits; No. 14 AWG for potential transformer, relaying, and control circuits; No. 16 AWG for annunciator circuits; and No. 19 AWG for alarm circuits.

#### 2.1.3.3 Stranding

Conductor stranding classes cited herein must be as defined for control conductors in NEMA WC 57 or as defined for 0-2,000 volts power conductors in NEMA WC 70, as applicable. Lighting conductors No. 10 AWG and smaller must be solid or have Class B stranding. Any conductors used between stationary and moving devices, such as hinged doors or panels, must have Class H or K stranding. All other conductors must have Class B or C stranding, except that conductors as shown, or in the schedule, as No. 12 AWG may be 19 strands of No. 25 AWG, and conductors shown as No. 10 AWG may be 19 strands of No. 22 AWG.

#### 2.1.3.4 Conductor Shielding

Use conductor shielding conforming to NEMA WC 57 for control wire and cable as applicable.

#### 2.1.3.5 Separator Tape

Where conductor shielding, strand filling, or other special conductor treatment is not required, a separator tape between conductor and insulation is permitted.

### 2.1.4 Insulation

#### 2.1.4.1 Insulation Material

Unless specified otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt, Type THWN/THHN conforming to UL 83. Insulation for control wire and cable must meet the requirements of NEMA WC 57. Insulation requirements for wire and cable rated less than 2,000 volts must meet the requirements of NEMA WC 70.

#### 2.1.4.2 Insulation Thickness

The insulation thickness for each conductor must be based on its rated circuit voltage.

2.1.4.2.1 Power Cables, 2,000 Volts and Below

The insulation thickness for single-conductor and multiple-conductor power cables rated 2,000 volts and below must be as required by NEMA WC 70, as applicable. Some thicknesses of NEMA WC 70 will be permitted only for single-conductor cross-linked thermosetting polyethylene insulated cables without a jacket. NEMA WC 70 ethylene-propylene rubber-insulated conductors must have a jacket.

2.1.4.2.2 Single-Conductor and Multiple-Conductor Control Cables

The insulation thickness of control conductor sizes 22 AWG to 10 AWG used for control and related purposes must be as required by NEMA WC 57, as applicable. Control conductors larger than 10 AWG must be as required by NEMA WC 70.

2.1.5 Jackets

All cables must have jackets meeting the requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, and NEMA WC 74/ICEA S-93-639, as applicable, and as specified herein. Individual conductors of multiple-conductor cables must be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables, except for shielded cables, must be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables and shielded single-conductor cables must be provided with a common overall jacket, which must be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including jacket, afterward fully meets these specifications and the requirements of the applicable standards.

2.1.5.1 Jacket Material

The jacket must be one of the materials listed below. Variations from the materials required below will be permitted only if approved for each specific use, upon submittal of sufficient data to prove that they exceed all specified requirements for the particular application.

2.1.5.1.1 General Use

| | |
|---|---|
| Heavy-duty black neoprene | NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |
| Heavy-duty chlorosulfonated polyethylene | NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |
| Heavy-duty cross-linked (thermoset) chlorinated polyethylene | NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |

2.1.5.1.2 Accessible Use Only, 2,000 Volts or Less

Cables installed where they are entirely accessible, such as cable trays and raceways with removable covers, or where they pass through less than 10 feet of exposed conduit only, must have jackets of one of the materials in item "a. General Use" or one of the following:

| | |
|---|---|
| General-purpose neoprene | NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |
| Black polyethylene (MDPE) | NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |
| Thermoplastic chlorinated polyethylene | NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 |

2.1.5.2 Jacket Thickness

The minimum thickness of the jackets must be not less than 80 percent of the respective nominal thicknesses specified below.

2.1.5.2.1 Multiple-Conductor Cables

Thickness of the jackets of the individual conductors of multiple-conductor cables must be as required by NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable and must be in addition to the conductor insulation thickness required by the applicable respective NEMA publication for the insulation used. Thickness of the outer jackets and associated coverings of the assembled multiple-conductor cables must be as required by NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable.

2.1.5.2.2 Single-Conductor Cables

Single-conductor cables must have a jacket thickness as specified in NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable.

2.1.6 Instrumentation Cable

Wire for process instrumentation shall be twisted, shielded pairs No. 16 AWG, stranded with individual drain wires.

2.1.7 Multiple-Conductor Cables

Grounding conductor(s) conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable must be furnished for each multiple-conductor cable. Assembly and cabling must be as specified in paragraph CABLING.

2.2 CABLE IDENTIFICATION

2.2.1 Color-Coding

Insulation of individual conductors of multiple-conductor cables must be color-coded in accordance with ICEA S-58-679, except that colored braids will not be permitted. Only one color-code method must be used for each cable construction type. Control cable color-coding must be in accordance with ICEA S-58-679. Power cable color-coding must be black for Phase A, red for Phase B, blue for Phase C, white for grounded neutral, and green for an insulated grounding conductor, if included.

### 2.2.2 Cabling

Individual conductors of multiple-conductor cables must be assembled with flame-and moisture-resistant fillers, binders, and a lay conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639. Flat twin cables are prohibited. Fillers must be used in the interstices of multiple-conductor round cables with a common covering where necessary to give the completed cable a substantially circular cross section. Fillers must be non-hygroscopic material, compatible with the cable insulation, jacket, and other components of the cable. The rubber-filled or other approved type of binding tape must consist of a material that is compatible with the other components of the cable and must be lapped at least 10 percent of its width.

### 2.2.3 Dimensional Tolerance

The outside diameters of single-conductor cables and of multiple-conductor cables must not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

## PART 3 EXECUTION

## 3.1 INSTALLATION INSTRUCTIONS

Submit cable manufacturing data. The following information must be provided by the cable manufacturer for each size, conductor quantity, and type of cable furnished:

a. Minimum bending radius, in inches - For multiple-conductor cables, this information must be provided for both the individual conductors and the multiple-conductor cable.

b. Pulling tension and sidewall pressure limits, in pounds.

c. Instructions for stripping semiconducting insulation shields, if furnished, with minimum effort without damaging the insulation.

d. Upon request, compatibility of cable materials and construction with specific materials and hardware manufactured by others must be stated. Also, if requested, recommendations must be provided for various cable operations, including installing, splicing, terminating, etc.

## 3.2 TEST REPORT(S), INSPECTION REPORT(S), AND VERIFICATION REPORT(S)

### 3.2.1 Cable Data

Do not begin any wire and cable fabrication until materials are submitted and approved by the Construction Manager. Submit cable data for approval including, but not limited to, dimensioned sketches showing cable construction and sufficient additional data to show that wire and cable meet the requirements of this Section.

### 3.2.2 Inspection and Tests

Inspection and tests of wire and cable furnished under these specifications must be made by and at the plant of the manufacturer, and the manufacturer must provide certification and certification reports of completed

inspections and completed tests. The District may require or perform further tests before or after installation. Testing in general must comply with NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Specific tests required for particular materials, components, and completed cables must be as specified in the sections of the above standards applicable to those materials, components, and cable types. Tests must also be performed in accordance with the additional requirements specified below. Submit 6 certified copies of test reports.

3.2.2.1 High-Voltage Test Source

Where the applicable standards allow a choice, high-voltage tests for cables to be used exclusively on dc circuits must be made with dc test voltages. Cables to be used exclusively on ac circuits must be tested with ac test voltages. If both ac and dc will be present, on either the same or separate conductors of the cable, ac test voltages must be used.

3.2.2.2 Flame Tests

All multiple-conductor and single-conductor cable assemblies must pass either the vertical cable tray flame tests required by ICEA T-30-520 (stated in, but not required by NEMA WC 70), the vertical tray flame propagation test requirements of UL 1685 and IEEE 1202, the wire and cable burning characteristics test of the UL 2556 VW-1 Test, or (for control cables only) the flame test as required by NEMA WC 57. If such tests, however, have previously been made on identical cables, these tests need not be repeated. Instead, certified reports of the original qualifying tests must be submitted. In this case the reports furnished under paragraph "Reports," must include information, identify critical information, and verify that all of each cable's materials, construction, and dimensions are the same as those in the qualifying tests.

3.2.2.3 Independent Tests

The District may make visual inspections, continuity or resistance checks, insulation resistance readings, power factor tests, or dc high potential tests at field test values. A cable's failure to pass these tests and inspections, or failure to produce readings consistent with acceptable values for the application, will be grounds for rejection of the cable.

3.2.2.4 Reports

Furnish results of tests. No wire or cable must be shipped until authorized. Lot number and reel or coil number of wire and cable tested must be indicated on the test reports.

-- End of Section --

# SECTION 26 05 71.00 40

# LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES

## 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.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A167 | (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C57.13 | (2016) Requirements for Instrument Transformers |

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

| | |
|---|---|
| IPC D330 | (1992) Design Guide Manual |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C12.1 | (2008) Electric Meters Code for Electricity Metering |
| ANSI C78.23 | (1995; R 2003) American National Standard for Incandescent Lamps - Miscellaneous Types |
| NEMA 250 | (2014) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA AB 3 | (2013) Molded Case Circuit Breakers and Their Application |
| NEMA FU 1 | (2012) Low Voltage Cartridge Fuses |
| NEMA ICS 1 | (2000; R 2015) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 489 | (2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 50 | (2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations |
| UL 508 | (1999; Reprint Oct 2013) Industrial Control Equipment |

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

- SD-01 Preconstruction Submittals
  - Connection Diagrams
  - Fabrication Drawings
  - Fuses
- SD-02 Shop Drawings
  - Control Devices
  - Protective Devices
- SD-03 Product Data
  - Motor Control
  - Enclosures
  - Circuit Breakers
  - Control Devices
  - Indicating Lights
- SD-06 Test Reports
  - Final Test Reports
- SD-07 Certificates
  - Circuit Tests

SD-08 Manufacturer's Instructions

Control Devices

Protective Devices

SD-10 Operation and Maintenance Data

Manual Motor Controllers

Magnetic Motor Controllers

Combination Motor Controllers

Circuit Breakers

PART 2 PRODUCTS

2.1 SYSTEM DESIGN

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 performed in the factory.

2.2 MOTOR CONTROL

Conform to NEMA ICS 1, NEMA ICS 2, and UL 508 for motor controllers. Ensure controllers have thermal overload protection in each phase.

2.2.1 Manual Motor Controllers

Provide full-voltage, manually operated manual motor controllers for the control and protection of single-phase 60-hertz ac fractional-horsepower squirrel-cage induction motors.

Provide single-throw, single- or double-pole, three-position controllers rated at not more than 1 horsepower at 115- and 230-volts single phase. Include a supporting base or body of electrical insulating material with enclosed switching mechanism, yoke, thermal overload relay, and terminal connectors. Provide controllers that clearly indicate operating condition: on, off, or tripped.

Provide toggle- or key-operated type manual motor controllers as indicated and arrange so that they are lockable with a padlock in the "OFF" position.

Provide recessed manual motor controllers for single-speed, fractional-horsepower squirrel-cage induction motors. Include a single controller and indicating light in a 4-inch square wall outlet box, for flush-wiring devices include matching corrosion-resistant steel flush cover plate. Provide surface-mounted manual motor controllers for single-speed, fractional-horsepower squirrel cage induction motors that include a single

controller and indicating light in a NEMA 250, Type 1 general-purpose enclosure.

Provide recessed and surface-mounted manual motor controllers for two-speed,fractional-horsepower squirrel-cage induction motors; include two controllers, two indicating lights, and a selector switch in a multiple-gang wall outlet box for flush-wiring devices, with matching corrosion-resistant steel flush-cover plate. Provide surface-mounted manual motor controllers for two-speed fractional-horsepower squirrel-cage induction motors; include two controllers, two indicating lights, and a selector switch in a NEMA 250, Type 1 general-purpose enclosure.

### 2.2.2 Magnetic Motor Controllers

#### 2.2.2.1 Full-Voltage Controllers

Provide full-voltage, full magnetic devices for the control and protection of single- and three-phase, 60-hertz, squirrel-cage induction motors in accordance with NEMA ICS 1, NEMA ICS 2, and UL 508 for magnetic motor controllers.

Ensure the operating coil assembly 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 is 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.

Include three manual reset thermal overload devices for overcurrent protection, one in each bimetallic nonadjustable type with continuous current ratings and service-limit current ratings. Ensure ratings have a plus or minus 15 percent adjustment to compensate for ambient operating conditions.

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.

#### 2.2.2.2 Solid State Reduced Voltage Starters

Solid state reduced voltage starters shall meet the requirements of UL 508 and shall consist of an incoming power circuit breaker, a power section, logic board, isolation contactor, and paralleling full load bypass contactor. Soft Starters shall conform to the following:

a. The SCR-based power section shall consist of 6 back-to-back SCRs, two SCRs per phase, and shall be rated for a minimum peak inverse voltage rating of 2.5 times line voltage, 1200 PIV for 480 volts. Units using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt characteristics of the electrical system.

b. Starters shall include the following logic and control functions:

1. Adjustable maximum starting current from 200 percent to 500 percent

2. Ramp time adjustment from 1 to 40 seconds

3. Adjustable linear voltage deceleration

4. Kick start

5. Phase loss protection

6. Adjustable Undervoltage/ overvoltage protection

7. Current unbalance protection

8. Instantaneous overcurrent detection

9. Phase rotation protection (prevents starting)

10. Shorted SCR detection

11. Selectable Class 10, 20, 30 electronic overload protections. Heat sink overtemperature protection shall be provided.

12. Dry contacts for remote indication of RUN and TRIP status

13. Battery "back up" of set starter parameters

14. Event recorder

15. Elapsed time meter

16. LCD status display

c. The paralleling bypass contactor shall energize when the motor reaches full speed. The contactor shall be fully rated for across-the-line starting duty. The effect of the bypass contactor during normal operation is the elimination of heat buildup resulting from the voltage drop across the SCR's. It is the intent of the DISTRICT to use the bypass contactor also as a means of starting the motor should problems be encountered with the soft starter. A door mounted selector switch shall be furnished such that the starting means can be selected as being either via the soft starter or via the bypass contactor as across-the-line.

d. An isolation contactor shall be supplied. The isolation contactor shall remove three (3) phase power from the input side of the solid state controller when the bypass contactor is selected for across-the-line starting

e. The starter shall be housed in an appropriate NEMA rated enclosure as directed by Project drawings. Heaters and cooling fans shall be provided if required to maintain the equipment within the Manufacturer's environmental guidelines.

f. The enclosure shall be of two-door compartment type construction. The left hand compartment shall contain the starter power section and any equipment rated at line voltage. The right hand compartment shall include only that equipment rated at 120 VAC or less including the starter's CPU PC card and LCD display. The enclosure shall include a partition dividing the two compartments. Each compartment shall be designed to provide a barrier between the equipment at line voltage and the equipment at 120 VAC or less

g. The starter shall be provided with a control power transformer sized to accommodate all controls indicated on the Contract Drawings. An input power circuit breaker shall be provided. Lug termination of the incoming power conductors shall not be permitted. The starter and circuit breaker shall be rated for 42 KAIC RMS minimum, at 480V.

h. The starter shall have door mounted indication of run, phase rotation, phase loss, undervoltage, current unbalance, and current trip.

i. Door mounted LCD / keyboard display assembly designed to:

Set or examine operating parameters

Provide starter status information

Provide real-time information about line current, voltage, and frequency

Provide a means to start and stop the starter

### 2.2.3 Combination Motor Controllers

Following requirements are in addition to the requirements specified for magnetic motor controller:

a. 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.

b. 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:

(1) Provide full-voltage, full-magnetic devices as specified in this section under paragraph titled, "Remote-Control Station Enclosures." for magnetic motor controllers and enclosures.

(2) Provide thermal-magnetic breakers as specified in paragraph titled, "Manual Motor Controllers." for molded-case circuit breakers. Manufacturer's standard MCP may be used in lieu of molded-case circuit breakers.

(3) Provide control-power transformers 120-volt ac maximum, selector switches, pushbuttons, and pilot lights as required.

(4) Identify combination motor controllers with identification plates affixed to front cover of the controller.

2.2.3.1 Non-reversing Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

a. 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.

b. Provide rating of single and three-phase single-speed full-voltage magnetic controllers for nonplugging and nonjogging duty in accordance with NEMA ICS 1 and NEMA ICS 2.

c. Provide wiring and connections for full-voltage single-speed magnetic controllers in accordance with NEMA ICS 1 and NEMA ICS 2.

2.2.3.2 Reversing Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

a. For the control and protection of single-speed squirrel-cage induction motors, include two interlocked magnetic controllers with molded-case circuit breaker or MCP, with selector switch or forward/reverse/stop pushbutton and two indicating lights in the cover of the enclosure. Identify with indicating lights the forward and reverse running connection of the motor controller.

b. Provide rating of single and three-phase single-speed full-voltage magnetic controllers for plug-stop, plug-reverse, or jogging duty in accordance with NEMA ICS 1 and NEMA ICS 2.

c. Provide wiring and connections for full-voltage single-speed magnetic controllers in accordance with NEMA ICS 1 and NEMA ICS 2.

## 2.3 ENCLOSURES

### 2.3.1 Equipment Enclosures

Provide enclosures for equipment in accordance with NEMA 250.

Contain equipment installed inside, clean, dry locations in a NEMA Type 1, general-purpose sheet-steel enclosure.

Contain equipment installed in wet locations in a NEMA Type 4 watertight, corrosion-resistant sheet-steel enclosure. Construct enclosure to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4 enclosures.

Contain equipment installed in industrial locations in a NEMA Type 12 industrial use, sheet-steel enclosure. Construct enclosure to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.

Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet conforming to ASTM A167 Type 300 series with ASM No. 4 general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with UL 50.

2.3.2 Remote-Control Station Enclosures

Provide remote-control station enclosures for pushbuttons, selector switches, and indicating lights in accordance with the appropriate articles of NEMA ICS 6 and NEMA 250.

Contain remote-control stations installed in indoor, clean, dry locations in NEMA Type 1 general-purpose, sheet-steel enclosures. Contain recessed remote-control stations in standard wall outlet boxes with matching corrosion-resistant steel flush cover plate.

Contain remote-control stations installed in wet locations in NEMA Type 4 watertight, corrosion-resistant sheet-steel enclosures. Construct enclosure to prevent entrance of water when tested in accordance with NEMA ICS 6 and NEMA 250 for Type 4 enclosures.

Contain remote-control stations installed in wet locations in NEMA Type 4 watertight, cast-iron enclosures. Construct enclosure to prevent entrance of water when tested in accordance with NEMA ICS 6 and NEMA 250 for Type 4 enclosures.

Contain remote-control stations installed in dry noncombustible dust-laden atmospheres in NEMA Type 12 dust tight, cast-iron enclosures with gaskets or their equivalent to prevent the entrance of dust.

Contain remote-control stations installed in industrial locations in NEMA Type 12 industrial-use, sheet-steel enclosures. Construct enclosure to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Contain remote-control stations installed in industrial locations in NEMA Type 12 industrial-use, cast-iron enclosures. Construct enclosure to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.

Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet, conforming to ASTM A167, Type 300 series with ASM No. 4 general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with UL 50.

Install remote-control stations with the centerline 66 inches above the finished floor.

## 2.4 CIRCUIT BREAKERS

Provide circuit breakers that conform to UL 489, and NEMA AB 3.

### 2.4.1 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.

For circuit breakers used for meter circuit disconnects, meet the applicable requirements of NFPA 70 and are 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.

### 2.4.2 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 UL 489.

## 2.5 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 is first obtained by the Construction Manager.

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 high impact thermal plastic 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.

## 2.6 CONTROL DEVICES

### 2.6.1 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 1 and NEMA ICS 2.

### 2.6.2 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.

### 2.6.3 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.

Ensure the core-and-coil assembly 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.

### 2.6.4 Pushbuttons and Switches

#### 2.6.4.1 Pushbuttons

For low-voltage ac full-voltage pushbutton controllers, provide heavy-duty oil-tight NEMA 250, Type 12, 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. Identify the system being controlled on the identification plate.

#### 2.6.4.2 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. Identify the system being controlled on the identification plate.

#### 2.6.4.3 Miscellaneous Switches

Provide float, limit, door, pressure, proximity, and other types of switches in accordance with IPC D330 and of the types and classes indicated.

## 2.7 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.

## 2.8 INDICATING LIGHTS

### 2.8.1 General-Purpose Type

For indicating lights, provide oil tight instrument devices with threaded base and collar for flush-mounting, translucent convex lens, candelabra screw-base lamp holder, and 120-volt, 6-watt, Type S-6 incandescent lamp in accordance with ANSI C78.23. Provide indicating lights color coded in accordance with NEMA ICS 6.

Provide indicating lights in remote-control stations when pushbuttons and selector switches are out of sight of the controller.

### 2.8.2 Switchboard Indicating Lights

For switchboard indicating lights, provide the manufacturer's standard transformer type units 120-volt input utilizing low-voltage lamps and convex lenses of the colors indicated. Provide indicating lights that are capable of being relamped from the switchboard front. Indicating lights utilizing resistors in series with the lamps are not permitted except in direct-current control circuits. Provide lights that have a press-to-test feature.

## 2.9 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. Field adjust and operations test the control and protective devices. Conform to NFPA 70, NEMA ICS 1 and NEMA ICS 2 requirements for installation of control and protective devices.

## 3.2 FIELD TESTING

Demonstrate the operation and controls of protective devices of non-factory installed equipment.

Verify tap settings of instrumentation, potential, and current transformers.

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 by the Construction Manager. Provide final test reports with a cover letter/sheet clearly marked with the System name, Date, and the words Final Test Reports to the Construction Manager for approval.

-- End of Section --

# SECTION 26 08 50

# FIELD TESTING

## PART 1 GENERAL

### 1.1 SCOPE

A. Summary of Work: This Section specifies the Work necessary to test, commission, and demonstrate that the electrical work satisfies the criteria of these specifications and functions as required by the Contract Documents. The Work of this Section includes furnishing the labor, equipment, and power required to support the testing specified in other divisions of these Specifications. This scope may require the Contractor to activate circuits, shutdown circuits, and run equipment, make electrical measurements, replace blown fuses, install temporary jumpers, etc.

B. Related Work Specified Elsewhere:

1. Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS requirements apply to the Work of this Section.

### 1.2 APPLICABLE STANDARDS AND PUBLICATIONS

A. Standards or Codes: The edition of the publications of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. In the case of a conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail:

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM | ASTM Standards |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 81 | (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14) National Electrical Code |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA | NEMA Requirements |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA | Acceptance Testing Specifications |

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA ICEA Standards

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET Certifications

1.3 DEFINITIONS

Not Used

1.4 SUBMITTALS

SD-06 Test Reports

Five (5) bound copies of the certified test reports shall be submitted by the independent testing firm to the Contractor upon completion of the Project. The final report shall be signed and shall include the following information:

Summary of Work

Description of equipment tested

Visual Equipment report

Description of tests

Test data

Analysis and recommendations

Appropriate test forms

Identification of test equipment used and calibration dates

1.5 QUALIFICATIONS

A. The testing Contractor shall submit appropriate documentation to demonstrate that it satisfactorily complies with the following. The Contractor shall have a Full Membership classification issued by the International Electrical Testing Association. The following criteria shall be met.

1. The testing Contractor shall be an independent, third party, testing organization which can function as an unbiased testing authority, professionally independent of the Manufacturers, suppliers, and installers of equipment or systems evaluated by the Contractor.

2. The testing Contractor shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

B. The testing organization shall utilize technicians who are regularly employed for testing services.

C. Each on-site crew leader shall hold a current registered certification in electrical testing applicable to each type of apparatus to be inspected or tested. The certification in electrical testing shall be issued by an independent, nationally-recognized, technician certification agency. The following entities shall qualify as independent, nationally-recognized, technician certification agencies:

1. International Electrical Testing Association (NETA)

   Accepted certifications:

   a. Certified Senior Technician/Level IV

   b. Certified Technician/Level III

2. National Institute of Certification in Engineering Technologies (NICET)

   Accepted certifications specifically in Electrical Testing Engineering Technology:

   a. Senior Engineering Technician/Level IV

   b. Engineering Technician/Level III

1.6 RESPONSIBILTIES

A. The Contractor shall notify and coordinate scheduling with the Independent Testing Subcontractor when equipment becomes available for acceptance tests.

B. The Contractor shall provide the Independent Testing Subcontractor with a complete set of approved electrical drawings, appropriate test forms, coordination study (if applicable), settings of all adjustable devices (if applicable), Manufacturer's instruction manuals and any other information necessary for an accurate evaluation of the equipment and systems prior to performance of any tests.

C. The Contractor shall provide a suitable source of electrical power as specified by the Independent Testing Firm at each test Site point of need.

D. The Contractor shall provide a visual equipment report in addition to a report to the District about any system, equipment, material, or workmanship which is found deficient on the basis of acceptance tests.

E. The Contractor shall correct deficiencies identified by tests and make ready for retest.

F. The Contractor shall hire and pay for the services of the Independent Testing Firm to retest any equipment found to be deficient at initial testing until specified requirements are met.

## 1.7 DESCRIPTION OF EQUIPMENT TESTED

A. The following ASTM and NEMA related test data requirements supplement test and acceptance criteria that may be stated elsewhere.

1. Lighting: Switching, including remote control, if indicated. Verify circuitry is in accordance with panel schedules. Switches rated less than 600V shall be tested in accordance with NETA ATS Section 7.5.1.1. Switches shall be toggled, back and or side contacts tested for correct wiring, any special features verified.

2. Instrument transformers shall be tested as per NETA ATS Section 7.10.

3. Activate ground fault tripping by operating test features provided with ground current protective systems and by injecting a known and reasonable current in the ground current sensor circuit. Testing procedures outlined in NETA ATS Section 7.14 - Ground Fault Protection Systems - shall also be used.

4. Surge arrestors rated less than 600V shall be tested as per NETA ATS Section 7.19.1

5. Protective relays shall be tested as per NETA ATS Section 7.9.

6. Electric panels rated less than 600V shall be tested as per the requirements of NETA ATS Section 7.1.

7. Automatic Transfer Switches shall be tested as per NETA ATS Section 7.22.3.

8. Batteries shall be tested as per NETA ATS Section 7.18.1.

9. Battery chargers shall be tested as per NETA ATS Section 7.18.2.

10. Emergency/Standby generators shall be tested as per NETA ATS Section 7.22.1.

11. Motor starters rated less than 600V shall be tested in accordance with NETA ATS Section 7.16.1.1.

12. Cable Testing: Low voltage 600-volt maximum cable shall be tested for insulation resistance. Testing shall be done after the equipment is terminated. Inspection and test procedures, as outlined in NETA ATS Section 7.3.2 Cables, shall be followed. Test results, stating equipment used and time of test shall be submitted for review 30 days prior to plant operation and any system testing. Equipment which may be damaged during this test shall be disconnected. Perform tests with all other equipment connected to the circuit. In order to be acceptable, the cable must withstand the test high voltage without breakdown, have steady or decreasing leakage current during the high potential test, and have satisfactory comparable megger readings in each megger test as identified in the ICEA standards.

13. Test ground interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle Manufacturer. Inspection and test procedures outlined in NETA Acceptance Testing

Specifications Section 7.14 - Ground Fault Protection Systems - shall also be used.

14. A functional test and check of all electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Inspection and test procedures outlined in NETA ATS Section 8.1 - System Functional Tests - shall be used. Functional testing shall comprise:

a. Circuit breakers insulated case or molded shall be tested per the requirements set forth in NETA ATS Section 7.6.1.1. Circuit breakers which have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field adjusted by a representative of the circuit breaker Manufacturer. Time and pickup setting shall correspond to the analysis and recommendations of the Short Circuit Study provided by the equipment vendor. Setting shall be tabulated and proven for each circuit breaker in its installed position.

b. Switches rated less than 600V shall be tested in accordance with NETA ATS Section 7.5.1.1. Switches shall be toggled, back and or side contacts tested for correct wiring, any special features verified.

15. Complete ground testing of all grounding electrodes per requirements below prior to operating the equipment. Inspection and test procedures outlined in NETA ATS Section 7.13 - Grounding Systems - shall be used.

## 1.8 DESCRIPTION OF TESTS

A. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the DISTRICT and after process control devices have been adjusted as accurately as possible. It is intended that the Contractor will adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.

B. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.

C. Motor operated valves shall be tested after having been phased and tested for correct motor rotation and after travel and torque limit switches have been adjusted by a representative of the valve Manufacturer. Tests shall verify status indication, proper valve travel, and correct command control from local and remote devices.

D. Provide ground resistance tests on the main grounding electrode or system in the presence of the District and submit results. Utilize the fall-of-potential method or alternative, in accordance with IEEE 81.

E. Subsystems shall be defined as individual and groups of pumps, chemical feeders, air conditioning units, ventilation fans, air compressors, etc.

F. General: Carry out tests indicated herein for individual items of materials and equipment in other Sections especially ones related to the NFPA 70 (National Electric Code).

1.9 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide 48 hours notice of its intention to begin new Work activities

1.10 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 IDENTIFICATION OF TEST EQUIPMENT USED AND CALIBRATION DATES

The Contractor shall provide date-calibrated testing equipment required which includes but are not limited to the following:

A. Wet- and dry-bulb thermometer

B. 1000V meggers

C. Battery-powered portable telephone sets and portable radios

D. Digital High Precision Multimeter

E. Commercial model three-point ground test set

F. Miscellaneous cable, test lights, buzzers, bells, switches, receptacles, plugs, and other equipment as required

PART 3 EXECUTION

Not Used

-- End of Section --

# SECTION 26 14 00

# LPG FUEL TANK MONITORING SYSTEM

## PART 1 GENERAL

### 1.1 SCOPE

The Contractor shall furnish the fuel leak detection system and related products which satisfy the performance, design and material criteria of this section. The Contractor is responsible for insuring all tests, adjustments and demonstrations are performed to the satisfaction of the District as well as for providing the required warranty, manuals and training as described herein.

### 1.2 STANDARD REFERENCES

The latest edition of the following standard references shall apply to the design and fabrication of the products and equipment to be supplied under this contract.

A. National Electrical Code, (NEC).

B. National Electrical Manufacturer's Association, (NEMA).

C. Underwriters Laboratories, (UL).

### 1.3 SUBMITTALS

SD-03 Product Data

Fuel Detection Leak System

Monitoring System

The Contractor shall submit for the District's approval complete product data and specifications. The submittal shall also include a drawing showing all conduit layout for each system provided.

SD-06 Test Reports

Performance Test

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

### 1.4 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

## PART 2 PRODUCTS

### 2.1 GENERAL

The fuel detection leak system provided shall continuously monitor for leakage of Liquefied Petroleum Gas (LPG) fuel. The system provided shall be the standard product of a Manufacturer regularly engaged in the manufacture of this type of equipment and shall be suitable for the intended use as defined herein or as necessary to satisfy the overall intent of these specifications. Reference to any equipment, article or catalog number shall not be construed as limiting competition, but only as establishing a standard of quality.

### 2.2 SYSTEM COMPONENTS

The monitoring system shall be a MDI LPG Stationary Tank Monitor (PN 94442A). The Contractor shall submit complete product data of any desired substitution to the District for approval.

## PART 3 EXECUTION

### 3.1 INSPECTION

Examine the substrates and conditions under which the monitoring system is to be installed and notify the District, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION AND TESTING

Install equipment complete with necessary hardware in accordance with the Drawings, Manufacturer's instructions, and as specified herein.

The control unit shall be wall mounted within the office of the pump station (exact location to be field determined).

Sensors shall be installed as shown on the Drawings. Cable from the sensors shall be routed to the control unit via 3/4 inch galvanized steel conduit. The Contractor shall route the conduit to minimize conflicts.

A performance test of the complete system after installation shall be tested to insure proper performance. All final adjustments necessary to all parts of the equipment furnished under this Contract shall be made during this operating test. All tests specified herein shall be at the expense of the Contractor and shall be conducted by a representative of the Manufacturer and witnessed by the District.

### 3.3 OPERATION AND MAINTENANCE MANUALS

The Contractor shall submit, prior to Contract Close-out, the system's maintenance and operation manuals. All manuals shall be reviewed by the District for approval. Any manual rejected by the District shall be revised and resubmitted by accordingly.

-- End of Section --

# SECTION 26 20 00

# INTERIOR DISTRIBUTION 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 in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B1 | (2013) Standard Specification for Hard-Drawn Copper Wire |
| ASTM B8 | (2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM D709 | (2017) Standard Specification for Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE 81 | (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |
| IEEE C2 | (2017; Errata 1 2017) National Electrical Safety Code |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C80.1 | (2005) American National Standard for Electrical Rigid Steel Conduit (ERSC) |
| NEMA 250 | (2014) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA FU 1 | (2012) Low Voltage Cartridge Fuses |
| NEMA ICS 1 | (2000; R 2015) Standard for Industrial Control and Systems: General Requirements |

| | |
|---|---|
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA KS 1 | (2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum) |
| NEMA RN 1 | (2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit |
| NEMA ST 20 | (1992; R 1997) Standard for Dry-Type Transformers for General Applications |
| NEMA TC 14 | (2002) Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings |
| NEMA TC 2 | (2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit |
| NEMA TC 3 | (2016) Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing |
| NEMA VE 1 | (2009) Standard for Metal Cable Tray Systems |
| NEMA WD 1 | (1999; R 2015) Standard for General Color Requirements for Wiring Devices |
| NEMA WD 6 | (2016) Wiring Devices Dimensions Specifications |
| NEMA Z535.4 | (2011) American National Standard for Product Safety Signs and Labels |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |
| NFPA 70E | (2015; ERTA 1 2015) Standard for Electrical Safety in the Workplace |
| NFPA 780 | (2014) Standard for the Installation of Lightning Protection Systems |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA-568-C.1 | (2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard |
| TIA-569 | (2015d) Commercial Building Standard for Telecommunications Pathways and Spaces |
| TIA-607 | (2011b) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises |

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

| | |
|---|---|
| 29 CFR 1910.147 | Control of Hazardous Energy (Lock Out/Tag Out) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1 | (2005; Reprint Jul 2012) Standard for Flexible Metal Conduit |
| UL 4 | (2004; Reprint Feb 2018) Standard for Armored Cable |
| UL 1203 | (2013; Reprint Apr 2015) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations |
| UL 1242 | (2006; Reprint Mar 2014) Standard for Electrical Intermediate Metal Conduit -- Steel |
| UL 1283 | (2015; Reprint Jan 2016) Electromagnetic Interference Filters |
| UL 1449 | (2014; Reprint Mar 2016) Surge Protective Devices |
| UL 1561 | (2011; Reprint Jun 2015) Dry-Type General Purpose and Power Transformers |
| UL 1569 | (2014; Reprint Dec 2015) Standard for Metal-Clad Cables |
| UL 1660 | (2014) Liquid-Tight Flexible Nonmetallic Conduit |
| UL 1699 | (2006; Reprint Nov 2013) Arc-Fault Circuit-Interrupters |
| UL 198M | (2003; Reprint Feb 2013) Standard for Mine-Duty Fuses |
| UL 20 | (2010; Reprint Feb 2012) General-Use Snap Switches |
| UL 2043 | (2013) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces |
| UL 360 | (2013; Reprint Jan 2015) Liquid-Tight Flexible Steel Conduit |
| UL 4248-1 | (2007; Reprint Oct 2013) UL Standard for Safety Fuseholders - Part 1: General Requirements |

| | |
|---|---|
| UL 4248-12 | (2007; Reprint Dec 2012) UL Standard for Safety Fuseholders - Part 12: Class R |
| UL 467 | (2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment |
| UL 486A-486B | (2013; Reprint Jan 2016) Wire Connectors |
| UL 486C | (2013; Reprint Jan 2016) Splicing Wire Connectors |
| UL 489 | (2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 498 | (2012; Reprint Jan 2016) Attachment Plugs and Receptacles |
| UL 5 | (2011) Surface Metal Raceways and Fittings |
| UL 50 | (2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations |
| UL 510 | (2005; Reprint Jul 2013) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape |
| UL 514A | (2013) Metallic Outlet Boxes |
| UL 514B | (2012; Reprint Nov 2014) Conduit, Tubing and Cable Fittings |
| UL 514C | (2014; Reprint Dec 2014) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers |
| UL 5A | (2015) Nonmetallic Surface Raceways and Fittings |
| UL 6 | (2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel |
| UL 651 | (2011; Reprint May 2014) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings |
| UL 67 | (2009; Reprint Apr 2015) Standard for Panelboards |
| UL 674 | (2011; Reprint Jul 2013) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations |
| UL 719 | (2006; Reprint Apr 2013) Nonmetallic-Sheathed Cables |
| UL 817 | (2015; Reprint Jan 2016) Standard for Cord Sets and Power-Supply Cords |

| | |
|---|---|
| UL 83 | (2014) Thermoplastic-Insulated Wires and Cables |
| UL 854 | (2004; Reprint Nov 2014) Standard for Service-Entrance Cables |
| UL 869A | (2006) Reference Standard for Service Equipment |
| UL 870 | (2008; Reprint Feb 2013) Standard for Wireways, Auxiliary Gutters, and Associated Fittings |
| UL 943 | (2006; Reprint Jun 2012) Ground-Fault Circuit-Interrupters |

## 1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

Panelboards

Transformers

Cable trays

Wireways

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. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submit a conduit layout for all exterior and interior underground conduit installations indicating the number and size of conduits, conduit routing, and conduit depth or location within concrete slabs and underground. The District shall be given adequate time for comparison inspection and approval of the conduit layout plans prior to any concrete being poured or any backfill being placed.

Conduit Layout Plans

SD-03 Product Data

Receptacles

Circuit breakers

Switches

Transformers

Surge protective devices

Include device performance and characteristic curves.

Marking strips

SD-06 Test Reports

600-volt wiring tests

Transformer tests

Ground-fault receptacle test

SD-07 Certificates

Fuses

SD-09 Manufacturer's Field Reports

SD-10 Operation and Maintenance Data

Electrical Systems~~, Data Package 5~~

Submit operation and maintenance data in accordance with Section 01 78 05 OPERATION AND MAINTENANCE INFORMATION and as specified herein.

## 1.4 QUALITY REQUIREMENTS

### 1.4.1 Labor Qualifications

All electrical work shall be performed by personnel employed by an Electrical Contractor licensed in the State of Florida. Actual work shall be performed by Master and or Journeyman electricians or personnel under direct on-site supervision of a Master and or a Journeyman electrician. If the work is performed under the direct on-site supervision of a Journeyman electrician, he or she shall be certified in the county in which the work is performed or meet the reciprocity standards of Florida State Statue 489 part II. The credentials of the Electrical Contractor, Master and/or Journeyman electricians shall be supplied to the District upon request.

### 1.4.2 Fuses

Submit coordination data as specified in paragraph, FUSES of this section.

1.4.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" 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 Construction Manager. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been in satisfactory commercial or industrial use for at least 1 year prior to substantial completion including applications of equipment and materials under similar circumstances and of similar size. If not, get with Construction Manager to determine course of action before installation.

~~b~~c. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

~~c~~d. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.5 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.6 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.5 MAINTENANCE

1.5.1 Electrical Systems

Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

~~a~~1.5.1.1. Single line diagram of the "as-built" building electrical system.

~~b~~1.5.1.2. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

~~c~~1.5.1.3. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.6 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices. Provide the standard cataloged materials and equipment of manufacturers regularly engaged in the manufacture of the products. For material, equipment, and fixture lists submittals, show manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

2.2 CONDUIT AND FITTINGS

Conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40, and EPC-80 in accordance with NEMA TC 2, UL 651 in accordance with NEMA TC 14.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40(40 mils thick).

2.2.5 Flexible Metal Conduit

UL 1.

2.2.5.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

2.2.6 Fittings for Metal Conduit and Flexible Metal Conduit

UL 514B. Ferrous fittings: cadmium- or zinc-coated in accordance with UL 514B.

2.2.6.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, and UL 514B.

2.2.8 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

2.3 SURFACE RACEWAY

2.3.1 Surface Metal Raceway

UL 5, two-piece painted steel, totally enclosed, snap-cover type. Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Provide receptacles as specified herein, spaced a minimum of one every 18 inches. Wire alternate receptacles on different circuits.

2.3.2 Surface Nonmetallic Raceway

UL 5A, nonmetallic totally enclosed, snap-cover type. Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Provide receptacles as specified herein, spaced a minimum of one every 455 inches. Wire alternate receptacles on different circuits.

2.4 CABLE TRAYS

NEMA VE 1. Provide the following:

a. Cable trays: form a wireway system, with a nominal 6-inch depth.

b. Cable trays: constructed of aluminum.

c. Cable trays: include splice and end plates, dropouts, and miscellaneous hardware.

d. Edges, fittings, and hardware: finished free from burrs and sharp edges.

e. Fittings: ensure not less than load-carrying ability of straight tray sections and have manufacturer's minimum standard radius.

f. Radius of bends 36 inches.

2.4.1 Ladder-Type Cable Trays

Provide size as indicated of nominal 36-inch width with maximum rung spacing of 18 inches.

2.4.2 Channel-Type Cable Trays

Provide of nominal 6-inch width. Provide trays with one-piece construction having slots spaced not more than 4 1/2 inches on centers.

## 2.5 OPEN TELECOMMUNICATIONS CABLE SUPPORT

### 2.5.1 Open Top Cable Supports

Provide open top cable supports in accordance with UL 2043. Provide galvanized steel open top cable supports.

### 2.5.2 Closed Ring Cable Supports

Provide closed ring cable supports in accordance with UL 2043. Provide galvanized steel closed ring cable supports as indicated.

## 2.6 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

### 2.6.1 Outlet Boxes for Telecommunications System

Provide the following:

a. Standard type 4 11/16 inches square by 2 1/8 inches deep.

b. Outlet boxes for wall-mounted telecommunications outlets: 4 by 2 1/8 by 2 1/8 inches deep.

c. Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.

d. Outlet boxes for fiber optic telecommunication outlets: include a minimum 3/8 inch deep single or two gang plaster ring as shown and installed using a minimum 1-inch conduit system.

### 2.6.2 Clock Outlet for Use in Other Than Wired Clock System

Provide the following:

a. Outlet box with plastic cover, where required, and single receptacle with clock outlet plate.

b. Receptacle: recessed sufficiently within box to allow complete insertion of standard cap, flush with plate.

c. Suitable clip or support for hanging clock: secured to top plate.

d. Material and finish of plate: as specified in paragraph DEVICE PLATES of this section.

## 2.7 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 100 cubic inches, UL 50, hot-dip, zinc-coated, if sheet steel.

## 2.8 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

### 2.8.1 Conductors

Provide the following:

a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise.

b. Conductors No. 8 AWG and larger diameter: stranded.

c. Conductors No. 10 AWG and smaller diameter: stranded, except solid for lighting circuits, telephone circuits, and small gauge signal circuits only.

d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.

e. All conductors: copper. Conductors indicated to be No. 6 AWG or smaller diameter: copper. Conductors indicated to be No. 4 AWG and larger diameter: copper unless type of conductor material is specifically indicated, or specified, or required by equipment manufacturer.

#### 2.8.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.

#### 2.8.1.2 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

a. Branch circuits: No. 12 AWG.

b. Class 1 remote-control and signal circuits: No. 14 AWG.

c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.

d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.

### 2.8.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling circuit conductors.

#### 2.8.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

a. Grounding conductors: Green.

b. Neutral conductors: White.

c. Exception, where neutrals of more than one system are installed in same raceway or box, other neutrals color coding: white with a different colored (not green) stripe for each.

2.8.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase: Black and red

d. On three-phase, four-wire delta system, high leg: orange, as required by NFPA 70.

2.8.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, provide power and lighting wires rated for 600-volts, Type THWN/THHN conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits: Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.8.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.8.4.1 Telecommunications Bonding Backbone (TBB)

| **Sizing of the TBB** | |
|---|---|
| TBB length linear m feet | TBB Size (AWG) |
| less than 4 13 | 6 |

| Sizing of the TBB | |
|---|---|
| 4 - 6 14 - 20 | 4 |
| 6 - 8 21 - 26 | 3 |
| 8 - 10 (27 - 33) | 2 |
| 10 - 13 34 - 41 | 1 |
| 13 - 16 (42 - 52) | 1/0 |
| 16 - 20 53 - 66 | 2/0 |
| greater than 20 66 | 3/0 |

Provide a copper conductor TBB in accordance with TIA-607 with No. 6 AWG minimum size and sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. Provide insulated TBB with insulation as specified in the paragraph INSULATION and meeting the fire ratings of its pathway.

2.8.4.2 Bonding Conductor for Telecommunications

Provide a copper conductor Bonding Conductor for Telecommunications between the telecommunications main grounding busbar (TMGB) and the electrical service ground in accordance with TIA-607. Size the bonding conductor for telecommunications the same as the TBB. Bond the ends of the cable tray in the control room to the TMGB.

2.8.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

2.8.6 Nonmetallic Sheathed Cable

UL 719, Type NM or NMC.

2.8.7 Wire and Cable for 400 Hertz (Hz) Circuits

Insulated copper conductors.

2.8.8 Metal-Clad Cable

UL 1569; NFPA 70, Type MC cable.

2.8.9 Armored Cable

UL 4; NFPA 70, Type AC cable.

2.8.10 Mineral-Insulated, Metal-Sheathed Cable

UL listed; NFPA 70, Type MI cable. Do not use sheathing containing asbestos fibers.

2.8.11 Cord Sets and Power-Supply Cords

UL 817.

## 2.9 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

## 2.10 DEVICE PLATES

Provide the following:

a. UL listed, one-piece device plates for outlets to suit the devices installed.

b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.

c. For nonmetallic boxes and fittings, other suitable plates may be provided.

d. Plates on finished walls: nylon or Lexan, minimum 0.03-inch wall thickness and same color as receptacle or toggle switch with which they are mounted.

e. Plates on finished walls: satin finish stainless steel or brushed-finish aluminum, minimum 0.03 inch thick.

f. Screws: machine-type with countersunk heads in color to match finish of plate.

g. Sectional type device plates are not to be permitted.

h. Plates installed in wet locations: gasketed and UL listed for "wet locations."

## 2.11 SWITCHES

### 2.11.1 Toggle Switches

NEMA WD 1, UL 20, single pole, double pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

a. Handles: white thermoplastic.

b. Wiring terminals: screw-type, side-wired or of the solderless pressure type having suitable conductor-release arrangement.

c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.

d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

### 2.11.2 Switch with Red Pilot Handle

NEMA WD 1. Provide the following:

a. Pilot lights that are integrally constructed as a part of the switch's handle.

b. Pilot light color: red and illuminate whenever the switch is closed or "on".

c. Pilot lighted switch: rated 20 amps and 120 volts or 277 volts as indicated.

d. The circuit's neutral conductor to each switch with a pilot light.

2.11.3 Breakers Used as Switches

For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.

2.11.4 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in NEMA 3R, enclosure or as indicated per NEMA ICS 6.

2.12 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch and control center. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

2.12.1 Fuseholders

Provide in accordance with UL 4248-1.

2.12.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 198M, Class RK-5 time-delay type. Provide only Class R associated fuseholders in accordance with UL 4248-12.

2.12.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 198M, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.12.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 198M, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.13 RECEPTACLES

Provide the following:

a. UL 498, hard use (also designated heavy-duty), grounding-type.

b. Ratings and configurations: as indicated.

c. Bodies: white as per NEMA WD 1.

d. Face and body: thermoplastic supported on a metal mounting strap.

e. Dimensional requirements: per NEMA WD 6.

f. Screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.

g. Grounding pole connected to mounting strap.

h. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.

2.13.1 Switched Duplex Receptacles

Provide separate terminals for each ungrounded pole. Top receptacle: switched when installed.

2.13.2 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations". Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, die-cast metal/aluminum cover plate.

2.13.3 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.13.4 Special Purpose Receptacles

Receptacles as special purpose. Provide in ratings indicated. Provide in ratings and configuration indicated. Receptacles on a standby-generator system shall be colored red. Furnish one matching plug with each receptacle.

2.13.5 Plugs

Provide heavy-duty, rubber-covered three-, four-, or five-wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the District.

2.13.6 Range Receptacles

NEMA 14-50 configuration, rated 50 amperes, 125/250 volts. Furnish one matching plug with each receptacle.

2.13.7 Dryer Receptacles

NEMA 14-30 configuration, rated 30 amperes, 125/250 volts. Furnish one matching plug with each receptacle.

## 2.14 PANELBOARDS

Provide panelboards in accordance with the following:

a. UL 67 and UL 50 having a short-circuit current rating as indicated.

b. Panelboards for use as service disconnecting means: additionally, conform to UL 869A.

c. Panelboards: circuit breaker-equipped.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings.

f. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise.

g. Main breaker: "separately" mounted "above" or "below" branch breakers.

h. Where "space only" is indicated, make provisions for future installation of breakers.

i. Directories: indicate load served by each circuit in panelboard.

j. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP).

k. Type directories and mount in holder behind transparent protective covering.

l. Panelboards: listed and labeled for their intended use.

m. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

### 2.14.1 Enclosure

Provide panelboard enclosure in accordance with the following:

a. UL 50.

b. Cabinets mounted outdoors or flush-mounted: hot-dipped galvanized after fabrication.

c. Cabinets: painted in accordance with paragraph PAINTING.

d. Outdoor cabinets: NEMA 3R raintight with a removable steel plate 1/4-inch-thick in the bottom for field drilling for conduit connections.

e. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.

f. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 1/8 inch.

g. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2-inch clear space between the back of the cabinet and the wall surface.

h. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.

i. Each door: fitted with a combined catch and lock, except that doors over 24 inches long provided with a three-point latch having a knob with a T-handle, and a cylinder lock.

j. Keys: two provided with each lock, with all locks keyed alike.

k. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

2.14.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.14.2.1 Panelboard Neutrals for Non-Linear Loads

Provide in accordance with the following:

a. UL listed, with panelboard type specifically UL heat rise tested for use on non-linear loads.

b. Panelboard: heat rise tested in accordance with UL 67, except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing.

c. Verification of the testing procedure: provided upon request.

d. Two neutral assemblies paralleled together with cable is not acceptable.

e. Nameplates for panelboard rated for use on non-linear loads: marked "SUITABLE FOR NON-LINEAR LOADS" and in accordance with paragraph FIELD FABRICATED NAMEPLATES.

f. Provide a neutral label with instructions for wiring the neutral of panelboards rated for use on non-linear loads.

### 2.14.3 Circuit Breakers

UL 489, thermal magnetic-type solid state-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

#### 2.14.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

#### 2.14.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A ground-fault circuit interrupter.

#### 2.14.3.3 Circuit Breakers for HVAC Equipment

Provide circuit breakers for HVAC equipment having motors (group or individual) marked for use with HACR type and UL listed as HACR type.

#### 2.14.3.4 Arc-Fault Circuit Interrupters

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated. Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable. Provide with "push-to-test" button.

## 2.15 TRANSFORMERS

Provide transformers in accordance with the following:

a. NEMA ST 20, general purpose, dry-type, self-cooled, ventilated.

b. Provide transformers in NEMA 3R enclosure.

c. Transformer insulation system:

   (1) 220 degrees C insulation system for transformers 15 kVA and greater, with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C.

   (2) 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 80 degrees C under full-rated load in maximum ambient of 40 degrees C.

d. Transformer of 115 degrees C temperature rise: capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.

e. Transformer of 80 degrees C temperature rise: capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.

2.15.1 Transformers With Non-Linear Loads

Provide transformers for non-linear loads in accordance with the following:

a. Transformer insulation: UL recognized 220 degrees C system. Neither the primary nor the secondary temperature is allowed to exceed 220 degrees C at any point in the coils while carrying their full rating of non-sinusoidal load.

b. Transformers are to be UL listed and labeled for K-Factor rating as indicated in accordance with UL 1561.

c. Transformers evaluated by the UL K-Factor evaluation: listed for 115 degrees C average temperature rise only.

d. Transformers with K-Factor ratings with temperature rise of 150 degrees C rise are not acceptable.

e. K-Factor rated transformers impedance: allowed range of 3 percent to 5 percent, with a minimum reactance of 2 percent to prevent excessive neutral current when supplying loads with large amounts of third harmonic.

2.16 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Comply with requirements of Division 23, "Mechanical" for mechanical isolation of machines and other equipment.

2.17 TELECOMMUNICATIONS SYSTEM

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires wireways, cable trays, and other accessories for telecommunications outlets and pathway in accordance with TIA-569 and as specified herein.

2.17.1 Backboards

Provide void-free, fire rated interior grade plywood, 3/4-inch-thick, 4 by 8 feet as indicated. Do not cover the fire stamp on the backboard.

2.18 GROUNDING AND BONDING EQUIPMENT

2.18.1 Ground Rods

UL 467. Ground rods: copper-clad steel, with minimum diameter of 3/4 inch and minimum length 10 feet. Sectional ground rods are permitted.

2.19 GROUNDING AND BONDING EQUIPMENT

Provide grounding and bonding in accordance with NFPA 70 and NFPA 780. In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA-607.

## 2.20 HAZARDOUS LOCATIONS

Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70: specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for particular "Class," "Division," and "Group" of hazardous locations involved. Boundaries and classifications of hazardous locations: as indicated. Equipment in hazardous locations: comply with UL 1203 for electrical equipment and industrial controls and UL 674 for motors.

## 2.21 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

## 2.22 FIELD FABRICATED NAMEPLATES

Provide 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. Attach identification plates to process control devices and pilot lights.

Install identification plates for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source.

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 0.125-inch-thick, white with black center core.

e. Provide red laminated plastic label with white center core where indicated.

f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

g. Minimum size of nameplates: one by 2.5 inches.

h. Lettering size and style: a minimum of 0.25-inch-high normal block style.

## 2.23 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

## 2.24 WIREWAYS

UL 870. Material: steel epoxy painted galvanized 16 gauge for heights and depths up to 6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length required for the application with hinged-cover NEMA 12 enclosure per NEMA ICS 6.

## 2.25 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service entrance, load centers, panelboards, MCC. Provide surge protectors in a NEMA 1 3R enclosure per NEMA ICS 6. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker. Include performance and characteristic curves.

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Phase to phase ( L-L )
Each phase to neutral ( L-N )

FOR DELTA CONNECTIONS-
Phase to phase ( L-L )
Phase to ground ( L-G )

SPDs at the service entrance: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G) and downstream SPDs rated 40,000 amperes for L-L mode minimum and 20,000 amperes for other modes (L-N, L-G, and N-G).

Provide SPDs per NFPA 780 for the lightning protection system.

Maximum L-N, L-G, and N-G Voltage Protection Rating:

600V for 120V, single phase system
600V for 120/240V, single phase system
600V for 208Y/120V, three phase system
1,200V for 480Y/277V, three phase system

Maximum L-L Voltage Protection Rating:

1,200V for 120V, single phase system
1,200V for 120/240V, single phase system
1,200V for 208Y/120V, three phase system

1,200V for 480Y/277V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120% of nominal voltage for 240 volts and below; 115% of nominal voltage above 240 volts to 480 volts.

Provide EMI/RFI filtering per UL 1283 for each mode with the capability to attenuate high frequency noise. Minimum attenuation: 20db.

## 2.26 FACTORY APPLIED FINISH

Provide factory-applied finish on electrical equipment in accordance with the following:

a. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.

b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.

c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.

d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.

e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.

f. Equipment located indoors: ANSI Light Gray, and equipment located outdoors: ANSI Dark Gray.

g. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

### 3.1.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

### 3.1.2 Hazardous Locations

Perform work in hazardous locations, as defined by NFPA 70, in strict accordance with NFPA 70 for particular "Class," "Division," and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Provide conduit with tapered threads.

### 3.1.3 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

#### 3.1.3.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

### 3.1.4 Wiring Methods

Provide insulated conductors installed in rigid steel conduit or rigid nonmetallic conduit, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Shared neutral, or multi-wire branch circuits, are not permitted with arc-fault circuit interrupters. Minimum conduit size: 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 6 inches.

#### 3.1.4.1 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

### 3.1.5 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

Ensure that conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting does 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 replace conduit.

3.1.5.1 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40 and PVC Schedule 80

(1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, hospitals, power plants, missile magazines, and other such areas.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

(4) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

3.1.5.2 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS.

3.1.5.3 Underground Conduit

Plastic-coated rigid steel; PVC, Type EPC-40; or fiberglass. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or steel conduit before rising through floor slab. Plastic coating: extend minimum 6 inches above floor.

3.1.5.4 Conduit for Circuits Rated Greater Than 600 Volts

Rigid metal conduit or IMC only.

3.1.5.5 Conduit Installed Under Floor Slabs

Conduit run under floor slab: located a minimum of 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.

3.1.5.6 Conduit Through Floor Slabs

Where conduits rise through floor slabs, do not allow curved portion of bends to be visible above finished slab.

3.1.5.7 Conduit Installed in Concrete Floor Slabs

Rigid steel; or PVC, Type EPC-40. PVC, Type EPC-40, unless indicated otherwise. Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Do not stack conduits. Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum one inch cover over conduit. Where embedded conduits cross building and/or expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings must allow horizontal and vertical movement of raceway. Conduit larger than one inch trade size: installed parallel with or at right angles to main reinforcement; when at right angles to reinforcement, install conduit close to one of supports of slab. Where nonmetallic conduit is used, convert raceway to plastic coated

rigid steel before rising above floor, unless specifically indicated. Provide conduit layout plans for comparison inspection and District approval prior to any concrete being poured or any backfill being placed..

3.1.5.8 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.5.9 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations.

3.1.5.10 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.5.11 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.5.12 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semi recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 1/2-inch diameter. Provide liquid tight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.1.5.13 Telecommunications and Signal System Pathway

Install telecommunications pathway in accordance with TIA-569.

a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room: installed and cabling length requirements in accordance with TIA-568-C.1. Size conduits, wireways, and cable trays in accordance with TIA-569 and as indicated.

b. Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and, telecommunications equipment rooms (backbone cabling): installed in accordance with TIA-569. Size conduits, wireways, and cable trays for telecommunications risers in accordance with TIA-569 and as indicated.

3.1.6 Telecommunications Cable Support Installation

Install open top and closed ring cable supports on 4 ft to 5 ft centers to adequately support and distribute the cable’s weight. Use these types of supports to support a maximum of 50 0.25 in diameter cables. Install suspended cables with at least 3 in of clear vertical space above the ceiling tiles and support channels (T-bars). Open top and closed ring cable supports: suspended from or attached to the structural ceiling or walls with hardware or other installation aids specifically designed to support their weight.

3.1.7 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 7 feet above floors and walkways, and when specifically indicated. Boxes in other locations: sheet steel, and nonmetallic boxes may be used with nonmetallic sheathed cable conduit system. Provide each box with volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; provide readily removable fixtures for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and

supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. Threaded studs driven in by powder charge and provided with lockwashers and nuts or nail-type nylon anchors may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.7.1 Boxes

Boxes for use with raceway systems: minimum 1-1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 4 inches square, except that 4 by 2-inch boxes may be used where only one raceway enters outlet. Telecommunications outlets: a minimum of 4 inches square by 2 1/8 inches deep, except for wall mounted telephones and outlet boxes for handicap telephone stations. Mount outlet boxes flush in finished walls.

3.1.7.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge galvanized sheet steel, and compatible with nonmetallic raceway systems, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.7.3 Extension Rings

Extension rings are not permitted for new construction.

3.1.8 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches and handicapped telecommunications stations 48 inches above finished floor. Mount receptacles and telecommunications outlets 18 inches above finished floor, unless otherwise indicated. Wall-mounted telecommunications outlets: mounted at height 60 inches above finished floor indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets in non-hazardous areas to center of device or outlet.

3.1.9 Nonmetallic Sheathed Cable Installation

Where possible, install cables concealed behind ceiling or wall finish. Thread cables through holes bored on approximate centerline of wood members; notching of end surfaces is not permitted. Provide sleeves through concrete or masonry for threading cables. Install exposed cables parallel to or at right angles to walls or structural members. Protect exposed nonmetallic sheathed cables less than 4 feet above floors from mechanical injury by installation in conduit or tubing. When cable is used in metal stud

construction, insert plastic stud grommets in studs at each point through which cable passes, prior to installation of cable.

3.1.10 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves.

3.1.10.1 Marking Strips

Provide marking strips in accordance with the following:

a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.

b. Use permanent ink for the wire numbers

c. Provide reversible marking strips to permit marking both sides or provide two marking strips with each block.

d. Size marking strips to accommodate the two sets of wire numbers.

e. Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.

f. 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 District's wire designations.

g. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.11 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector and cover with insulation material equivalent to conductor insulation.

3.1.11.1 Splices of Aluminum Conductors

Make with solderless circumferential compression-type, aluminum-bodied connectors UL listed for AL/CU. Remove surface oxides from aluminum conductors by wire brushing and immediately apply oxide-inhibiting joint compound and insert in connector. After joint is made, wipe away excess joint compound, and insulate splice.

### 3.1.12 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

### 3.1.13 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance standard industry practices.

### 3.1.14 Grounding and Bonding

Provide in accordance with NFPA 70 and NFPA 780. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, grounding conductor of nonmetallic sheathed cables, and neutral conductor of wiring systems. Make ground connection at main service equipment and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. Make ground connection to driven ground rods on exterior of building. Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system. In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA-607. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection. Reference Motorola R56 Standards and Guidelines for Communication Sites, NFPA 70 and NFPA 780.

#### 3.1.14.1 Ground Rods

Provide cone pointed ground rods. Measure the resistance to ground using the fall-of-potential method described in IEEE 81. Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod, additional rods, spaced on center, not less than twice the distance of the length of the rod, additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Construction Manager who will decide on the number of ground rods to add.

#### 3.1.14.2 Ground Bus

Provide a copper ground bus in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical

equipment: effectively grounded by bonding to the ground bus. Bond the ground bus to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Make connections and splices of the brazed, welded, bolted, or pressure-connector type, except use pressure connectors or bolted connections for connections to removable equipment. For raised floor equipment rooms in computer and data processing centers, provide a minimum of 4, one at each corner, ground buses connected to the building grounding system. Use bolted connections in lieu of thermoweld, so they can be changed as required by additions and/or alterations.

3.1.14.3 Telecommunications System

Provide telecommunications grounding in accordance with the following:

a. Telecommunications Grounding Busbars: Provide a telecommunications main grounding busbar (TMGB) in the telecommunications entrance facility. Install the TMGB as close to the electrical service entrance grounding connection as practicable. Provide a telecommunications grounding busbar (TGB) in all other telecommunications rooms and telecommunications equipment rooms. Install the TGB as close to the telecommunications room panelboard as practicable, when equipped. Where a panelboard for telecommunications equipment is not installed in the telecommunications room, locate the TGB near the backbone cabling and associated terminations. In addition, locate the TGB to provide for the shortest and straightest routing of the grounding conductors. Where a panelboard for telecommunications equipment is located within the same room or space as a TGB, bond that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure to the TGB. Install telecommunications grounding busbars to maintain clearances as required by NFPA 70 and insulated from its support. A minimum of 2 inches separation from the wall is recommended to allow access to the rear of the busbar and adjust the mounting height to accommodate overhead or underfloor cable routing.

b. Telecommunications Bonding Conductors: Provide main telecommunications service equipment ground consisting of separate bonding conductor for telecommunications, between the TMGB and readily accessible grounding connection of the electrical service. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, bond the conductors to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum. Provide a telecommunications bonding backbone (TBB) that originates at the TMGB extends throughout the building using the telecommunications backbone pathways and connects to the TGBs in all telecommunications rooms and equipment rooms. Install the TBB conductors such that they are protected from physical and mechanical damage. The TBB conductors should be installed without splices and routed in the shortest possible straight-line path. Make the bonding conductor between a TBB and a TGB continuous. Where splices are necessary, the number of splices should be a minimum. Make the splices accessible and located in telecommunications spaces. Connect joined segments of a TBB using exothermic welding, irreversible compression-type connectors, or equivalent. Install all joints to be adequately supported and protected from damage. Whenever two or more TBBs are used within a multistory building, bond the TBBs together with a grounding equalizer

(GE) at the top floor and at a minimum of every third floor in between. Do not connect the TBB and GE to the pathway ground, except at the TMGB or the TGB.

c. Telecommunications Grounding Connections: Telecommunications grounding connections to the TMGB or TGB: utilize listed compression two-hole lugs, exothermic welding, suitable and equivalent one hole non-twisting lugs, or other irreversible compression type connections. Bond all metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the TMGB. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; bond each TMGB to the vertical steel metal frame using a minimum No. 6 AWG conductor. Where the metal frame is external to the room and readily accessible, bond the metal frame to the TGB or TMGB with a minimum No. 6 AWG conductor. When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the TGB may be bonded to these horizontal members in lieu of the vertical column members. All connectors used for bonding to the metal frame of a building must be listed for the intended purpose.

### 3.1.15 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

### 3.1.16 District-Furnished Equipment

Contractor rough-in for District-furnished equipment make connections to District-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

### 3.1.17 Repair of Existing Work

#### 3.1.17.1 Workmanship

Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

### 3.1.18 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is 3 feet.

## 3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

## 3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

## 3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting: as specified in Section 09 06 90 PAINTS AND COATINGS. Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

## 3.5 POSTED OPERATING INSTRUCTIONS

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. Ensure operating instructions do not fade when exposed to sunlight. Secure instructions to prevent easy removal or peeling.

Ensure each system and principal item of equipment is as specified in the technical sections for use by operation and maintenance personnel. Include the following information with the operating instructions:

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.

## 3.6 FIELD QUALITY CONTROL

Submit test reports in accordance with UL 83 for 600-volt wiring, UL 1561 for transformer, and UL 943 for Ground-Fault Receptacle as referenced ~~standards~~ in SD-06 of this section.

Furnish test equipment and personnel and submit written copies of test results. Give Construction Manager 5 working days' notice prior to each test.

### 3.6.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

### 3.6.2 600-Volt Wiring Tests

Final acceptance requires 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 District.

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist.

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Use substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices to isolate the circuits under test.

Perform insulation-resistance test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential is 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 are not less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes AWG No. 8 and smaller insulation resistance testing is not required.

Perform continuity test to insure correct cable connection end-to-end (i.e. correct phase conductor, grounded conductor, and grounding conductor wiring). Repair and verify any damages to existing or new electrical equipment resulting from mis-wiring. Receive approval for all repairs from the District prior to commencement of the repair.

### 3.6.3 Transformer Tests

Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NETA ATS. Measure primary and secondary voltages for proper tap settings.

### 3.6.4 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug-in light) to verify that the "line" and "load" leads are not reversed.

### 3.6.5 Phase Rotation Test

Conduct phase-rotation tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment in a clockwise direction, facing the source.

-- End of Section --

# SECTION 26 28 01.00 10

# 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 C2 | (2017; Errata 1 2017) National Electrical Safety Code |
| IEEE C57.13 | (2016) Requirements for Instrument Transformers |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA C37.50 | (2012) American National Standard for Switchgear--Low-Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |

### 1.2 SYSTEM DESCRIPTION

This section covers the requirements of the coordinated power and arc flash study. The coordinated power and arc flash study shall be provided by an independent engineering firm and paid for by the contractor. Complete testing and coordination for this system shall be performed by the contractor in accordance with the findings and recommendations of this study.

### 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fault Current Analysis

Protective Device Coordination Study

Arc Flash Study

Coordination Study

Calibration, Testing

System Coordinator

Protective Relays

Installation

SD-06 Test Reports

Field Testing

1.4 QUALITY REQUIREMENTS

1.4.1 System Coordinator

System coordination, recommended ratings and settings of protective devices, and design analysis shall be accomplished by a registered professional electrical power engineer with a minimum of 3 years of current experience in the coordination of electrical power systems. Submit verification of experience and license number, of a registered Professional Engineer as specified above. 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.

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 with a minimum of two years of current product experience in protective devices.

1.5 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 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 load flow analysis, a fault current analysis, and a protective device coordination study. Submit 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 District 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. 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 Construction Manager.

2.1.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses, as indicated for main electric supply substations.

2.1.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. Coordinate with the commercial power company for fault current availability at the site.

2.1.3 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.

2.1.4 Fault Current Analysis (Study)

2.1.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE 242, and IEEE 399.

2.1.4.2 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.

2.1.4.3 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.

2.1.5 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.

2.1.6 Arc Flash Analysis

a. Perform incident energy calculations in accordance with IEEE 1584-2002 Guide for Performing Arc Flash Hazard Calculations for all equipment analyzed in the short circuit study. Tabular results and recommended labels from the software program are acceptable.

b. Furnish recommendations for Personal Protective Equipment, in accordance with OSHA standards, and proper labels to be located on the electrical equipment in accordance with NEC Article 110.16.

c. Use data from short circuit and device coordination study.

d. Use manufacturer data for: enclosure type; gap between exposed conductors or busway; grounding type; number of phases and connection; and working distance.

2.1.7 Arc Flash Study report

a. 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.

b. 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, and definition of the fixed or adjustable features of the existing or new protective devices.

c. The report shall document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings; and existing power system data including time-current characteristic curves and protective device ratings and settings.

d. The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.

e. 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.

# PART 3 EXECUTION

## 3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Construction Manager of any discrepancy before performing any work.

## 3.2 INSTALLATION

Submit procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment. Install protective devices in accordance with the manufacturer's published instructions and in accordance with the requirements of NFPA 70 and IEEE C2.

## 3.3 FIELD TESTING

Prior to field tests, submit the proposed test plan consisting of complete field test procedure, tests to be performed, test equipment required, and tolerance limits, and complete testing and verification of the ground fault protection equipment, where used. Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

### 3.3.1 General

Perform field testing in the presence of the Construction Manager. Notify the Construction Manager 5 days prior to conducting tests. Furnish all materials, labor, and equipment necessary to conduct field tests. Perform all tests and inspections recommended by the manufacturer unless specifically waived by the Construction Manager. Maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number, and name of test equipment, and test results.

### 3.3.2 Safety

Provide and use safety devices such as 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.

### 3.3.3 Molded-Case Circuit Breakers

Circuit breakers shall be visually inspected, operated manually, and connections checked for tightness. Current ratings shall be verified, and adjustable settings incorporated in accordance with the coordination study.

### 3.3.4 Power Circuit Breakers

#### 3.3.4.1 General

Visually inspect the circuit breaker and operate the circuit breaker manually; adjust and clean primary contacts in accordance with manufacturer's published instructions; check tolerances and clearances; check for proper lubrication; and ensure that all connections are tight. For electrically operated circuit breakers, verify operating voltages on closing and tripping coils. Verify fuse ratings in control circuits; electrically operate the breaker, where applicable; and implement settings in accordance with the coordination study.

3.3.4.2 Power Circuit Breaker Tests

The power circuit breakers shall be tested in accordance with NEMA C37.50.

3.3.5 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Submit data using submittal format including calibration and testing procedures and instructions pertaining to the frequency of calibration, inspection, adjustment, cleaning, and lubrication. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.

-- End of Section --

# 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 | (2014) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ICS 1 | (2000; R 2015) Standard for Industrial Control and Systems: General Requirements |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1008 | (2014) Transfer Switch Equipment |
| UL 508 | (1999; Reprint Oct 2013) Industrial Control Equipment |

### 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Connection Diagrams

Fabrication Drawings

Installation Drawings

SD-03 Product Data

Equipment and Performance Data

Contacts

Indicating Lights

Terminal Board

Enclosures

SD-06 Test Reports

Qualification Testing

Operation Tests

SD-07 Certificates

Listing of Product Installations

SD-08 Manufacturer's Instructions

Automatic Transfer Switch

## 1.3 QUALITY REQUIREMENTS

### 1.3.1 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.

## 1.4 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

There are six (6) automatic transfer switches required. One each at S-471, S-473, S-475, S-481A, S-477, and S-479.

Furnish the automatic transfer switch with a solid-state time-delay feature, field adjustable from 0 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.

Submit 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.

Submit fabrication drawings for contacts, indicating lights, terminal board enclosures, and accessories consisting of fabrication and assembly details to be performed in the factory.

Submit installation drawings for automatic transfer equipment in accordance with paragraph INSTALLATION.

Submit equipment and performance data for automatic transfer equipment including life, test, system functional flows, safety features, and mechanical automated details.

2.1.1 Performance Requirements

2.1.1.1 Application

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 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 or three-pole type for single or three-phase application as required. Provide a solid neutral conductor connection.

Ensure the automatic transfer switch is capable of being placed in either the normal or the emergency position.

2.1.1.2 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.

2.1.1.3 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 test switch that includes an auto, off, no-load engine test and load test position. A white light shall be included to indicate that the switch is in the off position. The transfer switch controller shall include a programmable engine exerciser with the following selections: Disabled, 7, 14 and 28 day intervals, 15 minutes fixed time, load or no load with Failsafe. Design the key-operated switch to prevent removal of the key while the switch is in the self-test mode.

2.1.1.4 Manufacturer

Provide automatic transfer switches as manufactured by Onan, Model OTPC ATS, ASCO, or approved equal.

2.2 COMPONENTS

2.2.1 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. Provide an automatic transfer switch with a solid neutral.

Use two pole auxiliary contacts.

Provide a test automatic transfer switch mounted on the control panel with contacts rated for operation at 10 amperes.

2.2.2 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.

2.2.3 Terminal Board

Provide contactor type automatic transfer switch terminal board for 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.

2.2.4 Enclosures

Provide automatic transfer switch enclosures with solid, code-gage 14-gage, minimum sheet metal, NEMA 250, Type 1/12, with manufacturer's standard finish.

2.2.5 Communications

Provide automatic transfer switch with the hardware necessary to communicate to the station control system over Ethernet IP for remote monitoring.

2.2.6 Transfer Switch Equipment:

a. Provide type OTPC automatic transfer switch for the specified engine-generator with Level 2 Control features.

b. The transfer switch shall have 3 poles with a current rating as shown in electrical drawings. System voltage rated at 208 VAC, 3 phase, 60 cycle.

c.Transfer switch shall be mounted in a U.L. Type 1 enclosure.

d. Transfer switch equipment shall have a withstand and closing rating (WCR) of 42k RMS symmetrical amperes minimum, at 208 Volts.

2.2.7 Transfer Switch Automatic Controls:

a. Solid-state sensors shall simultaneously monitor all phases of the normal source and all phases of the emergency source.

b. Controls shall start the engine-generator upon signal from normal source voltage sensors. Solid-state time delay start, adjustable from 0 to 15 seconds shall avoid nuisance start-ups on momentary voltage dips.

c. Controls shall delay transfer of the load to the emergency power system after the generator reaches proper voltage and frequency to stabilize the engine-generator before application of load. Solid-state time delay shall be adjustable from 0 to 120 seconds (factory set at 2 seconds).

d. Controls shall delay retransfer of the load to the normal source after normal power is restored. Solid-state time delay retransfer shall be adjustable from 0 to 30 minutes (factory set at 15 minutes).

e. Controls shall delay stopping the engine-generator after retransfer to the normal source. This feature permits the engine to run unloaded to cool down before stopping. Also availability of the emergency source is maintained in the event the normal source fails shortly after retransfer.

f. Solid-state time delay stop shall be adjustable from 0 to 30 minutes (factory set at 5 minutes).

g. Controls shall cause the transfer switch to pause in the neutral position during transfer and retransfer for an adjustable delay period of 0 to 60 seconds. (programmed transition). This feature allows

residual voltages from motors and transformers to decay before completing the switching cycle.

h. Provide an auto/manual retransfer switch. The "auto" position automatically retransfers the load upon return of the normal power source. The "manual" position disables the automatic retransfer. Retransfer must be manually initiated unless the generator set fails.

2.2.8 Transfer Switch Accessory Items:

a. Provide 7-day solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. Provide a with/without load selector switch for the exercise period.

b. Provide a float charge battery charger rated at 2 amperes. The battery charger will provide a charge for the engine-generator batteries located on the engine-generator skid. D.C. output voltage shall be as required. An ammeter shall display charging current. The battery charger shall have fused AC input and fused DC output.

c. Furnish relay module option M023-7 for District use that provides status relay outputs for Utility Connected, Generator Connected, Utility Available, and Generator Available.

d. Provide Level 2 Control features with Digital Bar Graph Meters.

2.2.9 Resolutions Of Conflicts:

Any conflicts arising from various parts of this specification shall be resolved by relying on the statements in paragraph TRANSFER SWITCH EQUIPMENT through paragraph TRANSFER SWITCH ACCESSORY ITEMS

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 QUALITY CONTROL

Demonstrate the automatic transfer switch operates in accordance with the specification requirements in conjunction with the normal and emergency power sources.

-- End of Section --

# SECTION 26 32 15

# LPG FUEL SYSTEM FOR EMERGENCY GENERATOR

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work:

The Work of this Section shall consist of furnishing all labor, materials, and equipment necessary for installation of Liquefied Petroleum Gas (LPG) fuel systems for emergency generators as shown on the Drawings and specified herein.

Conditions of the Contract apply.

Related Work Specified Elsewhere:

Section 01 33 00 SUBMITTAL PROCEDURES

Section 31 00 00 EARTHWORK

Section 03 11 15.00 10 CONCRETE FORMWORK AND ACCESSORIES

Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING

Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM

Section 26 28 21.00 40 AUTOMATIC TRANSFER SWITCHES

### 1.2 APPLICABLE STANDARDS AND PUBLICATIONS

Standards or Codes: The edition of the publications of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. See the various paragraphs for the specified standard. In the case of a conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/UL 132 - Standard for Safety Relief Valves.

ANSI/UL 144 - Standard for LP-Gas Regulators

ANSI/UL 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

ANSI/ASME B1.20.1 - Pipe Threads, General Purpose

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A53 | Standard Specification for Pipe, Steel, Black, and Hot-Dipper, Zinc-Coated Welded and Seamless |
| ASTM A234/A234M | (2016) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM D2513 | Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings |

Codes for pressure vessels for petroleum liquids and gases

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B16.3 | (2011) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.11 | (2011) Forged Fittings, Socket-Welding and Threaded |

ASME B31.4 - Boiler and Pressure Vessel Code Section VIII

ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 175 psi

Code for Pressure Vessels for Petroleum Liquids and Gases

FLORIDA ADMINISTRATIVE CODE (F.A.C.)

Chapter 527, F.A.C.

Chapter 5F-11, F.A.C.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 58 | Storage and Handling of Liquefied Petroleum Gases |

NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines

NFPA 54 - National Fuel Gas Code

NFPA 70 - National Electrical Code (NEC), Article 501

## 1.3 DEFINITIONS

1. Anodeless Riser: An assembly of steel-cased plastic pipe used to make the transition between underground plastic piping and above ground metal piping.

2. ASME Tank: A container constructed in accordance with the AMSE Pressure Vessel code.

3. Automatic Safety Shutoff Valve (ASSV): A valve that upon shutdown conditions will automatically stop the flow of gas to the engine and to the generator building.

4. Container: Any vessel, including tanks used for the storage of LPG.

5. Container Appurtenances: Devices installed in the container openings for safety, control, or operating purposes.

6. Engine: Prime mover such as internal combustion engines using gaseous fuel.

7. Excess-Flow Valve: A valve designed to close when the liquid or vapor passing through it exceeds a prescribe flow rate.

8. Filler Valve: A valve that is designed to allow liquid flow into a container.

9. First Stage (Service) Regulator: A pressure regulator for LPG vapor service designed to reduce pressure from a container to 10 psig or less.

10. Gas Train: The portion of the fuel gas supply piping starting with and including the equipment isolation valve and extending to the point at which the fuel enters the engine.

11. Maximum Allowable Working Pressure (MAWP): The maximum pressure at which a pressure vessel is to operate as prescribed by ASME Code.

12. Overfilling Prevention Device (OPD): A safety device that is designed to provide an automatic means to prevent the filling of a container in excess of the maximum permitted filling limit.

13. Shutoff Valve: A shutoff valve that in the closed position does not allow the flow of product in either direction.

14. Pressure Relief Device (PRD): A device designed to open to prevent a rise of internal pressure in excess of a specified value.

15. Pressure Test: An operation performed to verify the gastight integrity of gas piping following its installation or modification.

16. Point of Delivery (POD): For LPG systems, the point of delivery shall be considered to be the outlet of the first regulator that reduces the pressure to 2 psig or less.

17. Second Stage Regulator: A pressure regulator for LP-Gas service designed to reduce first stage regulator outlet pressure to the pressure required at the point of delivery.

## 1.4 SUBMITTALS

Submit as specified in Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's data (for approval before any Work is commenced).

SD-02 Shop Drawings

Layout and Installation Drawings

Piping Drawings

SD-03 Product Data

Catalog Data

ASME Nameplate/Dataplate

SD-05 Design Data

Design Calculations

SD-06 Test Reports

Pressure and Leakage Tests

SD-07 Certificates

Certificates

SD-08 Manufacturer's Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

## 1.5 SUBMITTAL REQUIREMENTS

The Contractor shall submit complete Shop Drawings and certificates, test reports in accordance with the requirements in the Section 01 33 00 SUBMITTAL PROCEDURES and as specified in the individual sections herein.

Data to be submitted shall include, but not be limited to:

1. Catalog Data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various LP Tanks system components and accessories.

2. Complete layout and installation drawings with clearly marked dimensions and elevations.

3. Design calculations, as applicable.

   When any material is specified to comply with applicable standards, codes, or laws, Manufacturer's data must clearly state such compliance.

Shop Drawings:

1. The Contractor shall submit to the District for approval, in accordance with the Contract, complete piping drawings of each piping system as shown on the Drawings. Shop Drawings shall be construction drawings showing locations, dimensions, and details of all runs of piping, with pipe sizes, fittings, valves, and supports shown. The Manufacturer's catalog number of all valves, hangers, supports and other items shall be submitted for approval.

2. Each Shop Drawing submittal shall be complete in all aspects incorporating all information and data listed herein and all additional information required to evaluate the proposed piping material's compliance with the Contract Documents. Partial or incomplete submissions will be returned to the Contractor without review.

Proof of qualified ASME containers:

1. Photo of ASME Nameplate/Dataplate for the tank(s) to be used for the Project in accordance with NFPA 58 and ASME requirements.

1.6 CERTIFICATION AND TESTING

1. Pressure and leakage tests shall be performed by the Contractor to insure a complete and usable LPG fuel system.
2. Since all tanks are less that 4000 gallons and do not serve the public directly, no registration is required.

1.7 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 VALVES, FITTINGS AND EQUIPMENT

All valves, fittings, equipment, etc. shall meet the following requirements:

1. Be complete with all necessary pipe, valves, fittings, etc, required, whether indicated or not.

2. Be insulated and covered in accordance with the pipe system to which they attach.

Piping connected to equipment, which vary from the Drawings because of requirements peculiar to the particular equipment furnished shall be furnished and installed as required to make a complete and workable installation at no additional cost to the District.

The necessary pipes and fittings required to install pipe vents on the fuel regulators.

## 2.2 REQUIREMENTS

### 2.2.1 General

1. All equipment comprising the components shall be furnished and coordinated by a single supplier who has a history of previous successful installations of this type.

2. Furnish and install all piping components as indicated and as specified.

### 2.2.2 LPG Storage Tank

1. Horizontal pressure tank, steel construction for below ground installation, furnish a tank with the following capacity for each area:

| Area: | Capacity: |
|---|---|
| S-477 | 850 (gallons) |
| S-479 | 850 (gallons) |
| S-481A | 1450 (gallons) |

Horizontal pressure tank, steel construction for above ground installation, furnish a tank with the following capacity for each area:

| Area: | Capacity: |
|---|---|
| S-471 | 1450 (gallons) |
| S-473 | 1450 (gallons) |
| S-475 | ~~1000~~ 1450 (gallons) |

2. For Flood Control Pump Stations, the tank capacity shall include seven (7) continuous days of fuel for the emergency generator.

3. Tank(s) shall be stamped for 250 psig (pounds per square inch) working pressure in accordance with ASME Code for "Pressure Vessels for Petroleum Liquids and Gases".

4. Tank(s) shall have certification of testing for 1.5 times the working pressure and suitable for underground installation.

5. Tank(s) shall be provided with welded steel supports with provisions for bolting to the concrete foundation.

6. Tank(s) shall meet NFPA 58 and all other applicable local, state, and federal standards.

7. The location of the tank(s) should be reviewed by the Fire Marshall, over the jurisdiction of the Project to determine minimum distances and type of fuel tank required for the Site.

8. Provide all necessary tank openings, gauges, and valves.

9. Provide all the accessories required for complete installation.

10. The tank shall be factory coated per the Manufacturer's recommendations. If primer is used, it shall not contain lead pigments.

11. Provide approved non-slip surface finish on top of tank.

12. Provide a cathodic protection in accordance with Section 26 42 14.00 CATHODIC PROTECTION SYSTEM.

13. Provide all necessary tank anchors for above ground tanks.

2.2.3 Other Accessories

1. Automatic Safety Shutoff Valves and engine pressure regulator with vent-limiting device, supplied by the generator Manufacturer as part of Original Equipment Manufacturer (OEM) package.

2. Primary fuel pressure regulator.

3. Fuel tank shut-off valve.

4. Exterior NEMA 4x rated automatic safety shutoff valve.

5. Pressure relief vent system as per NFPA 58 code requirements.

6. Signage: Signs shall be of dimensions indicated on the Drawings. Signage shall read "DANGER NO SMOKING". All signage shall comply with local and federal hazardous material regulations and identification. Additional signage may be required by the District.

7. Fuel Tank Level Transmitter: Fuel tank level transmitter shall be MDI LPG Stationary Tank Monitor (PN 94442A) or District approved equal. The fuel tank level transmitter shall be connected to the enterprise system consistent with Drawings. Submit for review a package consisting of the design and Site layout for fuel tank monitoring system, including interface with enterprise network.

2.2.4 Overfill Protection

1. An overfill prevention device shall be installed for each tank.

2. The overfill protection device(s) shall be compatible with the tank and installed in accordance with the Manufacturer's specifications and recommendations.

2.2.5 Pipe and Fittings

1. Aboveground pipe shall be Schedule 40 black carbon steel, ASTM A53. Galvanized steel piping will not be accepted.

2. Underground piping shall be yellow high density polyethylene (HDPE) piping approved by NFPA 58 and meet current ASTM D2513 specifications.

3. Assembled anodeless riser

4. All piping not in contact with the soil shall be rigid piping meeting and constructed to the size and dimensions as specified in the Drawings.

5. Full port LP gas rated manual shutoff valve.

6. Connections:

   a. Fittings on steel piping shall be threaded malleable iron or steel welded fittings.

   b. All above ground fittings outside of building shall be welded type and HDPE underground piping shall use mechanical or heat fusion couplings.

   c. Fittings inside building to be threaded type.

7. Flexible fuel line connector at engine shall be corrugated flexible stainless steel with a single cover braid.

8. Piping components shall be compatible with LP gas and installed to the Manufacturer's specifications and recommendations.

9. For additional piping and fitting requirements refer to Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING.

2.2.6 Steel Pipe and Fittings

Exposed:

1. Pipe: ASTM A53, Schedule 40 black:

2. Fittings: ASME B16.3, malleable iron, ASME B16.11, forged steel, or ASTM A234/A234M Grade WPB, forged steel welding type.

3. Joints: Threaded for nominal pipe size (NPS) three (3) inches and smaller; welded for over three (3) inches.

PART 3 EXECUTION

3.1 GENERAL

Furnish all labor, materials and equipment necessary to make a complete installation as indicated and specified and as required by local practice, codes and regulations.

3.2 SITE PREPARATION

3.2.1 Excavation, Backfill, and Compaction

1. The area needed for the installation of the concrete pad shall be cleared and stripped of all topsoil and unsuitable material.

2. The Site shall be excavated or flow filled to a depth as necessary to achieve the final elevation of the concrete pad.

3. All earthen and subgrade fill required shall be Select Fill in accordance with Section 03 11 15.00 10 CONCRETE FORMWORK AND ACCESSORIES.

3.2.2 Concrete Pad

1. Tank shall be anchored to a concrete pad constructed to the dimensions shown on the Drawings for the size of the tank to be installed.

2. The concrete pad shall be built on a minimum thickness of six (6) inches of Florida Department of Transportation (FDOT) #57 stone, unless otherwise noted on the Drawings.

3. Concrete for the slab shall meet specification Section 03 11 15.00 10 CONCRETE FORMWORK AND ACCESSORIES

4. Concrete shall be allowed 28 days to cure before placement of the tank(s).

3.3 INSTALLATION

1. All underground piping for LPG fuel lines shall be installed a minimum of 18 inches below grade (18 inch cover) except where greater bury depth is required as indicated in the Drawing. The pipe trench shall be free of rock and graded so that the pipe has a firm continuous bearing on the bottom of the trench.

2. Continuous lengths of underground warning tape shall be installed 12-inches above and parallel to all underground fuel piping. Tape shall be six (6) inches wide polyethylene with foil backing film imprinted as follows: "CAUTION - BURIED GAS LINE BELOW."

3. Secondary fuel pressure regulator shall be installed on exterior of building.

4. NEMA 4X Automatic Safety Shutoff Valve (ASSV) shall be installed on exterior gas train downstream (low pressure side) of secondary pressure regulator.

5. The LPG system shall be installed in accordance with NFPA 58, NFPA 54 and all applicable Manufacturer's recommendations.

6. All valves, fittings, equipment, etc., shall be installed, inspected, tested, and put into successful operation.

7. For additional installation requirements refer to Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING.

3.4 PRESSURE AND LEAKAGE TESTS

1. Prior to acceptance all components of the LPG fuel system shall be inspected, and pressure tested, to determine that the system is acceptable for operation as required by all other applicable local, state, and federal agencies.

2. In the event repairs or additions are made after the pressure test, the affected piping shall be tested.

3. The test medium shall be air, nitrogen, carbon dioxide or an inert gas. Oxygen shall not be used.

4. When using an air compressor to pressure test the fuel system, filters shall be used on the discharge side to minimize contaminates.

5. Pipe joints, including welds shall be left exposed for examination during the test.

6. Test pressures shall be measured with a manometer or with a pressure-measuring device designed and calibrated to read or indicate a pressure loss caused by leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made.

7. The test pressure to be used shall be at least 1-1/2 times the proposed maximum working pressure, but not less than three (3) psig, irrespective of design pressure. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than five times the test pressure.

8. Test duration shall not be less than ten (10) minutes. Any reduction of test pressure as indicated by pressure measuring devices shall be deemed to indicate the presence of a leak.

9. Fuel gas shall be permitted to be used for leak checks in piping systems that have been previously pressure tested. During the process of turning the gas on into a system of new gas piping, the entire system shall be inspected to determine that there are no open fittings or ends.

10. Immediately after the gas is turned on into a new system the piping shall be checked for leakage. Leakage shall be located by means of an approved gas detector or other approved detection means. Matches, candles, open flames or other methods that could provide a source of ignition shall not be used.

11. Where a leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made.

## 3.5 FIELD QUALITY CONTROL

Test equipment and installation to verify tightness, operation, and unit heat pump vibration is within manufacturer's submitted maximum.

Test equipment performance and balance equipment as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

### 3.5.1 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 05 OPERATION AND MAINTENANCE INFORMATION. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data.

### 3.5.2 Operation ~~A~~and Maintenance Training

Conduct a training course for the members of the operating staff as designated by the District. Make the training period consist of a total of 8 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved.

Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

# SECTION 26 36 14

# PROPANE FUELED GENERATOR

## PART 1 GENERAL

### 1.1 SCOPE

#### 1.1.1 Summary of Work

This specification covers the requirements for furnishing complete and operable emergency/standby spark-ignited propane fueled generators for structures S-471, S-473, S-475, S-477, S-479, & S-481A, with all appurtenances. The manufacturer shall be Cummins/Onan. Equipment shall be new; factory tested, and delivered ready for installation. Sizing of the generators can be found in the drawings.

#### 1.1.2 Related Work Specified Elsewhere

Section 01 33 00 SUBMITTAL PROCEDURES

### 1.2 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

Submit the following (3 copies minimum) to the District.

SD-02 Shop Drawings

Connection Diagrams

Fabrication Drawings

Installation Drawings

SD-03 Product Data

Equipment and Performance Data

Specification and Data Sheets

SD-06 Test Reports

Factory Tests

On Site Acceptance Test

SD-07 Certificates

Manufacturer's Certification of Prototype Testing

SD-08 Manufacturer's Instructions

Manufacturer's published warranty documents

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

1.3 SUPPLIERS

The supplier shall be the manufacturer's authorized distributor, who shall provide initial start-up services, conduct field acceptance testing, and warranty service. The supplier shall have 24-hour service availability and factory-trained service technicians authorized to do warranty service on all warrantable products.

1.4 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

Provide Manufacturer's published warranty documents.

PART 2 PRODUCTS

2.1 MANUFACTURERS

Equipment, documentation, and services described in this specification and shown on the plans are as provided by Cummins/Onan.

2.2 SUBSTITUTES

Proposed equipment substitutions shall include complete submittal data, as specified herein, clearly denoting any and all deviations and/or exceptions to the equipment specified.

The complete proposal must be submitted to the DISTRICT for approval/disapproval not less than 10 days prior to the scheduled bid date. If approved, the manufacturer/distributor is responsible for the charges of all necessary revisions to the proposal.

2.3 RATINGS AND OPERATING CONDITIONS

Generator set ratings: As noted on drawings for each of six (6) control building locations

System voltage of: 208 V, 3Ø

Site conditions: Altitude 100 feet (30 meters), Temperatures up to 120 degrees Fahrenheit (49 degrees Celsius)

Test: Prototype tests shall be accomplished on a complete and functional unit, component level type tests will not substitute for this requirement.

2.4 PERFORMANCE

Voltage regulatory shall be +/- 2.0 percent for any constant load between no load and rated load.

Frequency regulation shall be 5.0 percent maximum under varying loads from no load to 100 percent rated load.

The engine-generator set shall be capable of single step load pick up of 100 percent% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

The generator set shall be capable of sustaining a minimum of 90 percent of rated no load voltage with the specified KVA load at near zero power factor applied to the generator set.

The generator shall be extended stack capable of full single-phase output at its rated kilowatts.

## 2.5 AC GENERATOR

The AC generator shall be: brushless synchronous type, four (4) pole, revolving field, drip proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s).

All insulation system components shall meet NEMA MG1 standard temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees Centigrade.

The generator shall be broad range, twelve (12) lead reconnectable. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage within the broad range.

## 2.6 ENGINE-GENERATOR SET CONTROL

The control shall have automatic remote start capability from a panel-mounted 3-position (Stop, Run, Remote) switch.

Provide cycle cranking of 15 SEC (ON)/15 SEC (OFF) for three attempts (75 SEC). If engine fails to start, lockout the engine and indicate overcrank on alarm status panel.

Provide Power Command Control with Amp Sentry protection.

1. Provide operator interface display panel and pushbuttons for viewing engine and alternator data and providing setup, controls, adjustments, and emergency stop options.

2. Provide optional analog AC meter display.

3. Provide optional engine lube oil temperature data readout with high oil temperature warning.

The NEMA 1 enclosed control/monitor panel shall be mounted on the generator set with vibration isolators.

The control/monitor panel shall be powered from the engine-generator starting batteries. The control shall include surge suppression for protection of solid state components. Operation of shut down circuits shall be independent of indication and prealarm circuits. A common alarm contact for external connection to an audible alarm shall be provided.

Each generator control panel shall have the hardware necessary to communicate to the station control system over Ethernet IP for remote monitoring. The Microwave Tower Shelter generator shall have alarm wiring for discrete, analog, and relays integrated to the Enterprise network as shown on the drawings.

## 2.7 ENGINE

The engine shall be 1800 rpm, stationary, liquid-cooled, propane fueled.

The engine shall be cooled by a unit-mounted closed loop radiator system rated for full load operation in 122 degree F (50 degrees C) ambient as measured at the generator air inlet. Radiators shall be provided with a duct adapter flange permitting the attachment of an air duct directing the discharge of radiator air.

The cooling system shall be filled with 50/50 ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact.

## 2.8 ENGINE ACCESSORY EQUIPMENT

The engine-generator set shall include the engine accessories as follows:

An electric starter capable of three complete cranking cycles without overheating, before overcrank shutdown (75 seconds).

Skid mounted batteries used for starting the engine along with battery cables and connectors. Batteries shall be lead acid sized as recommended by the engine manufacturer. Battery charger shall be provided with the transfer switch.

Engine mounted, thermostatically controlled, water jacket heater. The heater(s) shall be sized as recommended by the equipment supplier. Heater voltage shall be 120 volt.

Vibration isolators, pad isolators type, quantity as recommended by the generator set manufacturer.

Provide an engine starter charging alternator, with solid state voltage regulator.

Provide a complete 304 stainless steel exhaust system including a critical-grade silencer, stainless steel flexible pipe for the exhaust connection, and required mounting hardware. All piping inside the building shall be insulated.

Provide a secondary fuel regulator, shut off solenoid, and vacuum safety switch for mounting on the Districts LP gas fuel line.

Provide a radiator duct adapter used to attach the radiator duct to discharge air duct shroud.

## 2.9 BASE

The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with battery hold down clamps within the rails. Provisions for stub up of electrical conduits shall be within the footprint of the set. Vibration isolators, standard quantity and type of the manufacturer, shall be integral between generator set and base.

## 2.10 GENERATOR SET AUXILIARY EQUIPMENT AND ACCESSORIES

Gate Structure Generator main circuit breaker, set mounted and wired, UL listed, molded case thermal-magnetic type, 3 pole, ratings: 208 volts, 100 ampere frame, 100 ampere trip. Provide shunt trip.

Provide a thermostatically controlled heater to help alleviate buildup of condensation on the alternator windings. The heater(s) shall be sized as recommended by the equipment supplier. Heater voltage rating shall be 120 volt.

## 2.11 CONNECTION DIAGRAMS

Provide complete connection diagrams for all required connections to be made in the field by the contractor.

## 2.12 FABRICATION DRAWINGS

Provide complete generator fabrication drawings of the complete generator system.

## 2.13 INSTALLATION DRAWINGS

Provide complete installation drawings showing all required mounting hardware and locations that are to be made in the field by the contractor.

## 2.14 EQUIPMENT AND PERFORMANCE DATA

Provide complete equipment and performance data sheets.

## 2.15 SPECIFICATION AND DATA SHEETS

Provide complete specification and data sheets for the generator system.

## 2.16 MANUFACTURER'S CERTIFICATION OF PROTOTYPE TESTING

Provide complete manufacturer's prototype testing data sheets for the generator system.

# PART 3 EXECUTION

## 3.1 FACTORY TESTS

Generator set factory tests shall be performed at rated load and 0.8 PF. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady state governing, single step load pickup, and safety shutdowns.

## 3.2 FIELD QUALITY CONTROL

### ON SITE ACCEPTANCE TEST

Following completion of the site work, representatives of the manufacturer shall test the generator and transfer switch for compliance with the specifications. Testing shall be scheduled and witnessed by the DISTRICT. Installation acceptance tests to be conducted on-site by the manufacturer shall include a "cold start" test, a two-hour full load test, and a one-step rated load pickup test in accordance with NFPA 110. Manufacturer shall provide a resistive load bank and make temporary connections for full load test.

## 3.3 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 05 OPERATION AND MAINTENANCE INFORMATION~~. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data~~, especially the items/units listed under paragraph 1.2.

## 3.4 OPERATION AND MAINTENANCE TRAINING

Conduct a training course for the members of the operating staff as designated by the District. Make the training period consist of a total of 8 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

# SECTION 26 41 00

# 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 81 | (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |
| NFPA 780 | (2014) Standard for the Installation of Lightning Protection Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 467 | (2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment |
| UL 96 | (2005; Reprint Mar 2015) Standard for Lightning Protection Components |
| UL Electrical Construction | (2012) Electrical Construction Equipment Directory |

### 1.2 RELATED REQUIREMENTS

#### 1.2.1 Verification of Dimensions

Confirm all details of Work, verify all dimensions in field, and advise District of any discrepancy before performing Work. Obtain prior approval of Construction Manager before making any departures from the design.

#### 1.2.2 System Requirements

Provide a system furnished under this specification consisting of the latest UL Listed products of a Manufacturer regularly engaged in production of lightning protection system components. Comply with NFPA 70, NFPA 780, and UL 96.

#### 1.2.3 Lightning Protection System Installers Documentation

Provide documentation showing that the installer is certified with a commercial third-party inspection company whose sole work is lightning

protection, or is a UL Listed Lightning Protection Installer. In either case, the documentation must show that they have completed and passed the requirements for certification or listing and have a minimum of 2 years documented experience installing lightning protection systems for projects of similar scope and complexity.

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overall Lightning Protection System

Each Major Component

SD-06 Test Reports

Lightning Protection and Grounding System Test Plan

Lightning Protection and Grounding System Test

SD-07 Certificates

Lightning Protection System Installers Documentation

Component UL Listed and Labeled

Lightning Protection System Inspection Certificate

## 1.4 QUALITY REQUIREMENTS

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" or "must" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Construction Manager.

### 1.4.1 Installation Drawings

#### 1.4.1.1 Overall System Drawing

Submit installation shop drawing for the overall lightning protection system. Include on the drawings the physical layout of the equipment (plan view and elevations), mounting details, relationship to other parts of the Work, and wiring diagrams.

#### 1.4.1.2 Major Components

Submit detail drawings for each major component including Manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. The major components are air terminals, conductor, connectors, and ground rods.

### 1.4.2 Component UL Listed and Labeled

Submit proof of compliance that components are UL Listed and Labeled. Listing alone in UL Electrical Construction, which is the UL Electrical Construction Directory, is not acceptable evidence. In lieu of Listed and Labeled, submit written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that items have been tested and conform to requirements and testing methods of Underwriters Laboratories.

### 1.4.3 Lightning Protection and Grounding System Test Plan

Provide a lightning protection and grounding system test plan. Detail both the visual inspection and electrical testing of the system and components in the test plan. Identify (number) the system test points/locations along with a listing or description of the item to be tested and the type of test to be conducted. As a minimum, include a sketch of the facility and surrounding lightning protection system as part of the specific test plan for each structure. Include the requirements specified in paragraph, "Testing of Integral Lightning Protection System" in the test plan.

### 1.4.4 Lightning Protection System Inspection Certificate

Provide certification from a commercial third-party inspection company whose sole work is lightning protection, stating that the lightning protection system complies with NFPA 780. Third party inspection company cannot be the system installer or the system designer.

Inspection must cover every connection, air terminal, conductor, fastener, accessible grounding point and other components of the lightning protection system to ensure 100 percent system compliance. This includes witnessing the tests for the resistance measurements for ground rods with test wells, and for continuity measurements for bonds. It also includes verification of proper surge protective devices for power, data and telecommunication systems. Random sampling or partial inspection of a facility is not acceptable.

## 1.5 SITE CONDITIONS

Confirm all details of work, verify all dimensions in field, and advise Construction Manager of any discrepancy before performing work. Obtain prior approval of Construction Manager before changing the design.

## 1.6 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

# 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 the 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 coatings, such as tin or lead, or oversize conductors. Where a mechanical hazard is involved, increase conductor size to compensate for the hazard or protect conductors. 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). All lightning protection components, such as bonding plates, air terminals, air terminal supports and braces, chimney bands, clips, connector fittings, and fasteners are to comply with the requirements of UL 96 classes as applicable.

2.1.1 Main and Bonding Conductors

NFPA 780 and UL 96 Class I, Class II, or Class II modified materials as applicable.

2.1.2 Copper Only

Provide copper conductors, except where aluminum conductors are required for connection to aluminum equipment.

2.2 COMPONENTS

2.2.1 Air Terminals

Provide solid air terminals with a blunt tip. Tubular air terminals are not permitted. Support air terminals more than 24 inches in length by suitable brace, supported at not less than one-half the height of the terminal.

2.2.2 Ground Rods

Provide ground rods made of copper-clad steel conforming to conform to UL 467. Provide ground rods that are not less than 5/8 inch in diameter and 10 feet in length. Do not mix ground rods of copper-clad steel or solid copper on the job.

2.2.3 Grounding Plates

Provide grounding plates made of copper-clad steel conforming to UL 96.

2.2.4 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.

2.2.5 Connector Fittings

Provide connector fittings for "end-to-end", "Tee", or "Y" splices that conform to NFPA 780 and UL 96.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

Provide a lightning protection system that meets the requirements of NFPA 780, including tie-ins to existing lightning protection systems. Lightning protection system consists of air terminals, down conductors, ground connections, and grounding electrodes and ground ring electrode conductor. Expose conductors on the structures except where conductors are required to

be in protective sleeves. Bond secondary conductors with grounded metallic parts within the building. Make interconnections within side-flash distances at or below the level of the grounded metallic parts.

### 3.1.1 Ground Connections

Attach each down conductor and ground ring electrode to ground rods by welding (including exothermic), brazing, or compression. All connections to ground rods below ground level must be by exothermic weld connection or with a high compression connection using a hydraulic or electric compression tool to provide the correct circumferential pressure. Accessible connections above ground level and in test wells can be accomplished by mechanical clamping.

### 3.1.2 Grounding Electrodes

Extend driven ground rods vertically into the existing undisturbed earth for a distance of not less 10 feet. Set ground rods not less than 3 feet nor more than 8 feet, from the structure foundation, and at least beyond the drip line for the facility. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE 81. Maximum allowed resistance of a driven ground rod is 25 ohms, under normally dry conditions when a ground ring electrode is not used. Contact the Construction Manager for direction on how to proceed when two of any three ground rods, driven not less than 10 feet into the ground, a minimum of 10 feet apart, and equally spaced around the perimeter, give a combined value exceeding 50 ohms immediately after having driven. For ground ring electrode, provide continuous No. 2/0 bare stranded copper cable. Lay ground ring electrode around the perimeter of the structure in a trench not less than 2.5 feet and not more than 3 feet deep nor more than 8 feet from the nearest point of the structure foundation, and at least beyond the drip line for the facility. Install ground ring electrode to a minimum depth of 30 inches. Install a ground ring electrode 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.

## 3.2 APPLICATIONS

### 3.2.1 Nonmetallic Exterior Walls with Metallic Roof

Bond metal roof sections together which are insulated from each other so that they are electrically continuous, having a surface contact of at least 3 square inches.

### 3.2.2 Lightning Protection for MOV's near S-470

This protection system will start with the installation of a #2/0 AWG ground ring around all single location for the 4 MOV's. Three 4" GRC conduit masts each 17.5' high will provide a top mounting point for a 48" air terminal. Each one will be place between each of the 4 MOV facilities. Each mast shall be centrally embedded in a 4'X 4'X 2.5'deep concrete foundation with sloping away from pipe to meet wind loading code requirements. A #2/0 AWG will be installed down the outside of the mast with needed supports to an attachment point on the ground ring. See detail on E-12103.

## 3.3 INTERFACE WITH OTHER STRUCTURES

### 3.3.1 Fences

Bond metal fence and gate systems to the lightning protection system whenever the fence or gate is within 6 feet of any part of the lightning protection system in accordance with ANSI C2.

### 3.3.2 Exterior Overhead Systems

Bond to the nearest down conductor as close to grade as possible. This includes overhead pipes, conduits, cable trays, or any other metallic objects on the exterior of the building that enter a building. In addition, bond pipes, conduits, and cable trays to any metallic objects (such as steel structural support of air handling units or cooling towers) that are within 6 feet.

## 3.4 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. Overfill to accommodate for settling. Include necessary topsoil, fertilizing, liming, seeding, sodding, sprigging or mulching in any restoration. Maintain disturbed surfaces and replacements until final acceptance.

## 3.5 FIELD QUALITY CONTROL

### 3.5.1 Lightning Protection and Grounding System Test

Test the lightning protection and grounding system to ensure continuity is not in excess of 1 ohm and that resistance to ground is not in excess of 25 ohms. Provide documentation for the measured values at each test point. 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 test points, measured values for continuity and ground resistances, and soil conditions at the time that measurements were made. Submit results of each test to the Construction Manager.

-- End of Section --

# SECTION 26 42 14.00 10

# CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)

## 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 B418 | (2012) Standard Specification for Cast and Wrought Galvanic Zinc Anodes |
| ASTM B843 | (2013) Standard Specification for Magnesium Alloy Anodes for Cathodic Protection |
| ASTM D1248 | (2012) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable |

NACE INTERNATIONAL (NACE)

| | |
|---|---|
| NACE SP0169 | (2015) Control of External Corrosion on Underground or Submerged Metallic Piping Systems |
| NACE SP0177 | (2014) Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems |
| NACE SP0188 | (1999; R 2006) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA TC 2 | (2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |

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

| | |
|---|---|
| 40 CFR 280 | Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST) |

| | |
|---|---|
| 49 CFR 192 | Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards |
| 49 CFR 195 | Transportation of Hazardous Liquids by Pipeline |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 510 | (2005; Reprint Jul 2013) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape |
| UL 514A | (2013) Metallic Outlet Boxes |
| UL 6 | (2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel |

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings
Contractor's Modifications

SD-03 Product Data

Equipment
Spare Parts

SD-06 Test Reports

Tests and Measurements
Contractor's Modifications

SD-07 Certificates

Cathodic Protection System
Services of "Corrosion Expert"

SD-10 Operation and Maintenance Data

Cathodic Protection System
Training Course

## 1.3 QUALITY REQUIREMENTS

### 1.3.1 Services of "Corrosion Expert"

Obtain the services of a "corrosion expert" to supervise, inspect, and test the installation and performance of the cathodic protection system. "Corrosion expert" refers to a person, who by thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is

qualified to engage in the practice of corrosion control of buried or submerged metallic surfaces.

a. Such a person must be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection (CP) Specialist or be a registered professional engineer who has certification or licensing that includes education and experience in corrosion control of buried or submerged metallic piping and tank systems, if such certification or licensing includes 5 years experience in corrosion control on underground metallic surfaces of the type under this contract.

b. The "corrosion expert" shall make at least ~~3~~ 18 visits to the project site. The first of these visits shall include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the Contractor the type of cathodic protection required. Once the submittals are approved and the materials delivered, the "corrosion expert" shall revisit the site t~~he~~o ensure the Contractor understands installation practices and laying out the components. The third visit shall involve testing the installed cathodic protection systems and training applicable personnel on proper maintenance techniques. The "corrosion expert" shall supervise installation and testing of all cathodic protection.

c. Submit evidence of qualifications of the "corrosion expert" including its name and qualifications certified in writing to the Construction Manager prior to the start of construction. Certification shall be submitted giving the name of the firm, the number of years of experience, and a list of not less than five (5) of the firm's installations, three (3) or more years old, that have been tested and found satisfactory.

1.3.2 Isolators

Isolators are required to insulate the indicated pipes from any other structure. Isolators shall be provided with lightning protection and a test station as shown.

1.3.3 Anode and Bond Wires

A minimum of 5 magnesium anodes with an unpackaged weight of 9 pounds shall be provided uniform distances along the metallic pipe lines. A minimum of 3 test stations shall be used for these anodes. These anodes shall be in addition to anodes for the pipe under concrete slab and casing requirements. For each cathodic system, the metallic components and structures to be protected shall be made electrically continuous. This shall be accomplished by installing bond wires between the various structures. Bonding of existing buried structures may also be required to preclude detrimental stray current effects and safety hazards. Provisions shall be included to return stray current to its source without damaging structures intercepting the stray current. The electrical isolation of underground facilities in accordance with acceptable industry practice shall be included under this section. All tests shall be witnessed by the Construction Manager.

1.3.4 Surge Protection

Approved zinc grounding cells or sealed weatherproof lightning arrestor devices shall be installed across insulated flanges or fittings installed in underground piping as indicated on the drawings. The arrestor shall be gapless, self-healing, solid state type. Zinc anode composition shall conform to ASTM B418, Type II. Lead wires shall be number 6 AWG copper with high molecular weight polyethylene (HMWPE) insulation. The zinc grounding cells shall not be prepackaged in backfill but shall be installed as detailed on the drawings. Lightning arrestors or zinc grounding cells are not required for insulated flanges on metallic components used on nonmetallic piping systems.

1.3.5 Nonmetallic Pipe System

In the event pipe other than metallic pipe is approved and used in lieu of metallic pipe, all metallic components of this pipe system shall be protected with cathodic protection. Detailed drawings of cathodic protection for each component shall be submitted to the Construction Manager for approval ~~within 45 days after date of receipt of notice to proceed, and~~60 days before ~~commencement of~~ any proposed work is scheduled.

1.3.5.1 Coatings

Coatings for metallic components shall be as required for metallic fittings. Protective covering (coating and taping) shall be completed and tested on each metallic component (such as valves, hydrants and fillings). This covering shall be as required for underground metallic pipe. Each test shall be witnessed by the Construction Manager. Coatings shall be selected, applied, and inspected as specified in these specifications. The use of nonmetallic pipe does not change other requirements of the specifications. Any deviations due to the use of nonmetallic pipe shall be submitted for approval.

1.3.5.2 Tracer Wire

When a nonmetallic pipe line is used to extend or add to an existing metallic line, an insulated No. 8 AWG copper wire shall be thermit-welded to the existing metallic line and run the length of the new nonmetallic line. This wire shall be used as a locator tracer wire and to maintain continuity to any future extensions of the pipe line.

1.3.6 Drawings

Submit six copies of detail drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, results of system design calculations including soil-resistivity, installation instructions and certified test data showing location of anodes and stating the maximum recommended anode current output density. Include in the detail drawings complete wiring and schematic diagrams, insulated fittings, test stations, permanent reference cells, and bonding and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. Locations shall be referenced to two (2) permanent facilities or mark points.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Storage area for magnesium anodes will be designated by the Construction Manager. If anodes are not stored in a building, tarps or similar protection should be used to protect anodes from inclement weather. Packaged anodes, damaged as a result of improper handling or being exposed to rain, shall be resacked and the required backfill added.

## 1.5 EXTRA MATERIALS

After approval of shop drawings, and not later than ~~three (3)~~six (6) months prior to the date of beneficial occupancy, furnish spare parts data for each different item of material and equipment specified~~, after approval of detail drawings and not later than six (6) months prior to the date of beneficial occupancy~~. The data shall include a complete list of parts, special tools, and supplies, with current unit prices and source of supply. One (1) spare anode of each type shall be furnished. In addition, supply information for material and equipment replacement for all other components of the complete system, including anodes, cables, splice kits and connectors, corrosion test stations, and any other components not listed above. Furnish a reference cell on a reel with 350 feet of conductor, along with other accessories, and a digital voltmeter that can be used in the maintenance of this cathodic protection system. Use of this equipment shall be demonstrated in actual tests during the training course, which shall include a description of the equipment and measurement of the pipe-to-soil potential, rainfall, and gas company voltages.

## 1.6 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

Provide a complete, operating, sacrificial anode cathodic protection system in complete compliance with NFPA 70, with all applicable Federal, State, and local regulations and with the minimum requirements of this contract.

a. In addition to the minimum requirements of these specifications, construction of gas pipelines and associated cathodic protection systems shall be in compliance with 49 CFR 192 and construction of hazardous liquid pipelines, including fuel pipelines, and associated cathodic protection systems shall be in compliance with 49 CFR 195 and construction and installation of underground fuel storage tanks and associated cathodic protection system shall be in compliance with 40 CFR 280.

b. The services required include planning, installation, adjusting and testing of a cathodic protection system, using sacrificial anodes for cathodic protection of the ~~Water, Force Main, and/or~~ Gas and sheet piles lines, their connectors and lines under the slab or floor foundation. The cathodic protection system shall include anodes, cables, connectors, corrosion protection test stations, and any other equipment required for a complete operating system providing the NACE criteria of protection as specified.

c. Submit an itemized list of equipment and materials including item number, quantity, and manufacturer ~~of each item, within 30 days after receipt of notice to proceed~~ between four (4) to six (6) months prior to the start of this type work. The list shall be accompanied by a description of procedures for each type of testing and adjustments, including testing of coating for thickness and holidays. Installation of materials and equipment shall not commence until this submittal is approved. Insulators are required whenever needed to insulate the pipes from any other structure. Any pipe crossing the pipe shall have a test station. The cathodic protection shall be provided ~~on~~ for ~~Water, Force Main, or~~ Gas pipes.

d. Submit proof that the materials and equipment furnished under this section conform to the specified requirements contained in the referenced standards or publications. The label or listing by the specified agency will be acceptable evidence of such compliance.

e. Before final acceptance of the cathodic protection system, submit 6 copies of operating manuals outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.

f. Submit 6 copies of maintenance manuals, listing routine maintenance procedures, recommendation for maintenance testing, possible breakdowns and repairs, and troubleshooting guides. The manuals shall include single-line diagrams for the system as installed; instructions in making pipe-to-reference cell and tank-to-reference cell potential measurements and frequency of monitoring; instructions for dielectric connections, interference and sacrificial anode bonds; instructions shall include precautions to ensure safe conditions during repair of pipe or other metallic systems. The instructions shall be neatly bound between permanent covers and titled "Operating and Maintenance Instructions." These instructions shall be submitted for the Construction Manager's approval. The instructions shall include the following:

(1) As-built drawings, to scale, of the entire system, showing the locations of the piping, location of all anodes and test stations, locations of all insulating joints, and structure-to-soil potential test points as measured during the tests required by paragraph TESTS AND MEASUREMENTS. Each test point shall be given a unique alphanumeric identification that is cross referenced to the data sheets.

(2) Recommendations for maintenance testing, including instructions in making pipe-to-reference cell potential measurements and frequency of testing.

(3) All maintenance and operating instructions and nameplate data shall be in English.

(4) Instructions shall include precautions to insure safe conditions during repair of pipe system.

### 2.1.1 Contractor's Modifications

The specified system is based on a complete system with magnesium sacrificial anodes. The Contractor may modify the cathodic protection system after review of the project, site verification, and analysis, if the proposed modifications include the anodes specified and will provide better overall system performance.

a. Submit six copies of detail drawings showing proposed changes in location, scope of performance indicating any variations from, additions to, or clarifications of contract drawings. Show proposed changes in anode arrangement, anode size and number, anode materials and layout details, conduit size, wire size, mounting details, wiring diagram, method for electrically-isolating each pipe, and any other pertinent information to proper installation and performance of the system. The modifications shall be fully described, shall be approved by the Construction Manager, and shall meet the following criteria.

b. The proposed system shall achieve a minimum pipe-to-soil "instant off" potential of minus 850 millivolts with reference to a saturated copper-copper sulfate reference cell on the underground components of the piping or other metallic surface. Take resistivity measurements of the soil in the vicinity of the pipes and ground bed sites. Based upon the measurements taken, the current and voltage shall be required to produce a minimum of minus 850 millivolts "instant off" potential between the structure being tested and the reference cell. This potential shall be obtained over 95 percent of the metallic area. The anode system shall be designed for a life of twenty-five (25) years of continuous operation.

c. Submit final report regarding Contractor's modifications. The report shall include pipe-to-soil measurements throughout the affected area, indicating that the modifications improved the overall conditions, and current measurements for anodes. The following special materials and information are required: taping materials and conductors; zinc grounding cell, installation and testing procedures, and equipment; coating material; system design calculations for anode number, life, and parameters to achieve protective potential; backfill shield material and installation details showing waterproofing; bonding and waterproofing details; insulated resistance wire; exothermic weld equipment and material.

### 2.1.2 Summary of Services Required

The scope of services shall include, but shall not be limited to, the following:

a. Close-interval potential surveys.

b. Cathodic Protection Systems.

c. System testing.

d. Casing corrosion control.

e. Interference testing.

f. Training.

g. Operating and maintenance manual.

h. Insulator testing and bonding testing.

i. Coating and holiday testing to be submitted within 45 days of notice to proceed.

2.1.3 Tests of Components

Perform a minimum of four (4) tests at each metallic component in the piping system. Two (2) measurements shall be made directly over the anodes and the other two (2) tests shall be over the outer edge of the component, but at the farthest point from the anodes. Structure and pipes shall be shown with the cathodic protection equipment. All components of the cathodic protection system shall be shown on drawings, showing their relationship to the protected structure or component. A narrative shall describe how the cathodic protection system will work and provide testing at each component. Components requiring cathodic protection shall include but not be limited to the following:

a. Pipes under the floor slab or foundations.

b. PIV.

c. Shutoff valves.

d. Metallic pipe extended from aboveground locations.

e. Each connector or change-of-direction device.

f. Any metallic pipe component or section.

g. Backflow preventer.

h. Culvert.

2.1.4 Electrical Potential Measurements

All potential tests shall be made at a minimum of 10 foot intervals witnessed by the Construction Manager. Submittals shall identify test locations on separate drawing, showing all metal to be protected and all cathodic protection equipment. Test points equipment and protected metal shall be easily distinguished and identified.

2.1.5 Achievement of Criteria for Protection

All conductors, unless otherwise shown, shall be routed to or through the test stations. Each system provided shall achieve a minimum pipe-to-soil "instant off" potential of minus 850 millivolt potentials with reference to a saturated copper-copper-sulfate reference cell on all underground components of the piping. Based upon the measurements taken, the current and voltage of the anodes should be adjusted as required to produce a minimum of minus 850 millivolts "instant off" potential between the structure being tested and the reference cell. This potential should be obtained over 95 percent of the metallic area. This must be achieved without the "instant

off" potential exceeding 1150 millivolts. Testing will be witnessed by the Construction Manager. Provide additional anodes if required to achieve the minus 850 millivolts "instant off". Although acceptance criteria of the cathodic protection systems are defined in NACE SP0169, for this project the "instant off" potential of minus 850 millivolts is the only acceptable criteria.

2.1.6 Metallic Components on Nonmetallic Systems and Typicals

2.1.6.1 Metallic Components

As a minimum, protect each metallic component with two (2) magnesium anodes. This number of anodes is required to achieve minus 850 millivolts "instant off" potential on the metallic area and at the same time not provide overvoltage above 1150 millivolts "instant off." As a minimum, the magnesium anode unpackaged weight shall be 9 pounds. The magnesium anodes shall be located on each side of the metallic component and routed through a test station.

2.1.6.2 Fire Hydrants, if applicable

Fire hydrant pipe components shall have a minimum of two (2) anodes. These magnesium anodes shall have an unpackaged weight of 17 pounds.

2.1.6.3 Pipe Under Concrete Slab

Pipe under concrete slab shall have a minimum of 2 magnesium anodes. These magnesium anodes shall have an unpackaged weight of 9 pounds. Pipe under concrete slab shall have 1 permanent reference electrodes located under the slab. One (1) permanent reference electrode shall be located where the pipe enters the concrete slab. All conductors shall be routed to a test station.

2.1.6.4 Valves

Each valve shall be protected with 1 magnesium anodes. The magnesium anode shall have an unpackaged weight of 9 pounds.

2.1.6.5 Metallic Pipe Component or Section

Each section of metallic pipe shall be protected with 2 magnesium anodes. The magnesium anodes shall have an unpackaged weight of 9 pounds.

2.1.6.6 Connectors or Change-of-Direction Devices

Each change-of-direction device shall be protected with 2 magnesium anodes. The magnesium anode shall have an unpackaged weight of 9 pounds.

2.1.7 Metallic Component Coating

Coatings for metallic components shall be as required for metallic fittings as indicated. This will include fire hydrants, T's, elbows, valves, etc. Coatings shall be selected, applied, and inspected as specified in these specifications. All aboveground pipeline shall be coated as indicated or as approved. The coating shall have a minimum thickness of 7 mil. The pipeline coating shall be in accordance with all applicable Federal, State, and local regulations.

## 2.2 MAGNESIUM ANODES

Install a minimum of 2 anodes on the Pipe or Tank systems. See Paragraph METALLIC COMPONENTS ON NONMETALLIC SYSTEMS AND TYPICALS for additional anodes under slab.

### 2.2.1 Anode Composition

Anodes shall be of high-potential magnesium alloy, made of primary magnesium obtained from sea water or brine, and not made from scrap metal. Magnesium anodes shall conform to ASTM B843 and to the following analysis (in percents) otherwise indicated:

| | |
|---|---|
| Aluminum, max. | 0.010 |
| Manganese, max. | 0.50 to 1.30 |
| Zinc | 0.05 |
| Silicon, max. | 0.05 |
| Copper, max. | 0.02 |
| Nickel, max. | 0.001 |
| Iron, Max. | 0.03 |
| Other impurities, max. | 0.05 each or 0.3 max. total |
| Magnesium | Remainder |

Furnish spectrographic analysis on samples from each heat or batch of anodes used on this project.

### 2.2.2 Dimensions and Weights

Dimensions and weights of anodes shall be approximately as follows:

| **TYPICAL MAGNESIUM ANODE SIZE (Cross sections may be round, square, or D shaped)** | | | |
|---|---|---|---|
| **Nominal Weight (lbs)** | **Approx. Size (inch)** | **Nominal Gross Weight (lbs) Packaged in Backfill** | **Nominal Package Dimensions (inch)** |
| 3 | 3 X 3 X 5 | 8 | 5-1/4 X 5-1/4 X 8 |
| 5 | 3 X 3 X 8 | 13 | 5-1/4 X 5-1/4 X 11-1/4 |
| 9 | 3 X 3 X 14 | 27 | 5-1/4 X 20 |
| 12 | 4 X 4 X 12 | 32 | 7-1/2 X 18 |
| 17 | 4 X 4 X 17 | 45 | 7-1/2 X 24 |
| 32 | 5 X 5 X 20-1/2 | 68 | 8-1/2 X 28 |
| 50 | 7 X 7 X 16 | 100 | 10 X 24 |

### 2.2.3 Packaged Anodes

Provide anodes in packaged form with the anode surrounded by specially-prepared quick-wetting backfill and contained in a water permeable cloth or paper sack. Anodes shall be centered by means of spacers in the backfill

material. The backfill material shall have the following composition, unless otherwise indicated:

| Material | Approximate Percent by Weight |
|---|---|
| Gypsum | 75 |
| Bentonite | 20 |
| Sodium Sulphate | 5 |
| Total | 100 |

2.2.4 Zinc Anodes

Zinc anodes shall conform to ASTM B418, Type II.

2.2.5 Connecting Wire

2.2.5.1 Wire Requirements

Wire shall be No. 12 AWG solid copper wire, not less than 10 feet long, unspliced, complying with NFPA 70, Type TW insulation. Connecting wires for magnesium anodes shall be factory installed with the place or emergence from the anode in a cavity sealed flush with a dielectric sealing compound. Connecting wires for zinc anodes shall be factory installed with the place of connection to the protruding steel core completely sealed with a dielectric material.

2.2.5.2 Anode Header Cable

Cable for anode header and distribution shall be No. 10 AWG stranded copper wire with type CP high molecular weight polyethylene, 7/64 inch thick insulation, 600-volt rating.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Electrical Wire

Wire shall be No. 10 AWG stranded copper wire with NFPA 70, Type TW insulation. Polyethylene insulation shall comply with the requirements of ASTM D1248 and shall be of the following types, classes, and grades:

High-molecular weight polyethylene shall be Type I, Class C, Grade E5.

High-density polyethylene shall be Type III, Class C, Grade E3.

2.3.1.1 Wire Splicing

Connecting wire splicing shall be made with copper compression connectors or exothermic welds, following instructions of the manufacturer. Single split-bolt connections shall not be used. Sheaths for encapsulating electrical wire splices to be buried underground shall fit the insulated wires entering the spliced joints and epoxy potting compound shall be as specified below.

2.3.1.2 Test Wires

Test wires shall be AWG No. 12 stranded copper wire with NFPA 70, Type TW or RHW-USE with outer covering or polyethylene insulation.

2.3.1.3 Resistance Wire

Resistance wire shall be AWG No. 16 or No. 22 nickel-chromium wire.

2.3.2 Conduit

Rigid galvanized steel conduit and accessories shall conform to UL 6. Non metallic conduit shall conform to NEMA TC 2.

2.3.3 Test Boxes and Junctions Boxes

Boxes shall be outdoor type conforming to UL 514A.

2.3.4 Joint, Patch, Seal, and Repair Coating

Sealing and dielectric compound shall be a black, rubber based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Compound shall be applied as recommended by the manufacturer, but not less than 1/2-inch thick. Coating compound shall be cold-applied coal-tar base mastic. Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.3.5 Backfill Shields

Shields shall consist of approved pipeline wrapping or fiberglass-reinforced, coal-tar impregnated tape, or plastic weld caps, specifically made for the purpose and installed in accordance with the manufacturer's recommendations. When joint bonds are required, due to the use of mechanical joints, the entire joint shall be protected by the use of a kraft paper joint cover. The joint cover shall be filled with poured-in, hot coat-tar enamel.

2.3.6 Epoxy Potting Compound

Compound for encapsulating electrical wire splices to be buried underground shall be a two package system made for the purpose.

2.3.7 Test Stations

Stations shall be of the aboveground and shall be the standard product of a recognized manufacturer. Test stations shall be complete with an insulated terminal block having the required number of terminals. The test station shall be provided with a lockable over and shall have an embossed legend, "C.P. Test." A minimum of one (1) test station shall be provided each component of the pipe or tank. A minimum of six (6) terminals shall be provided in each test station. A minimum of two (2) leads are required to the metallic pipe from each test station. Other conductors shall be provided for each anode, other foreign pipe, and reference cells as required.

2.3.8 Joint and Continuity Bonds

Bonds shall be provided across all joints in the metallic water or gas lines, across any electrically discontinuous connections and all other pipes and structures with other than welded or threaded joints that are included in this cathodic protection system. Unless otherwise specified in the specifications, bonds between structures and across joints in pipe with

other than welded or threaded joints shall be No. 8 AWG stranded copper cable with polyethylene insulation. Bonds between structures shall contain sufficient slack for any anticipated movement between structures. Bonds across pipe joints shall contain a minimum of 4 inch of slack to allow for pipe movement and soil stress. Bonds shall be attached by exothermic welding. Exothermic weld areas shall be insulated with coating compound and approved, and witnessed by the Construction Manager. Continuity bonds shall be installed as necessary to reduce stray current interference. Additional joint ~~bondings~~bonding shall be accomplished where the necessity is discovered during construction or testing or where the Construction Manager's representative directs that such bonding be done. Joint bonding shall include all associated excavation and backfilling. There shall be a minimum of two (2) continuity bonds between each structure and other than welded or threaded joints. Test for electrical continuity across all joints with other than welded or threaded joints and across all metallic portions or components. Provide bonding as required and as specified above until electrical continuity is achieved. Submit bonding test data for approval.

2.3.9 Resistance Bonds

Resistance bonds should be adjusted as outlined in this specification. Alternate methods may be used if they are approved by the Construction Manager.

2.3.10 Stray Current Measurements

Stray current measurements should be performed at each test station. Stray currents resulting from lightning or overhead alternating current (AC) power transmission systems shall be mitigated in accordance with NACE SP0177.

2.3.11 Electrical Isolation of Structures

As a minimum, isolating flanges or unions shall be provided at the following locations:

a. Connection of new metallic piping or components to existing piping.

b. Pressure piping under floor slab to a building.

Isolation shall be provided at metallic connection of all lines to existing system and where connecting to a building. Additionally, isolation shall be provided between water and/or gas line; and foreign pipes that cross the new lines within 10 feet. Isolation fittings, including isolating flanges and couplings, shall be installed aboveground or in a concrete pit.

2.3.11.1 Electrically Isolating Pipe Joints

Electrically isolating pipe joints shall be of a type that is in regular factory production.

2.3.11.2 Electrically Conductive Couplings

Electrically conductive couplings shall be of a type that has a published maximum electrical resistance rating given in the manufacturer's literature. Cradles and seals shall be of a type that is in regular factory production made for the purpose of electrically insulating the carrier pipe from the casing and preventing the incursion of water into the annular space.

2.3.11.3 Insulating Joint Testing

A Model 601 Insulation Checker, as manufactured by "Gas Electronics" or an approved equal, shall be used for insulating joint (flange) electrical testing.

2.3.12 Underground Structure Coating

This coating specification shall take precedence over any other project specification and drawing notes, whether stated or implied, and shall also apply to the pipeline or tank supplier. No variance in coating quality shall be allowed by the Contractor or Base Construction Representative without the written consent of the designer. All underground metallic pipelines and tanks to be cathodically protected shall be afforded a good quality factory-applied coating. This includes all carbon steel, cast-iron and ductile-iron pipelines or vessels. Coatings shall be selected, applied, and inspected as specified. If non-metallic pipelines are installed, all metallic fittings on pipe sections shall be coated in accordance with this specification section.

a. The nominal thickness of the metallic pipe joint or other component coating shall be 40 mils, plus or minus 5 percent.

b. Pipe and joint coating for factory applied or field repair material shall be applied as recommended by the manufacturer and shall be one of the following:

(1) Continuously extruded polyethylene and adhesive coating system.
(2) Polyvinyl chloride pressure-sensitive adhesive tape.
(3) High density polyethylene/bituminous rubber compound tape.
(4) Butyl rubber tape.
(5) Coal tar epoxy.

2.3.12.1 Field Joints

All field joints shall be coated with materials compatible with the pipeline coating compound. The joint coating material shall be applied to an equal thickness as the pipeline coating. Unbonded coatings shall not be used on these buried metallic components. This includes the elimination of all unbonded polymer wraps or tubes. Once the pipeline or vessel is set in the trench, an inspection of the coating shall be conducted. This inspection shall include electrical holiday detection. Any damaged areas of the coating shall be properly repaired. The Construction Manager shall be asked to witness inspection of the coating and testing using a holiday detector.

2.3.12.2 Inspection of Pipe Coatings

Any damage to the protective covering during transit and handling shall be repaired before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current in accordance with NACE SP0188 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. All holidays in the protective covering shall be repaired immediately upon detection. Occasional checks of holiday detector potential will be made by the Construction Manager's representative to determine

suitability of the detector. All labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor.

2.3.12.2.1 Protective Covering for Aboveground Piping System

Finish painting shall conform to the applicable paragraph of Section 09 06 90 PAINTS AND COATINGS and as follows:

2.3.12.2.2 Ferrous Surfaces

Shop-primed surfaces shall be touched-up with ferrous metal primer. Surfaces that have not been shop-primed shall be solvent-cleaned. Surfaces that contain loose rust, loose mil scale, and other foreign substances shall be mechanically-cleaned by power wire-brushing and primed with ferrous metal primer. Primed surface shall be finished with two (2) coats of exterior oil paint and vinyl paint. Coating for each entire piping service shall be an approved pipe line wrapping having a minimum coating resistance of 50,000 Ohms per square foot.

2.3.13 Resistance Wire

Wire shall be No. 16 or No. 22 nickel-chromium wire with TW insulation.

2.3.14 Electrical Connections

Electrical connections shall be done as follows:

a. Exothermic welds shall be "Cadweld", "Bundy", "Thermoweld", or an approved equal. Use of this material shall be in strict accordance with the manufacturer's recommendations.

b. Electrical-shielded arc welds shall be approved for use on steel pipe by shop drawing submittal action.

c. Brazing shall be as specified in Paragraph: Lead Wire Connections.

2.3.15 Electrical Tape

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.3.16 Permanent Reference Electrodes

Permanent reference electrodes shall be Cu-CuS04 electrodes suitable for direct burial. Electrodes shall be guaranteed by the supplier for 15 years' service in the environment in which they shall be placed. Electrodes shall be installed directly beneath pipe, or metallic component.

2.3.17 Casing

Where a pipeline is installed in a casing under a roadway or railway, the pipeline shall be electrically insulated from the casing, and the annular space sealed and filled with an approved corrosion inhibiting product against incursion of water.

# PART 3 EXECUTION

## 3.1 CRITERIA OF PROTECTION

Acceptance criteria for determining the adequacy of protection on a buried underground pipe or tank shall be in accordance with NACE SP0169 and as specified below.

### 3.1.1 Iron and Steel

The following method a. shall be used for testing cathodic protection voltages. If more than one method is required, method b. shall be used.

a. A negative voltage of at least minus 850 millivolts as measured between the underground component and a saturated copper-copper sulphate reference electrode connecting the earth (electrolyte) directly over the underground component. Determination of this voltage shall be made with the cathodic protection system in operation. Voltage drops shall be considered for valid interpretation of this voltage measurement. A minimum of minus 850 millivolts "instant off" potential between the underground component being tested and the reference cell shall be achieved over 95 percent of the area of the structure. Adequate number of measurements shall be obtained over the entire structure, pipe, tank, or other metallic component to verify and record achievement of minus 850 millivolts "instant off." This potential shall be obtained over 95 percent of the total metallic area without the "instant off" potential exceeding 1200 millivolts.

b. A minimum polarization voltage shift of 100 millivolts as measured between the underground component and a saturated copper-copper sulphate reference electrode contacting the earth directly over the underground component. This polarization voltage shift shall be determined by interrupting the protective current and measuring the polarization decay. When the protective current is interrupted, an immediate voltage shift will occur. The voltage reading, after the immediate shift, shall be used as the base reading from which to measure polarization decay. Measurements achieving 100 millivolts decay shall be made over 95 percent of the metallic surface being protected.

c. For any metallic component, a minimum of four (4) measurements shall be made using subparagraph a., above, and achieving the "instant off" potential of minus 850 millivolts. Two (2) measurements shall be made over the anodes and two (2) measurements shall be made at different locations near the component and farthest away from the anode.

### 3.1.2 Aluminum

Aluminum underground component shall not be protected to a potential more negative than minus 1200 millivolts, measured between the underground component and a saturated copper-copper sulphate reference electrode contacting the earth, directly over the metallic component. Resistance, if required, shall be inserted in the anode circuit within the test station to reduce the potential of the aluminum to a value which will not exceed a potential more negative than minus 1200 millivolts. Voltage shift criterion shall be a minimum negative polarization shift of 100 millivolts measured between the metallic component and a saturated copper-copper sulphate

reference electrode contacting the earth, directly over the metallic component. The polarization voltage shift shall be determined as outlined for iron and steel.

### 3.1.3 Copper Piping

For copper piping, the following criteria shall apply: A minimum of 100 millivolts of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The polarization voltage shift shall be determined as outlined for iron and steel.

## 3.2 TRENCHING AND BACKFILLING

Perform trenching and backfilling in accordance with Section 31 00 00 EARTHWORK. In the areas of the anode beds, all trees and underbrush shall be cleared and grubbed to the limits shown or indicated. In the event rock is encountered in providing the required depth for anodes, determine an alternate approved location and, if the depth is still not provided, submit an alternate plan to the Construction Manager. Alternate techniques and depths must be approved prior to implementation.

## 3.3 INSTALLATION

### 3.3.1 Anode Installation

Unless otherwise authorized, installation shall not proceed without the presence of the Construction Manager. Anodes of the size specified shall be installed to the depth indicated and at the locations shown. Locations may be changed to clear obstructions with the approval of the Construction Manager. Anodes shall be installed in sufficient number and of the required type, size, and spacing to obtain a uniform current distribution over the surface of the structure. The anode system shall e designed for a life of 25 years of continuous operation. Anodes shall be installed as indicated in a dry condition after any plastic or waterproof protective covering has been completely removed from the water permeable, permanent container housing the anode metal. The anode connecting wire shall not be used for lowering the anode into the hole. The annular space around the anode shall be backfilled with fine earth in 6 inch layers and each layer shall be hand tamped. Care must be exercised not to strike the anode or connecting wire with the tamper. Approximately 5 gallons of water shall be applied to each filled hole after anode backfilling and tamping has been completed to a point about 6 inch above the anode. After the water has been absorbed by the earth, backfilling shall be completed to the ground surface level.

#### 3.3.1.1 Single Anodes

Single anodes, spaced as shown, shall be connected through a test station to the pipeline, allowing adequate slack in the connecting wire to compensate for movement during backfill operation.

#### 3.3.1.2 Groups of Anodes

Groups of anodes, in quantity and location shown, shall be connected to an anode header cable. The anode header cable shall make contact with the structure to be protected only through a test station. Anode lead connection to the anode header cable shall be made by an approved crimp

connector or exothermic weld and splice mold kit with appropriate potting compound.

3.3.1.3 Welding Methods

Connections to ferrous pipe or metal tanks shall be made by exothermic weld methods manufactured for the type of pipe or tank supplied. Electric arc welded connections and other types of welded connections to ferrous pipe and structures shall be approved before use.

3.3.2 Anode Placement - General

Packaged anodes shall be installed completely dry, and shall be lowered into holes by rope sling or by grasping the cloth gather. The anode lead wire shall not be used in lowering the anodes. The hole shall be backfilled with fine soil in 6 inch layers and each layer shall be hand-tamped around the anode. Care must be exercised not to strike the anode or lead wire with the tamper. If immediate testing is to be performed, water shall be added only after backfilling and tamping has been completed to a point 6 inch above the anode. Approximately 2 gallons of water may be poured into the hole. After the water has been absorbed by the soil, backfilling and tamping may be completed to the top of the hole. Anodes shall be installed as specified or shown. In the event a rock strata is encountered prior to achieving specified augered-hole depth, anodes may be installed horizontally to a depth at least as deep as the bottom of the pipe, with the approval of the Construction Manager.

3.3.3 Underground Pipeline

Anodes shall be installed at a minimum of 8 feet and a maximum of 10 feet from the line to be protected.

3.3.4 Installation Details

Details shall conform to the requirements of this specification. Details shown on the drawings are indicative of the general type of material ~~required, and~~required and are not intended to restrict selection to material of any particular manufacturer.

3.3.5 Lead Wire Connections

3.3.5.1 Underground Pipeline (Metallic)

To facilitate periodic electrical measurements during the life of the sacrificial anode system and to reduce the output current of the anodes, if required, all anode lead wires shall be connected to a test station and buried a minimum of 24 inch in depth. The cable shall be No. 10 AWG, stranded copper, polyethylene or RHW-USE insulated cable. The cable shall make contact with the structure only through a test station. Resistance wire shall be installed between the cable and the pipe cable, in the test station, to reduce the current output, if required. Anode connections, except in the test station, shall be made with exothermic welding process, and shall be insulated by means of at least three (3) layers of electrical tape; and all lead wire connections shall be installed in a ~~moistureproof~~moisture proof splice mold kit and filled with epoxy resin. Lead wire-to-structure connections shall be accomplished by an exothermic welding process. All welds shall be in accordance with the manufacturer's

recommendations. A backfill shield filled with a pipeline mastic sealant or material compatible with the coating shall be placed over the weld connection and shall be of such diameter as to cover the exposed metal adequately.

3.3.5.2 Resistance Wire Splices

Resistance wire connections shall be accomplished with silver solder and the solder joints wrapped with a minimum of three (3) layers of pressure-sensitive tape. Lead wire connections shall be installed in a ~~moistureproof~~moisture proof splice mold kit and filled with epoxy resin.

3.3.6 Location of Test Stations

Test stations shall be of the type and location shown and shall be post mounted. Provide buried insulating joints with test wire connections brought to a test station. Reference all test stations with GPS coordinates. Unless otherwise shown, locate other test stations as follows:

a. At 1,000-foot intervals or less.

b. Where the pipe or conduit crosses any other metal pipe.

c. At both ends of casings under roadways and railways.

d. Where both sides of an insulating joint are not accessible above ground for testing purposes.

3.3.7 Underground Pipe Joint Bonds

Underground pipe having other than welded or threaded coupling joints shall be made electrically continuous by means of a bonding connection installed across the joint.

3.4 ELECTRICAL ISOLATION OF STRUCTURES

3.4.1 Isolation Joints and Fittings

Isolating fittings, including main line isolating flanges and couplings, shall be installed aboveground, or within manholes, wherever possible. Where isolating joints must be covered with soil, they shall be fitted with a paper joint cover specifically manufactured for covering the particular joint, and the space within the cover filled with hot coal-tar enamel. Isolating fittings in lines entering buildings shall be located at least 12 inch above grade of floor level, when possible. Isolating joints shall be provided with grounding cells to protect against over-voltage surges or approved surge protection devices. The cells shall provide a low resistance across isolating joint without excessive loss of cathodic current.

3.4.2 Gas Distribution Piping

Electrical isolation shall be provided at each building riser pipe to the pressure regulator, at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings.

## 3.5 TESTS AND MEASUREMENTS

Submit test reports in booklet form tabulating all field tests and measurements performed, upon completion and testing of the installed system and including close interval potential survey, casing and interference tests, final system test verifying protection, insulated joint and bond tests, and holiday coating test. Submit a certified test report showing that the connecting method has passed a 120-day laboratory test without failure at the place of connection, wherein the anode is subjected to maximum recommended current output while immersed in a three percent sodium chloride solution.

### 3.5.1 Baseline Potentials

Each test and measurement will be witnessed by the Construction Manager. Notify the Construction Manager a minimum of five (5) working days prior to each test. After backfill of the pipe or tank, the static potential-to-soil of the pipe or tank shall be measured. The locations of these measurements shall be identical to the locations specified for pipe or tank to-reference electrode potential measurements. The initial measurements shall be recorded.

### 3.5.2 Isolation Testing

Before the anode system is connected to the pipe or tank, an isolation test shall be made at each isolating joint or fitting. This test shall demonstrate that no metallic contact, or short circuit exists between the two isolated sections of the pipe or tank. Any isolating fittings installed and found to be defective shall be reported to the Construction Manager.

#### 3.5.2.1 Insulation Checker

A Model 601 insulation checker, as manufactured by "Gas Electronics", or an approved equal, using the continuity check circuit, shall be used for isolating joint (flange) electrical testing. Testing shall conform to the manufacturer's operating instructions. Test shall be witnessed by the Construction Manager. An isolating joint that is good will read full scale on the meter. If an isolating joint is shorted, the meter pointer will be deflected or near zero on the meter scale. Location of the fault shall be determined from the instructions, and the joint shall be repaired. If an isolating joint is located inside a vault, the pipe shall be sleeved with insulator when entering and leaving the vault.

#### 3.5.2.2 Cathodic Protection Meter

A Model B3A2 cathodic protection meter, as manufactured by "M.C. Miller", or an approved equal, using the continuity check circuit, shall be used for isolating joint (flange) electrical testing. This test shall be performed in addition to the Model 601 insulation checker. Continuity is checked across the isolation joint after the test lead wire is shorted together and the meter adjusted to scale. A full-scale deflection indicates the system is shorted at some location. The Model 601 verifies that the particular insulation under test is good and the Model B3A2 verifies that the system is isolated. If the system is shorted, further testing shall be performed to isolate the location of the short.

3.5.3 Anode Output

As the anodes or groups of anodes are connected to the pipe or tank, current output shall be measured with an approved clamp-on milliammeter, calibrated shunt with a suitable millivoltmeter or multimeter, or a low resistance ammeter. (Of the three methods, the low-resistance ammeter is the least desirable and most inaccurate. The clamp-on milliammeter is the most accurate.) The values obtained and the date, time, and location shall be recorded.

3.5.4 Reference Electrode Potential Measurements

Upon completion of the installation and with the entire cathodic protection system in operation, electrode potential measurements shall be made using a copper-copper sulphate reference electrode and a potentiometer-voltmeter, or a direct-current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements shall be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements shall be recorded. No less than eight (8) measurements shall be made over any length of line or component. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line.

3.5.5 Location of Measurements

3.5.5.1 Piping or Conduit

For coated piping or conduit, measurements shall be taken from the reference electrode located in contact with the earth, directly over the pipe. Connection to the pipe shall be made at service risers, valves, test leads, or by other means suitable for test purposes. Pipe-to-soil potential measurements shall be made at intervals not exceeding 10 feet. The Contractor may use a continuous pipe-to-soil potential profile in lieu of 5 foot interval pipe-to-soil potential measurements. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line adjacent to the riser. Potentials shall be plotted versus distance to an approved scale. Locations where potentials do not meet or exceed the criteria shall be identified and reported to the Construction Manager's representative.

3.5.5.2 Tanks

For underground tanks, at least 6 measurements shall be taken from the reference electrode located:

a. Directly over the center of the tank.

b. At a point directly over the tank and midway between each pair of anodes.

3.5.5.3 Casing Tests

Before final acceptance of the installation, the electrical separation of carrier pipe from casings shall be tested and any short circuits corrected.

3.5.5.4 Interference Testing

Before final acceptance of the installation, interference tests shall be made with respect to any foreign pipes or tanks in cooperation with the owner of the foreign pipes or tanks. A full report of the tests giving all details shall be made. Stray current measurements shall be performed at all isolating locations and at locations where the new pipeline crosses foreign metallic pipes; results of stray current measurements shall also be submitted for approval. The method of measurements and locations of measurements shall be submitted for approval. As a minimum, stray current measurements shall be performed at the following locations:

a. Connection point of new pipeline to existing pipeline.

b. Crossing points of new pipeline with existing lines.

3.5.5.5 Holiday Test

Any damage to the protective covering during transit and handling shall be repaired before installation. After field-coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current in accordance with NACE SP0188 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective covering shall be repaired upon detection. Occasional checks of holiday detector potential will be made by the Construction Manager to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor. The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

3.5.5.6 Recording Measurements

All tank to-soil potential measurements, including initial potentials where required, shall be recorded. Locate, correct and report to the Construction Manager any short circuits to foreign tanks encountered during checkout of the installed cathodic protection system. Tank to-soil potential measurements shall be taken on as many tanks as necessary to determine the extent of protection or to locate short-circuits.

## 3.6 TRAINING COURSE

Conduct a training course for the operating staff as designated by the Construction Manager. The training period shall consist of a total of 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. Submit the proposed Training Course Curriculum (including topics and dates of discussion) indicating that all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions, are to be covered. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions. At least 14 days prior to date of proposed conduction of the training course, the training course curriculum shall be submitted for approval, along with the proposed training

date. Training shall consist of demonstration of test equipment, providing forms for test data and the tolerances which indicate that the system works.

## 3.7 SYSTEM TESTING

Submit a report including potential measurements taken at adequately-close intervals to establish that minus 850 millivolts potential, "instant-off" potential, is provided, and that the cathodic protection is not providing interference to other foreign pipes causing damage to paint or pipes. The report shall provide a narrative describing how the criteria of protection is achieved without damaging other pipe or structures in the area.

## 3.8 SEEDING

Seeding shall be done as directed, in all unsurfaced locations disturbed by this construction. Refer to paragraph SEEDING in Section 32 92 19 SEEDING. In areas where grass cover exists, it is possible that sod can be carefully removed, watered, and stored during construction operations, and replaced after the operations are completed since it is estimated that no section of pipeline should remain uncovered for more than two (2) days. The use of sod in lieu of seeding shall require approval by the Construction Manager.

## 3.9 CLEANUP

The Contractor is responsible for cleanup of the construction site. All paper bags, wire clippings, etc., shall be disposed of as directed. Paper bags, wire clippings and other waste shall not be put in bell holes or anodes excavation.

-- End of Section --

# SECTION 26 51 00.00 40

# INTERIOR LIGHTING

## PART 1 GENERAL

Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

### 1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M | (2016) 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 | (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ~~ASTM A368~~ | ~~(1995; R 2013) Standard Specification for Stainless Steel Wire Strand~~ |
| ~~ASTM A467/A467M~~ | ~~(2007; R 2012) Standard Specification for Machine Coil Chain~~ |
| ASTM A47/A47M | (1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A580/A580M | (2016) Standard Specification for Stainless Steel Wire |
| ASTM A641/A641M | (2009a; R 2014) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire |
| ASTM A653/A653M | (2015; E 2016) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B26/B26M | (2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings |
| ASTM B633 | (2015) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C2 | (2017; Errata 1 2017) National Electrical Safety Code |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2014) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |

U.S. DEPARTMENT OF ENERGY (DOE)

| | |
|---|---|
| Energy Star | (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1598 | (2008; Reprint Oct 2012) Luminaires |
| UL 844 | (2012; Reprint Mar 2016) UL Standard for Safety Luminaires for Use in Hazardous (Classified) Locations |

## 1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. Average life is the time after which 50 percent has failed and 50 percent has survived under normal conditions.

c. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

## 1.3 ADMINISTRATIVE REQUIREMENTS

### 1.3.1 Pre-Installation Meetings

Within 30 days of Contract Award, the Construction Manager may schedule a Pre-Installation meeting. Submit the following for review and approval:

a. Local/Regional Materials Documentation

b. Environmental Data

c. Energy Efficiency Data

d. Operational Service

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lighting Fixtures

Enclosed and Gasketed Vapor-Tight Fixtures

~~Lowering Devices~~

SD-03 Product Data

LED Lighting Fixtures

Include lamp and electronic driver information for all LED lighting fixtures.

Lighting Contactor Time Switch

Photocell Switch

Power Hook Fixture Hangers Exit Signs

Emergency Lighting Equipment

Local/Regional Materials Documentation

Environmental Data

Energy Efficiency Data

LED Luminaires

For each luminaire, provide detailed Luminaire construction drawings, ballast information, Photometric Data, including IES computer files, Catalog Data, and Lamp Type and Color.

SD-04 Samples

LED Lighting Fixtures

SD-06 Test Reports

Operating Test

Submit test results as stated in paragraph entitled "Field Quality Control."

SD-07 Certificates

Energy Star Documentation

SD-10 Operation and Maintenance Data

Operational Service

Operation and Maintenance Data: Lighting Control System
Submit operation and maintenance data in accordance with Section 01 78 05 OPERATION AND MAINTENANCE INFORMATION and as specified herein, showing all light fixtures, control modules, control zones, occupancy sensors, light level sensors, power packs, dimming ballasts, schematic diagrams and all interconnecting control wire, conduit, and associated hardware.

## 1.5 QUALITY REQUIREMENTS

### 1.5.1 LED Lighting Fixtures, Complete with Lamps and Drivers

Submit one sample of each fixture type complete with lamps and drivers for inspection, review, and approval. Retain the sample for comparison against the remainder of the fixtures. The sample may be used in the final fixture installation. Provide samples for the following fixture types indicated on the drawings:

### 1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Construction Manager. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

### 1.5.3 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, which have been in satisfactory commercial or industrial use for 2-years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size, on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

#### 1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation for not less than 6000

hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 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 Sustainable Design Requirements

1.5.4.1 Local/Regional Materials Documentation

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500-mile radius from the project site, if available from a minimum of three sources.

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

1.5.5 Energy Efficiency Data

Comply with National Energy Policy Act and Energy Star requirements for lighting products. Submit Energy Star documentation for qualifying equipment. Include data indicating lumens per watt efficiency and color rendition index of light source.

Ensure lighting designs utilize Spectrally Enhanced Lighting (SEL) in designs for application in which the IES Illuminance Category is P or Higher. In this application the lamp color is a minimum 82 CRI. For the purpose of these calculations, the reference S/P value is 1.4. Submit a sample calculation utilizing the S/P value for the specified lamps to provide a factor for lighting reduction below IES recommendations. Light levels cannot go below the IES recommended levels.

Submit equipment and performance data for LED lighting fixtures.

1.6 WARRANTY

1.6.1 LED and Driver Warranty

The warranty period shall not be less than 5 years from the date of manufacture of the LED fixture. LEDs and Driver assembly in the lighting fixture, transportation, and on-site storage shall not exceed 12 months, thereby permitting 4 years of the LED and Driver warranty to be in service and energized. The warranty shall state that the malfunctioning LED and Driver shall be exchanged by the manufacturer and promptly shipped to the using DISTRICT facility. The replacement LED and Driver shall be identical to, or an improvement upon, the original design of the malfunctioning driver.

1.6.2 Contractor Warranty

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 DESIGN REQUIREMENTS

Furnish lighting fixtures completely assembled with wiring and mounting devices and ready for installation at the locations noted. Design and equip recessed fixtures in suspended ceilings for installation in the type of ceiling in which the fixture is installed. Design fixtures to be supported independent of the ceiling. Equip fixtures with the lamps required.

Ensure lighting fixtures conform to UL 1598. Ensure fixtures in hazardous areas conform to UL 844.

## 2.2 COMPONENTS

### 2.2.1 LED Lighting Fixtures

### 2.2.2 LED Driver

a. The driver shall be installed in an electrical enclosure.

b. Wiring inside the enclosure shall be 600V, 105 degrees rating or higher.

c. The driver shall be complying with UL 1012.

d. The driver shall have a Class A sound rating.

e. The driver shall be UL certified for use in a dry or damp location.

f. The driver shall tolerate sustained open circuit an short circuit output conditions without damage.

g. The driver shall comply with the requirements of the FCC rules and regulations, Title 47 CFR Part 15 Non-Consumer (Class A).

h. The driver shall have a minimum efficiency of 85 percent.

i. The input voltage shall be capable of 120V to 480V (+/-10 percent), single phase as indicated on the light fixture schedule.

j. The power factor (PF) shall be greater than of equal or 0.90.

k. The total harmonic distortion (THD) shall be less than or equal to 20 percent.

#### 2.2.2.1 LED Lamps

a. LED lamp shall have a lamp life hour of approximately 50,000 hours.

b. The color rendering index (CRI) shall be greater than 80.

### 2.2.3 Recess- And Flush-Mounted Fixtures

Provide type that can be relamped from the bottom. Access to the driver shall be from the bottom. Trim for the exposed surface of flush-mounted fixtures shall be as indicated.

2.2.4 Suspended Fixtures

Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers shall allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended fixtures shall have twin-stem hangers. Multiple-unit or continuous row fluorescent fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Rods shall be a minimum 0.18 inch diameter.

2.2.4.1 Surface-Mounted Fixtures

Design the surface-mounted fixtures to be fastened to wall or ceiling flush-mounted outlet boxes. Do not subject combustible ceiling materials to temperatures in excess of 195 degrees F.

2.2.4.2 Recessed Fixtures

Design recessed fixtures in suspended ceilings for the type of ceiling construction in which the fixture is installed. Do not subject combustible ceiling materials to temperatures in excess of 195 degrees F. Where recessed fixtures are supported on suspended ceilings, provide a minimum of four support rods per fixture with no support further than 6 inches from the edge of the fixture. Do not support fixtures by acoustic panels.

2.2.4.3 Pendant-Mounted Fixtures

Equip pendant-mounted fixtures with stems and swivel ball-and-socket self-aligning hangers. Allow a minimum of a 20-degree angle swing for all ceiling canopies, and fixture-hanging devices, made of seamless brass, aluminum, steel, corrosion-resistant steel tubing, or steel conduit not less than ~~2~~ 1/2 inch in diameter. Stem length, material, and finish are as noted.

2.2.5 Enclosed And Gasketed Vapor-Tight Fixtures

Submit manufacturer's catalog data for enclosed and gasketed vapor-tight fixtures.

Provide enclosed and gasketed vapor-tight fixtures suitable for wet or damp locations consisting of a cast-aluminum body, cap or matching outlet box, porcelain lampholder, glass enclosing globe, cork gaskets, and cast-aluminum guards for wall, ceiling, or pendant mounting in accordance with UL 1598 and NFPA 70.

Furnish exposed cast aluminum outlet boxes for wall- and ceiling-mounted fixtures with four tapped hubs, 90 degrees apart circumferentially, with three cast-aluminum threaded pipe plugs to fit the tapped holes. Provide boxes with ears or lugs for surface mounting to wall or ceiling. Provide body with mounting screws and gasket to ensure a vapor-tight joint between the body and outlet box. Provide cast-aluminum-alloy housings conforming to ASTM B26/B26M.

Concealed outlet boxes for wall- and ceiling-mounted fixtures may be standard sheet metal boxes. Provide fixture body with mounting screws and gasket to ensure a vapor-tight joint between the body and outlet box.

Seal body and cap for pendant-mounted fixtures with a gasket at the joint. Provide cast aluminum cap with top hub tapped for 1/2-inch tapered iron pipe threads.

Furnish cast aluminum exposed outlet boxes for pendant-mounted fixtures with the fixtures with four tapped hubs, 90 degrees apart circumferentially, with three cast-aluminum threaded pipe plugs to fit the tapped holes. Supply boxes with ears or lugs for surface mounting to the ceiling. Provide cast aluminum outlet-box covers for concealed and exposed outlet boxes with the center hub tapped for 1/2-inch tapered iron pipe threads. Provide cover and outlet box with mounting screws and gasket to ensure a vapor-tight joint between the cover and outlet box. Provide 1/2-inch galvanized rigid steel conduit stem.

Provide clear nondiffusing heat-resistant glass enclosing globe, molded in one piece into a cylindrical shape, with a closed bowl-shaped bottom and an open molded top bead or thread. Make edges of the open end either ground or molded to a smooth, true surface that ensures a vapor-tight joint when the globe is fastened to the gasketed body.

Provide a cast-aluminum guard of the same shape as the glass enclosing globe which is affixed to the fixture body with threads or setscrews.

### 2.2.6 Recess- And Flush-Mounted Fixtures

Provide type that can be relamped from the bottom, with access to ballast from the bottom, with trim for the exposed surface of flush-mounted fixtures as indicated.

### 2.2.7 Suspended Fixtures

Install hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Use cadmium-plated steel hangers with a swivel-ball tapped for the conduit size indicated. Provide hangers which allow fixtures to swing within an angle of 45 degrees. Brace pendants 4-feet or longer to limit swinging. Provide single-unit suspended fixtures with twin-stem hangers. Provide multiple-unit or continuous row fluorescent fixtures with tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Provide rods with a minimum 0.18-inch diameter.

### 2.2.8 Fixtures For Hazardous Locations

Provide LED fixtures for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated.

## 2.3 EQUIPMENT

### 2.3.1 Equipment Identification

#### 2.3.1.1 Manufacturer's Nameplate

Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent is not acceptable.

#### 2.3.1.2 Labels

Provide labeled LED luminaires in accordance with UL 1598 requirements. Clearly mark all LED luminaires for operation of specific lamps and drivers according to proper lamp type.

Ensure all markings related to lamp type are clear and located where they are readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Clearly mark ballasts indicating multi-level outputs and indicate proper terminals for the various outputs.

### 2.3.2 Power Hook Fixture Hangers Exit Signs

Provide UL listed assembly including through-wired power hook housing, interlocking plug and receptacle, power cord, and fixture support loop. Provide power hook housing of cast aluminum having two 3/4-inch threaded hubs, including support hook with safety screw. Provide fixture support loop of cast aluminum with provisions for accepting 3/4-inch threaded fixture stems. Include with a power cord 16-inches of 3 conductor No. 16 Type SO cord. Provide complete assembly rated 120 volts or 277 volts, 15 amperes.

### 2.3.3 Support Hangers for LED Lighting Fixtures in Suspended Ceilings

#### 2.3.3.1 Wires

Use wires that are: galvanized regular coating, soft temper, 0.1055-inches in diameter (12 gage). Ensure wires conform to ASTM A641/A641M.

#### 2.3.3.2 Wires, for Humid Spaces

Ensure wires conform to ASTM A580/A580M, with composition 302 or 304 steel, and annealed stainless steel 0.1055-inches in diameter (12 gage).

#### 2.3.3.3 Straps

Provide galvanized steel conforming to the following standards for the ~~,~~ 1 X 3/16-inch straps and any other galvanized steel product: ~~, conforming to~~ ASTM A653/A653M, ~~with a light commercial zinc coating~~ in accordance with ASTM A47/A47M, ~~and hot-dip galvanized coatings conforming to~~ ASTM A123/A123M~~.~~

~~, or,~~ ~~conform to~~ ASTM A1008/A1008M, ~~with an electrodeposited zinc coating conforming to~~ ASTM B633, Type RS.

2.3.3.4 Rods

Provide zinc or cadmium coated, threaded, steel rods, 3/16-inch diameter.

2.3.4 Factory Applied Finish

Provide electrical equipment with factory-applied painting systems which, as a minimum, meet the requirements of the NEMA 250 corrosion-resistance test.

~~2.4 ACCESSORIES~~

~~2.4.1 LOWERING DEVICES FOR HIGH-BAY LED LIGHTING FIXTURES~~

~~Submit manufacturer's catalog data for lowering devices for high-bay LED lighting fixtures.~~

~~Provide lowering devices for high-bay LED lighting fixtures consisting of a hand-operated mechanism that connects, disconnects, raises and lowers the lighting fixture to permit the servicing and maintenance of fixtures and equipment at floor level. Include with the lowering device: hangers, pulleys, beam clamps or suspension fittings, operating cable, hand chain, and cable and chain fittings.~~

~~Provide open face pulleys with cast-aluminum alloy housings and deep-grooved pulley wheels closely shrouded to prevent lines from becoming wedged between wheel and housing. Design pulleys to be straight through for top and bottom mounted operating cables and corner type as required. Hinge top mounted pulleys with mounting lugs. Provide fixed bottom mounted pulleys with mounting lugs. Bolt all pulleys to the supporting structure. Support horizontal runs of operating cable with pulleys located not more than 35-feet apart.~~

~~Provide cast-aluminum-alloy housings conforming to ASTM B26/B26M.~~

~~Provide malleable-iron fittings conforming to ASTM A47/A47M, and hot-dip galvanized coatings conforming to ASTM A123/A123M.~~

~~2.4.1.1 Contact Assembly~~

~~Provide hangers consisting of a two-piece latching spring-loaded mechanism with an upper and lower separable contact assembly and stem and guide assembly, with cast-aluminum protective housings. Provide contacts for two-pole, single 2-wire circuits, and four-pole for 3- and 4-wire circuits rated 15 amperes at 600 volts and 30 amperes at 250 volts ac.~~

~~Include with upper contact assembly an integrally mounted corner pulley with threaded hub for electrical-conduit connections and a top flange with lugs for mounting.~~

~~Include with lower contact assembly fixture adapters and swivel end fittings for anchoring operating cable in the stem of the hanger, with adapters of hot-dip galvanized malleable iron.~~

~~2.4.1.2 Lockbox~~

~~Include with terminal fittings an enclosed lockbox with hub, tapped for 3/4-inch conduit, flared conduit end fitting, pulley wheel, locking hooks, and hinged cover with provisions for padlocking.~~

~~Provide cast-aluminum alloy lockbox and cover, with the flared conduit end fitting of hot-dip galvanized malleable iron.~~

~~Mount wall mounted lockbox not less than 43-inches and not more than 54-inches above the floor at the operating level. Provide pulley designed to allow horizontal pull operation of the lowering device at the operating level.~~

~~2.4.1.3 Cable/Chain~~

~~Provide 1/8-inch diameter operating cable, 7 by 19 stranded, heat- and corrosion-resistant steel aircraft cable with link, cable loops, and serving sleeves. Preform cable with detachable fittings designed for connection to the terminal fittings. Ensure cable conforms to ASTM A368.~~

~~Provide hand chains which are separate detachable hand lines to provide means for disconnecting, lowering, raising, and reconnecting fixtures. Provide hand chain equal in length to the mounting height of the fixture and equipped with a snap hook for connection to the terminal end of the operating cable, size 4, hot-dip galvanized steel, conforming to ASTM A467/A467M, Class MS machine, straight link, steel chain.~~

2.~~5~~ 4 SWITCHES

2.~~5~~4.1 Toggle Switches

Provide toggle switches as specified in SECTION 26 20 00 INTERIOR SITE DISTRIBUTION SYSTEM.

2.~~6~~ 5 LIGHTING CONTACTOR

Provide in NEMA 1 enclosure conforming to NEMA ICS 6. Contactor shall have silver alloy double-break contacts. Provide contactor with hand-off-automatic selector switch.

2.~~7~~ 6 LIGHTING CONTACTOR TIME SWITCH

Astronomic dial type or electronic type, arranged to turn "ON" at sunset and turn "OFF" at predetermined time between 8:30 p.m. and 2:30 a.m. or sunrise, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Provide switch having automatically wound spring mechanism or capacitor to maintain accurate time for a minimum of 15 hours following power failure. Provide time switch with a manual on-off bypass switch. Housing for the time switch shall be surface-mounted, NEMA 1 enclosure conforming to NEMA ICS 6.

2.~~8~~ 7 PHOTOCELL SWITCH

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell ac, 60 Hz with single- throw contacts. Switch shall turn on at or below 3 footcandles and off at 2 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide switch:

a. In a high-impact-resistant, noncorroding and nonconductive molded plastic housing with a locking- type receptacle conforming to NEMA C136.10, rated 1800 VA, minimum.

2.~~9~~8 EXIT SIGNS

UL 924, NFPA 70, and NFPA 101. Exit signs shall be self-powered type. Exit signs shall use no more than 5 watts.

2.~~9~~8.1 Self-Powered LED Type Exit Signs (Battery Backup)

Provide with automatic power failure device, test switch, pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than 5 years. LED exit sign shall have emergency run time of 1 1/2 hours (minimum). The light emitting diodes shall have rated lamp life of 70,000 hours (minimum).

2.~~10~~9 EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 70, and NFPA 101. Provide lamps in wattage indicated. Provide accessories required for remote-mounted lamps where indicated. Remote-mounted lamps shall be as indicated.

2.~~10~~9.1 Emergency Lighting Unit

Provide as indicated. Emergency lighting units shall be rated for 12 volts, except units having no remote- mounted lamps and having no more than two unit-mounted lamps may be rated 6 volts and 15 minute time delay feature for areas with HID lighting.

2.~~11~~10 SELF-TESTING MODULE

Self-testing module for exit signs and emergency lighting equipment shall perform the following functions:

a. Continuous monitoring of charger operation and battery voltage with visual indication of normal operation and of malfunction.

b. Monthly discharge cycling of battery with monitoring of transfer circuit function, battery capacity and emergency lamp operation with visual indication of malfunction. The battery capacity test may be conducted by using a synthetic load.

c. Manual test switch to simulate a discharge test cycle.

d. Module shall have low voltage battery disconnect (LVD) and brown-out protection circuit.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Field Applied Painting

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Specify painting in Section 09 06 90 PROTECTIVE COATINGS.

## 3.2 INSTALLATION

Ensure all electrical installations conform to IEEE C2, NFPA 70, and to the requirements specified herein.

### 3.2.1 Lamps

Deliver lamps to the project in the original cartons. Install just prior to project completion. Replace lamps installed and used for working light during construction prior to turnover to the District if more than 15 percent of their rated life has been used. Test the lamps for proper operation prior to turn-over and replace if necessary with new lamps from the original manufacturer. Provide 10 percent spare lamps of each type from the original manufacturer.

### 3.2.2 LED Lighting Fixtures

Set LED lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent LED lighting fixtures. Secure fixtures in accordance with manufacturers' directions and approved drawings, in conformance with the requirements of NFPA 70. Mounting heights specified or indicated are to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for LED lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Independently support recessed and semi-recessed fixtures from the building structure by a minimum of four wires or rods per fixture and locate near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Independently support round fixtures smaller in size than the ceiling grid from the building structure by a minimum of four wires or rods per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. ~~Provide wires for lighting fixture support in this section. LED lighting fixtures installed in suspended ceilings are to comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.~~

### 3.2.3 Suspended Fixtures

Provide suspended fixtures with 45 degree swivel hangers so that they hang plumb and locate with no obstructions within the 45 degree range in all directions. Provide the stem, canopy and fixture capable of a 45 degree swing. Brace pendants, rods, or chains 4-feet or longer excluding fixture, to prevent swaying, using three cables at 120 degree separation. Provide suspended fixtures in continuous rows with internal wireway systems for end to end wiring and properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Use aligning splines on extruded aluminum fixtures to assure hairline joints. Support steel fixtures to prevent "oil-canning" effects. Ensure fixture finishes are free of scratches, nicks, dents, and warps, and matching the color and gloss

specified. Finish pendants to match furniture. Select aircraft cable made from stainless steel. Install canopies finished to match the ceiling and are low profile unless otherwise shown. Ensure maximum distance between suspension points is 10-feet or as recommended by the manufacturer, whichever is less.

## 3.3 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct each of the following ~~an~~ operating test to show that equipment operates in accordance with requirements of this section.

a.Exiting Sign Test
b.Emergency Lighting Test
c.Switch Test
d.Lighting Contactor Test
e.Photocell Switch Test

## 3.4 FIELD TESTING

Demonstrate that all LED lighting fixtures and their accessories~~, including lowering devices,~~ operate satisfactorily in the presence of the Construction Manager.

Perform operational tests in the presence of the Construction Manager and in accordance with referenced standards in this section.

## 3.5 MAINTENANCE

Submit operation and maintenance data in accordance with Section 01 78 05 OPERATION AND MAINTENANCE INFORMATION and as specified herein, showing all light fixtures, control modules, control zones, occupancy sensors, light level sensors, power packs, dimming ballasts, schematic diagrams and all interconnecting control wire, conduit, and associated hardware.

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

-- End of Section --

# SECTION 26 56 00

# EXTERIOR LIGHTING

## 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.

~~ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)~~

| | |
|---|---|
| ~~ATIS ANSI O5.1~~ | ~~(2008) Wood Poles -- Specifications & Dimensions~~ |

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO LTS | (2013; Errata 2013) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 90.1 - IP | (2010) Energy Standard for Buildings Except Low-Rise Residential Buildings |
| ~~ASHRAE 189.1~~ | ~~(2011) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings~~ |
| ~~ASHRAE 90.1 - SI~~ | ~~(2010) Energy Standard for Buildings Except Low-Rise Residential Buildings~~ |

~~AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)~~

| | |
|---|---|
| ~~AWPA U1~~ | ~~(2015) Use Category System: User Specification for Treated Wood~~ |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM B108/B108M | (2015) Standard Specification for Aluminum-Alloy Permanent Mold Castings |
| ASTM B117 | (2016) Standard Practice for Operating Salt Spray (Fog) Apparatus |

| | |
|---|---|
| ASTM C1089 | (2013) Standard Specification for Spun Cast Prestressed Concrete Poles |
| ~~ASTM G154~~ | ~~(2012a) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials~~ |

~~CALIFORNIA ENERGY COMMISSION (CEC)~~

| | |
|---|---|
| ~~CEC Title 24~~ | ~~(2008; Effective Jan 2010) California's Energy Efficiency Standards for Residential and Nonresidential Buildings~~ |

ILLUMINATING ENGINEERING SOCIETY (IES)

| | |
|---|---|
| IES HB-10 | (2011; Errata 2015) IES Lighting Handbook |
| IES LM-79 | (2008) Electrical and Photometric Measurements of Solid-State Lighting Products |
| IES LM-80 | (2015) Measuring Lumen Maintenance of LED Light Sources |
| IES RP-16 | (2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering |
| IES RP-8 | (2014) Roadway Lighting |
| IES TM-15 | (2011) Luminaire Classification System for Outdoor Luminaires |
| IES TM-21 | (2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C2 | (2017; Errata 1 2017) National Electrical Safety Code |
| IEEE C62.41.2 | (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits |
| IEEE C62.41 | (1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits |
| IEEE C62.41.1 | (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C136.13 | (2004; R 2009) American National Standard for Roadway Lighting Equipment, Metal Brackets for Wood Poles |
| ANSI C136.21 | (2014) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires |
| ANSI C136.3 | (2014) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments |
| NEMA 250 | (2014) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ANSLG C78.377 | (2015) American National Standard for Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products |
| NEMA C136.10 | (2010) American National Standard for Roadway and Area Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles--Physical and Electrical Interchangeability and Testing |
| NEMA C136.31 | (2010) American National for Roadway and Area Lighting Equipment - Luminaire Vibration |
| NEMA C82.77 | (2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment |
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA IEC 60529 | (2004) Degrees of Protection Provided by Enclosures (IP Code) |
| NEMA WD 7 | (2011; R 2016) Occupancy Motion Sensors Standard |
| ~~ANSI ANSLG C78.41~~ | ~~(2006) For Electric Lamps--Guidelines for Low-Pressure Sodium Lamps~~ |
| ~~ANSI ANSLG C78.42~~ | ~~(2009; R 2016) For Electric Lamps: High-Pressure Sodium Lamps~~ |
| ~~ANSI C78.1381~~ | ~~(1998) American National Standard for Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps~~ |

~~ANSI C82.4 (2002) American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)~~

~~ANSI/ANSLG C78.43 (2013) American National Standard for Electric Lamps - Single-Ended Metal-Halide Lamps~~

~~ANSI/NEMA C78.LL 1256 (2003; R 2015) Procedures for Fluorescent Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure (TCLP)~~

~~NEMA ANSLG C78.380 (2007) Electric Lamps - High Intensity Discharge Lamps, Method of Designation~~

~~NEMA ANSLG C78.44 (2008) For Electric Lamps - Double-Ended Metal Halide Lamps~~

~~NEMA ANSLG C82.11 (2011) Lamp Ballasts - High-Frequency Fluorescent Lamp Ballasts~~

~~NEMA ANSLG C82.14 (2006) Lamp Ballasts Low-Frequency Square Wave Electronic Ballasts - for Metal Halide Lamps~~

~~NEMA C136.20 (2012) American National Standard for Roadway and Area Lighting Equipment - Fiber Reinforced Composite (FRC) Lighting Poles~~

~~NEMA C78.LL 3 (2003; R 2015) Electric Lamps - Procedures for High Intensity Discharge Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure~~

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

~~U.S. DEPARTMENT OF AGRICULTURE (USDA)~~

~~RUS Bull 1728F-700 (2011) Specification for Wood Poles, Stubs, and Anchor Logs~~

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

47 CFR 15 Radio Frequency Devices

~~47 CFR 18 (2011) Industrial, Scientific, and Medical Equipment~~

UNDERWRITERS LABORATORIES (UL)

UL 1310 (2011; Reprint Dec 2014) UL Standard for Safety Class 2 Power Units

| | |
|---|---|
| UL 1598 | (2008; Reprint Oct 2012) Luminaires |
| UL 773 | (1995; Reprint Jul 2015) Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting |
| UL 773A | (2016) Standard for Nonindustrial Photoelectric Switches for Lighting Control |
| UL 8750 | (2009; Reprint May 2014) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products |
| ~~UL 1029~~ | ~~(1994; Reprint Dec 2013) High-Intensity-Discharge Lamp Ballasts~~ |
| ~~UL 916~~ | ~~(2007; Reprint Aug 2014) Standard for Energy Management Equipment~~ |
| ~~UL 935~~ | ~~(2001; Reprint Aug 2014) Standard for Fluorescent-Lamp Ballasts~~ |
| ~~UL 1029~~ | ~~(1994; Reprint Dec 2013) High-Intensity-Discharge Lamp Ballasts~~ |
| ~~UL 916~~ | ~~(2007; Reprint Aug 2014) Standard for Energy Management Equipment~~ |
| ~~UL 935~~ | ~~(2001; Reprint Aug 2014) Standard for Fluorescent-Lamp Ballasts~~ |

## 1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires or lighting equipment are specified in Section(s) 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Luminaires and accessories installed in interior of buildings are specified in Section 26 51 00.00 40 INTERIOR LIGHTING.

## 1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings shall be as defined in IEEE 100 and IES RP-16.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in IES LM-80.

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Photometric Plan

SD-02 Shop Drawings

LED Luminaire drawings

Poles

SD-03 Product Data

LED Luminaire Light Sources

LED Luminaire Drivers

Lighting contactor

Time switch

Motion Sensor

Photocell

Concrete poles

Aluminum poles

~~Steel poles~~

Brackets

SD-04 Samples

LED Luminaire Samples

SD-05 Design Data

Design Data for luminaires

SD-06 Test Reports

LED Luminaire - IES LM-79 Test Report

LED Light Source - IES LM-80 Test Report

Operating test

Submit operating test results as stated in paragraph entitled "Field Quality Control."

SD-07 Certificates

Luminaire Useful Life Certificate

Submit certification from the Manufacturer indicating the expected useful life of the luminaires provided. The useful life shall be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific

luminaire and local ambient operating temperature and conditions shall be taken into consideration.

SD-08 Manufacturer's Instructions

Concrete poles

Submit instructions prior to installation.

SD-10 Operation and Maintenance Data

LED Luminaire Warranty

## 1.5 SUBMITTAL REQUIREMENTS

### 1.5.1 LED Luminaire Samples

Submit one sample of each luminaire type, complete with light source and driver. Submit one sample for each item other than luminaires. Sample will be returned to the Contractor for installation in the project Work.

## 1.6 QUALITY REQUIREMENTS

### 1.6.1 Drawing Requirements

#### 1.6.1.1 LED Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data shall accompany shop drawings.

#### 1.6.1.2 Poles

Include dimensions, wind load determined in accordance with AASHTO LTS, lightning protection, pole deflection, pole class, and other applicable information. For concrete poles, include: section and details to indicate quantities and position of prestressing steel, spiral steel, inserts, and through holes; initial prestressing steel tension; and concrete strengths at release and at 28 days.

### 1.6.2 Photometric Plan

For LED luminaires, include computer-generated photometric analysis of the "designed to" values for the "end of useful life" of the luminaire installation using a light loss factor of 0.7. For LED and all other types of luminaires, the submittal shall include the following:

Horizontal illuminance measurements at finished grade, taken at a maximum of every 10 feet.

Vertical illuminance measurements at 5 feet above finished grade.

Minimum and maximum footcandle levels.

Average maintained footcandle level.

Maximum to minimum ratio for horizontal illuminance only.

### 1.6.3 Design Data for Luminaires

a. Provide distribution data according to IES classification type as defined in IES HB-10.

b. Shielding as defined by IES RP-8 or B.U.G. rating for the installed position as defined by IES TM-15.

c. Provide safety certification and file number for the luminaire family. Include listing, labeling and identification per NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

d. Provide long term lumen maintenance projections for each LED luminaire in accordance with IES TM-21. Data used for projections shall be obtained from testing in accordance with IES LM-80.

e. Provide wind loading calculations for luminaires mounted on poles. Weight and effective projected area (EPA) of luminaires and mounting brackets shall not exceed maximum rating of pole as installed in particular wind zone area.

### 1.6.4 LED Luminaire - IES LM-79 Test Report

Submit test report on Manufacturer's standard production model luminaire. Submittal shall include all photometric and electrical measurements, as well as all other pertinent data outlined under "14.0 Test Report" in IES LM-79.

### 1.6.5 LED Light Source - IES LM-80 Test Report

Submit report on Manufacturer's standard production LED package, array, or module. Submittal shall include:

a. Testing agency, report number, date, type of equipment, and LED light source being tested.

b. All data required by IES LM-80.

#### 1.6.5.1 Test Laboratories

Test laboratories for the IES LM-79 and IES LM-80 test reports shall be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program.

b. One of the qualified labs listed on the Department of Energy - Energy Efficiency & Renewable Energy, Solid-State Lighting web site.

c. A Manufacturer's in-house lab that meets the following criteria:

1. Manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires and the Manufacturer's lab has been successfully certifying these fixtures for a minimum of 15 years.

2. Annual equipment calibration including photometer calibration in accordance with National Institute of Standards and Technology.

1.6.6 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 District. 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.

1.6.7 Standard Products

Provide materials and equipment that are products of Manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, Manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single Manufacturer; however, the component parts of the item need not be the products of the same Manufacturer unless stated in this section.

1.6.7.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if the Manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires for a minimum of 15 years. Products shall have been in satisfactory commercial or industrial use for 15 years prior to bid opening. The product shall have been on sale on the commercial market through advertisements, Manufacturers' catalogs, or brochures during the 15-year period.

1.6.7.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 DELIVERY, STORAGE, AND HANDLING OF POLES

1.7.1 Concrete Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation.

1.7.2 ~~Steel~~ Aluminum Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.8 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

1.8.1 LED Luminaire Warranty

Provide Luminaire Useful Life Certificate.

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.

a. Provide a written on-site replacement warranty, as specified in Section 01 61 03 EQUIPMENT AND MATERIALS for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

   1. Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

   2. Material warranty shall include:

      (a) All power supply units (drivers).

      (b) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

b. Warranty period must begin on date of beneficial occupancy. Contractor shall provide the District signed warranty certificates prior to final payment.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be luminaires, equipment or accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires and associated equipment and accessories for interior applications are specified in Section 26 51 00.00 40 INTERIOR LIGHTING.

2.2 LED LUMINAIRES

UL 1598, NEMA C82.77, and UL 8750. Provide luminaires as indicated in luminaire schedule or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. All luminaires of the same type shall be provided by the same Manufacturer.

2.2.1 General Requirements

a. LED luminaire housings shall be die cast or extruded aluminum. Fabricated aluminum housings shall have all seams and corners internally welded to resist weathering, moisture, and dust.

b. LED luminaires shall be rated for operation within an ambient temperature range of minus 22 degrees F to 104 degrees F.

c. LED Luminaires shall be UL listed for wet locations per UL 1598. Optical compartment for LED luminaires shall be sealed and rated a minimum of IP65 per NEMA IEC 60529.

d. LED luminaires shall produce a minimum efficacy as shown in the following table, tested per IES LM-79. Theoretical models of initial raw LED lumens per watt are not acceptable.

| **Application** | **Luminaire Efficacy in Lumens per Watt** |
|---|---|
| Exterior Pole/Arm-Mounted Area and Roadway Luminaires | 65 |
| Exterior Pole/Arm-Mounted Decorative Luminaires | 65 |
| Exterior Wall-Mounted Area Luminaires | 60 |
| Bollards | 35 |

e. LED Luminaires shall have IES distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans per IES HB-10.

f. Housing finish shall be baked-on enamel, anodized, or baked-on powder coat paint. Finish shall be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling. Housing shall be capable of surviving IEEE C62.41.1 surge environment testing.

g. LED Luminaires shall not exceed the following IES TM-15 Backlight, Uplight and Glare (B.U.G.) ratings:

1. Maximum Backlight (B) rating shall be determined by lighting zone in which luminaire is placed.

2. Maximum Uplight (U) rating shall be U0.

3. Maximum Glare (G) rating shall be determined by lighting zone in which luminaire is placed.

h. LED Luminaires shall be fully assembled and electrically tested prior to shipment from factory.

i. The finish color shall be as indicated in the LED luminaire schedule or detail on the project plans.

j. LED Luminaire arm bolts shall be 304 stainless steel or zinc-plated steel.

k. LED Luminaire lenses shall be constructed of tempered glass or UV-resistant acrylic. Provide polycarbonate vandal-resistant lenses as indicated.

l. The wiring compartment on pole-mounted, street and area LED luminaires must be accessible without the use of hand tools to manipulate small screws, bolts, or hardware.

m. Incorporate modular electrical connections, and construct LED luminaires to allow replacement of all or any part of the optics, heat sinks, power supply units, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

n. LED Luminaires shall have a nameplate bearing the Manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

o. LED Roadway and area luminaires shall have an integral tilt adjustment of plus or minus 5 degrees to allow the unit to be leveled in accordance with ANSI C136.3.

p. LED Luminaire must pass 3G vibration testing in accordance with NEMA C136.31.

q. All factory electrical connections shall be made using crimp, locking, or latching style connectors. Twist-style wire nuts are not acceptable.

### 2.2.2 LED Luminaire Light Sources

#### 2.2.2.1 LED Light Sources

a. Correlated Color Temperature (CCT) shall be in accordance with NEMA ANSLG C78.377:

b. Color Rendering Index (CRI) shall be:

Greater than or equal to 70 for 4000 degrees K light sources.

c. Color Consistency:

d. Manufacturer shall utilize a maximum 4-step MacAdam ellipse binning tolerance for color consistency of LEDs used in luminaires.

2.2.3 LED Luminaire Power Supply Units (Drivers)

2.2.3.1 LED Power Supply Units (Drivers)

UL 1310. LED Power Supply Units (LED Luminaire Drivers) shall meet the following requirements:

a. Minimum efficiency shall be 85 percent.

b. Drive current to each individual LED Luminaire shall not exceed 600 mA, plus or minus 10 percent.

c. Shall be rated to operate between ambient temperatures of minus 22 degrees F and 104 degrees F.

d. Shall be designed to operate on the voltage system to which they are connected, typically ranging from 120 V to 480 V nominal.

e. Operating frequency shall be: 50 or 60 Hz.

f. Power Factor (PF) shall be greater than or equal to 0.90.

g. Total Harmonic Distortion (THD) current shall be less than or equal to 20 percent.

h. Shall meet requirements of 47 CFR 15, Class B.

i. Shall be RoHS-compliant.

j. Shall be mounted integral to LED luminaire. Remote mounting of power supply is not allowed.

k. Power supplies in LED luminaires mounted under a covered structure, such as a canopy, or where otherwise appropriate shall be UL listed with a sound rating of A.

l. Shall be dimmable, and compatible with a standard dimming control circuit of 0 - 10V or other approved dimming system.

m. Shall be equipped with over-temperature protection circuit that turns light source off until normal operating temperature is achieved.

2.2.4 LED Luminaire Surge Protection

Provide surge protection integral to LED luminaire to meet C Low waveforms as defined by IEEE C62.41 and IEEE C62.41.2, Scenario 1, Location Category C.

2.3 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.

2.4 EXTERIOR LED LUMINAIRE CONTROLS

Controls shall comply with Section 9 of ASHRAE 90.1 - IP. Provide a control system interface within each LED luminaire that is compatible with the energy management or control system used by the utility department in charge of the project area for control of site lighting.

### 2.4.1 Photocell

UL 773 or UL 773A. Photocells shall be hermetically sealed, cadmium sulfide or silicon diode light sensor type, rated at 120 volts, 50/60 Hz with single-pole, single-throw contacts. Photocell shall be designed to fail to the ON position. Housing shall be constructed of die cast aluminum, rated to operate within a temperature range of minus 40 to 158 degrees F. Photocell shall have a 1/2 in threaded base for mounting to a junction box or conduit. Provide swivel base type housing. Photocell shall be twist-lock receptacle type conforming to NEMA C136.10. Provide with solid brass prongs and voltage markings and color coding on exterior of housing. Photocell shall turn on at 1-3 footcandles and turn off at 3 to 15 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition. Provide photocell with metal oxide varistor (MOV) type surge protection.

### 2.4.2 Timeswitch

Timeswitch shall be electromechanical type with a astronomic dial that changes on/off settings according to seasonal variations of sunset and sunrise. Switch shall be powered by an enclosed synchronous motor with a maximum 3 watt operating rating. Timeswitch contacts shall be rated for 40 amps at 120-277 VAC resistive load in a DPST normally open (NO) normally closed (NC) configuration. Switch shall have an automatic spring mechanism to maintain accurate time for up to 16 hours during a power failure. Provide switch with function that allows automatic control to be skipped on certain selected days of the week. Provide switch with manual bypass or remote override control.

Timeswitch shall be housed in a surface-mounted, lockable NEMA 3R enclosure constructed of painted steel or plastic polymer conforming to NEMA ICS 6.

### 2.4.3 Lighting Contactor

NEMA ICS 2. Provide an electrically-held lighting contactor housed in a NEMA 3R enclosure conforming to NEMA ICS 6. Contactor shall have 12 poles, configured as normally open (NO). Contacts shall be rated 600 volts, 30 amperes for a resistive load. Coil operating voltage shall be 120 volts. Contactor shall have silver cadmium oxide double-break contacts and shall require no arcing contacts. Provide contactor with hand-off-automatic selector switch and lightning protection.

### 2.4.4 Motion Sensor

NEMA WD 7, UL 773A. Provide passive infrared technology passive infrared/microwave type sensors with 270 degree coverage, time delay that can be adjusted from 15 seconds to 15 minutes, and "fail to ON position" default state. Sensors shall be located to achieve coverage of areas as indicated on project plans. Coverage patterns shall be derated as recommended by Manufacturer based on mounting height of sensor and any obstructions such as trees. Do not use gross rated coverage in

Manufacturer's product literature. Sensors installed integral to the luminaire must be provided by the luminaire Manufacturer. Sensors shall have an integral light level sensor that does not allow luminaires to operate during daylight hours and shall be designed to operate on a voltage of 120/277 VAC. Provide sensors to operate in conjunction with bi-level controllers that lower LED luminaires to a 50 percent output. Sensor shall be equipped with a threaded base for mounting to a weatherproof junction box.

## 2.5 POLES

Provide poles designed for wind loading of 150 miles per hour determined in accordance with AASHTO LTS while supporting luminaires and all other appurtenances indicated. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole. Poles shall be anchor-base type designed for use with underground supply conductors. Poles shall have oval-shaped handhole having a minimum clear opening of 2.5 by 5 inches. Handhole cover shall be secured by stainless steel captive screws. Metal poles shall have an internal grounding connection accessible from the handhole near the bottom of each pole. Scratched, stained, chipped, or dented poles shall not be installed.

### 2.5.1 Concrete Poles

Provide concrete poles conforming to ASTM C1089. Cross-sectional shape shall be multi-sided.

#### 2.5.1.1 Steel Reinforcing

Prestressed concrete pole shafts shall be reinforced with steel prestressing members. Design shall provide internal longitudinal loading by either pretensioning or post tensioning of longitudinal reinforcing members.

#### 2.5.1.2 Tensioned Reinforcing

Primary reinforcement steel used for a prestressed concrete pole shaft shall be tensioned between 60 to 70 percent of its ultimate strength. The amount of reinforcement shall be such that when reinforcement is tensioned to 70 percent of its ultimate strength, the total resultant tensile force does not exceed the minimum section compressive strength of the concrete.

#### 2.5.1.3 Coating and Sleeves for Reinforcing Members

Where minimum internal coverage cannot be maintained next to required core openings, such as handhole and wiring inlet, reinforcing shall be protected with a vaporproof noncorrosive sleeve over the length without the 1/2 inch concrete coverage. Each steel reinforcing member which is to be post-tensioned shall have a nonmigrating slipper coating applied prior to the addition of concrete to ensure uniformity of stress throughout the length of such member.

#### 2.5.1.4 Strength Requirement

As an exception to the requirements of ASTM C1089, poles shall be naturally cured to achieve a 28-day compressive strength of 7000 psi. Poles shall not be subjected to severe temperature changes during the curing period.

2.5.1.5 Shaft Preparation

Completed prestressed concrete pole shaft shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost, and shall be clean, smooth, and free of surface voids and internal honeycombing. Poles shall not be installed for at least 15 days after manufacture.

2.5.2 Aluminum Poles

Provide aluminum poles manufactured of corrosion resistant aluminum alloys conforming to AASHTO LTS for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3,5) for cast alloys. Poles shall be seamless extruded or spun seamless type with minimum 0.188 inch wall thickness. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Tops of shafts shall be fitted with a round or tapered cover. Base shall be anchor bolt mounted, made of cast 356-T6 aluminum alloy in accordance with ASTM B108/B108M and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded. Base cover shall be cast 356-T6 aluminum alloy in accordance with ASTM B108/B108M. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel. Aluminum poles and brackets for lighting shall have a dark anodic bronze finish to match fixtures and shall not be painted. Manufacturer's standard provision shall be made for protecting the finish during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

~~2.5.3 Steel Poles~~

~~AASHTO LTS. Provide steel poles having minimum 11-gage steel with minimum yield/strength of 48,000 psi and hot-dipped galvanized in accordance with ASTM A123/A123M factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Pole shall be anchor bolt mounted type. Poles shall have tapered tubular members, either round in cross section or polygonal. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings shall be approximately 3 to 4 feet above grade and shall include Manufacturer, year of manufacture, top and bottom diameters, and length. Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 36,000 psi.~~

2.6 BRACKETS AND SUPPORTS

ANSI C136.3, ANSI C136.13, and ANSI C136.21, as applicable. Pole brackets shall be not less than 1 1/4 inch galvanized steel pipe secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head.

## 2.7 POLE FOUNDATIONS

Anchor bolts shall be steel rod having a minimum yield strength of 50,000 psi; the top 12 inches of the rod shall be galvanized in accordance with ASTM A123/A123M and ASTM A153/A153M. Concrete shall be as specified in Section 03 31 01.00 10 CAST-IN-PLACE STRUCTUARAL CONCRETE FOR CIVIL WORKS.

## 2.8 EQUIPMENT IDENTIFICATION

### 2.8.1 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the Manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

### 2.8.2 Labels

Provide labeled LED luminaires in accordance with UL 1598 requirements. Luminaires shall be clearly marked for operation of specific light sources and ballasts according to proper light source type. The following light source characteristics shall be noted in the format "Use Only _____":

Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

### 3.1.1 Concrete Poles

Install according to pole Manufacturer's instructions.

### 3.1.2 ~~Steel~~ Aluminum Poles

Provide pole foundations with galvanized steel anchor bolts according to ASTM A123/A123M, threaded at the top end and bent 90 degrees at the bottom end. Provide ornamental covers to match pole and ~~galvanized~~ either 2024-T4 anodized aluminum alloy or 316 stainless steel nuts and washers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods shall be as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location. Install according to pole Manufacturer's instructions. Alterations to poles after fabrication will void Manufacturer's warranty and shall not be allowed.

### 3.1.3 Pole Setting

Poles in straight runs shall be in a straight line. Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 6 inch maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.

### 3.1.4 Photocell Switch Aiming

Aim switch according to Manufacturer's recommendations.

### 3.1.5 GROUNDING

Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

### 3.1.6 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 06 90 PAINTS AND COATINGS.

## 3.2 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test after 100 hours of burn-in time to show that the equipment operates in accordance with the requirements of this section.

-- End of Section --

# 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 | (2014) Load Ratings and Fatigue Life for Roller Bearings |
| ABMA 9 | (2015) 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 | (2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |
| NETA MTS | (2015) Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 1940-1 | (2003; Cor 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (2016; SUPP 2016) Motors and Generators |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |

U.S. DEPARTMENT OF ENERGY (DOE)

| | |
|---|---|
| DOE CI-1 | (2001) How to Buy a Premium Energy-Efficient Electric Motor |

## 1.2 ADMINISTRATIVE REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to Work specified in this section.

### 1.2.1 Pre-Installation Meeting

At least 60 days prior to installation activities being scheduled, the Contractor shall request the Construction Manager to schedule a pre-installation meeting. Provide the following for review and approval:

a. Submit informational drawings for Low-Voltage Motors indicating the overall physical features, dimensions, ratings, service requirements, and weights of equipment.

b. Submit equipment and performance data for Low-Voltage Motors consisting of:

(1) Use life

(2) System functional flows

(3) Safety features

(4) Mechanical automated details

(5) Data curves indicating tested and certified equipment response and performance characteristics

(6) Sample warranty with submittal for review and approval by the Construction Manager

c. For Electric Motors rated over 25 and those specified to meet a special vibration class in accordance with NEMA MG 1indicate number of:

(1) Rotor bars

(2) Stator slots

(3) Rotational speed

(4) Cooling fan blades

(5) Bearing Manufacturer

(6) Bearing style

(7) Bearing type

(8) Balls/Elements

(9) Commutator bars

(10) Commutator brushes

(11) SCR firing frequencies (for variable speed motors)

d. Submit product certificates for the following tests showing conformance with the referenced standards contained in this section.

(1) Factory test results

(2) Efficiency

(3) Power-Factor

(4) Service factor

(5) Temperature rating

(6) Noise

(7) Full-Load

(8) Locked-Rotor

(9) Insulation resistance

(10) Winding resistance

(11) High-Potential tests

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sample Warranty

Equipment and Performance Data

SD-02 Shop Drawings

Informational Drawings

SD-03 Product Data

Motor Enclosures

Rotor Bars

Stator Slots

Rotational Speed

Cooling Fan Blades

Bearing Manufacturer

Bearing Style

Bearing Type

Balls/Elements

Commutator Bars

Commutator Brushes

SCR Firing Frequencies

SD-06 Test Reports

Factory Test Results

Field Test Results

SD-07 Certificates

Product Certificates

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-10 Operation and Maintenance Data

Operating and Maintenance Manual

SD-11 Closeout Submittals

Warranty

## 1.4 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Ensure all motors and related equipment are packaged and protected to prevent any damage during shipping, after acceptance of delivery, storage, and handling at the project site. Include Manufacturer's instructions for proper handling and uncrating with the shipment of the Low-Voltage Motor(s).

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

Provide Low-Voltage Motors of a sufficient size for the duty to be performed while not exceeding the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions.

### 2.1.1 Service Factor

Ensure service factor of general purpose and other open ac motors is in accordance with NEMA MG 1.

Provide totally enclosed ac motors with a service factor of 1.15.

2.1.2 Motor Types

Mark Low-Voltage Motor with an index letter, from the letters shown below or a letter that indicates a higher efficiency.

Provide Low-Voltage Motors of the following types:

a. 1/3 HP and smaller, single phase - capacitor start

b. 1/2 HP and larger, three-phase - induction squirrel-cage type, NEMA Design B, having normal starting torque and low starting current

2.1.3 Design Requirements

Provide Low-Voltage Motors (LVM) designed for across-the-line starting with torque characteristics to carry the specified rated starting load. Ensure LVM have factory-sealed ball bearings with an L-10 rated life of not less than 80,000 hours in accordance with ABMA 9 or ABMA 11.

Ensure design, fabrication, testing, allowable balance limits and performance of polyphase induction motors are in accordance with NEMA MG 1 and ISO 1940-1 and meets or exceeds the requirements as specified herein.

Provide the following motor design data prior to final turnover:

a. Number of motor rotor bars

b. Stator slots

c. Rotational speed

d. Number of cooling fan blades

e. RPM of motor

f. Bearing Manufacturer

g. Bearing type

h. Bearing style

i. Number of balls/elements

j. Number of commutator bars

k. Commutator brushes

l. SCR firing frequencies

2.1.3.1 Efficiency

Ensure motors have efficiencies in accordance with the recommended levels specified in DOE CI-1.

Ensure efficiency labeling is in accordance with NEMA MG 1.

2.1.4 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, make adjustments 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 District. Provide control and protective devices in accordance with NFPA 70 and Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.1.5 Voltage Ratings

Provide motors with the following minimum voltage ratings:

| MOTOR SIZE | | | MOTOR |
|---|---|---|---|
| **MOTOR TYPE** | **HORSEPOWER** | **SERVICE** | **VOLTAGE RATING** |
| Fractional horsepower, single-phase | 1/3 and smaller | 120/208-volt, 3-phase, 4-wire | 115-volt, 60-hertz |
| Fractional and integral horsepower, 3-phase | 1/2 and larger | 120/208-volt, 3-phase, 4-wire | 200-volt, 3-phase 60-hertz |
| Fractional and integral horsepower, 3-phase | 1/2 and larger | 480-volt, 3-phase, 3-wire | 230/460-volt, 3-phase, 60-hertz |

2.1.6 Temperature Rating and Insulation

Provide motors designed for continuous operation at the rated full load in an ambient temperature of 104 degrees F, with an insulation level of at least Class B.

2.2 COMPONENTS

2.2.1 Motor Housing

Provide a smooth surface motor housing in the vertical, horizontal, and axial directions at each bearing housing for attaching a magnet mounted accelerometer in order to monitor the motor vibration. Ensure the smooth surface is on the bearing housing, with the axial surface as close to the motor centerline as possible. Provide a motor housing with a surface finish of 63 micro-inch minimum, corrosion resistant, with a minimum diameter finished surface of 2-inch. As an option sound disks with a minimum thickness of 3/8-inch can be used to meet the smooth surface requirement.

Ensure surface is level within 1 degree or .001 inch.

Identify the smooth surface using a printed label or embossed plate stating "Vibration data collection point - Do Not Paint".

### 2.2.2 Motor Enclosures

#### 2.2.2.1 Indoor Type Enclosures

For motors installed in indoor, clean, dry, non-hazardous locations, provide the following:

a. Open-type drip-proof enclosures

b. Hinged access cover, large enough to enable the placement of a magnet/accelerometer data collection instrument, at each vibration collection point

For motors installed in indoor, wet, non-hazardous locations, provide the following:

a. Open splash-proof enclosures

b. Hinged access cover, large enough to enable the placement of a magnet/accelerometer data collection instrument, at each vibration collection point

For motors installed in indoor, non-hazardous locations where it is necessary to protect the motor from dirt, moisture, chemical fumes, or other harmful ingredients in the surrounding atmosphere, provide either of the following type of enclosure:

a. Totally enclosed, not fan-cooled, enclosures not equipped for cooling by means external to the enclosing parts, with a hinged access cover at each vibration collection point, large enough to enable the placement of a magnet/accelerometer data collection instrument.

b. Totally enclosed fan-cooled enclosures for exterior cooling by means of a fan or fans integral with the machine but external to the enclosing parts, with a hinged access cover at each vibration collection point, large enough to enable the placement of a magnet/accelerometer data collection instrument.

#### 2.2.2.2 Outdoor Type Enclosures

For motors installed in outdoor, non-hazardous locations, provide waterproof enclosures.

Provide all motors with weatherproof/waterproof enclosures with permanent accelerometers installed in the horizontal, vertical, and axial directions. Ensure the enclosure has a penetration installed to enable the accelerometer cables to be routed to outside the enclosure. Include a NEMA 4R rated data collection box mounted to the outside of the motor enclosure in a location that is easily accessible.

## 2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Factory test all motors in accordance with the requirements of NEMA MG 1. Ensure polyphase induction motors are factory-tested in accordance with IEEE 112, Method B, consisting of measurements of voltage, frequency, speed, and current under no-load conditions; voltage, frequency, and current under locked-rotor conditions; and efficiency, noise, power factor, and thermal

protection. Verify routine tests on wound-rotor induction motors include the measurement of wound-rotor open-circuit voltage across the slip rings under locked-rotor conditions. Provide written documentation of electrical tests including winding resistance, insulation resistance, and high-potential tests. Submit certified copies of factory test results for approval prior to shipment from the factory. Previous test reports on identical motors are not acceptable for these tests.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Install, align, and connect motors in accordance with the equipment Manufacturer's instructions.

Mount motors with bolts. Ensure motor feet are coplanar within 0.001-inch, and base mounting points are accessible and adjustable to enable machine alignment. Install alignment jack bolts for motors over 7.5 hp to enable alignment.

### 3.1.1 Alignment

Before attempting alignment, demonstrate that the load does not have any load/force imposed by the piping system. Minimum alignment values (below) are for motor and load at normal running temperatures. Ensure values are compensated for thermal growth. Correct limited movement of the motor or load (commonly known as bolt-bound) to ensure alignment capability. Do not undercut hold down bolts in order to perform adjustment.

Provide commercially die-cut shims, without seams or folds, made of corrosion resistant stainless steel. Use no more than four shims at any single point.

Align motor and load to the following minimum specifications:

| **Speed(RPM)** | **Close-Coupled Offset (mils)** | **Close-Coupled Angle(mils/in.)** | **Spool Piece Angle (mils/in. @ coupling pt.)** |
|---|---|---|---|
| 600 | 6.0 | 2.0 | 3.0 |
| 900 | 5.0 | 1.5 | 2.0 |
| 1200 | 4.0 | 1.0 | 1.5 |
| 1800 | 3.0 | 0.5 | 1.0 |
| 3600 | 1.5 | 0.4 | 0.5 |
| 7200 | 1.0 | 0.3 | 0.4 |

Perform motor and load alignment under the direction of the Manufacturer's representative.

Recheck alignment of motors and adjust as required after the motor has been in operation for not less than 48 hours.

Provide written final alignment settings as part of the final test data.

## 3.2 FIELD TEST RESULTS FOR QUALITY CONTROL

### 3.2.1 Electrical Tests

Perform continuity test on all phases.

Perform insulation resistance and polarization index test on each phase of motor. Conduct insulation tests on 480-volt and 600-volt motors using a 1000-volt insulation test set. For insulation tests on motors rated less than 480-volts, use a 500-volt insulation test set.

Include in test data the location and identification of motors and megohm readings versus time. Record test data at 15, 30, 45 seconds, and in 1 minute increments not to exceed 10 minutes. Ensure Megohm readings are not less than 25 megohms for each phase; and each phase reading is within 10 percent of the other two.

Perform inspections and test procedures on all motors in accordance with NETA ATS and NETA MTS 7.15.1 for rotating machinery, AC motors.

Calculate the polarization index of each phase by dividing the 10 minute reading by the 1 minute reading. Verify that the polarization index is less than 1.25. Reject any lower values and return the motor to the factory.

### 3.2.2 Vibration Tests

#### 3.2.2.1 Vibration Analyzer

To measure vibration levels, use a Fast Fourier Transformer (FFT) analyzer having the following characteristics:

a. A dynamic range greater than 70 dB; a minimum of 400 line resolution

b. A frequency response range of 5 Hz-10 KHz(300-600000 cpm)

c. The capacity to perform ensemble averaging

d. The capability to use a Hanning window

e. Auto-ranging frequency amplitude

f. A minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB

Use an accelerometer, either stud-mounted or mounted using a rare earth, low mass magnet and sound disk (or finished surface) with the FFT analyzer to collect data. Ensure the mass of the accelerometer and its mounting have minimal influence on the frequency response of the system over the selected measurement range.

#### 3.2.2.2 Vibration Data

Collect vibration data in the axial, vertical, and horizontal direction for each motor bearing.

Obtain two narrowband spectra for each data collection point in the following manner:

a. For all machines regardless of operating speed, obtain a 5 to 500 Hz spectrum with a minimum of 400 lines of resolution.

b. Acquire an additional spectrum of 5 to 2500 or 5 to 5000 Hz for machines operating at or below 1800 RPM or greater than 1800 RPM, respectively.

Ensure vibration limits conform to the following:

| **Frequency Range(CPM)** | **Vibration limit(inch/sec)** |
|---|---|
| 0.3 x RPM to 0.8 x RPM | 0.04 |
| 0.8 x RPM to 1.2 x RPM | 0.75 |
| 1.2 x RPM to 3.5 x RPM | 0.04 |
| 3.5 x RPM to 120,000cpm | 0.03 |

Provide final test reports to the Construction Manager. Include with reports a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

## 3.3 CLOSEOUT ACTIVITIES

### 3.3.1 Operation and Maintenance

Submit Manufacturer's operating and maintenance manual to the Construction Manager no later than 30 days prior to final acceptance.

Submit Manufacturer's instructions for Low-Voltage Motors including special provisions required to install equipment components and system packages. Include all special notices regarding detail impedances, hazards and safety precautions.

### 3.3.2 Warranty

Submit Manufacturer's warranty to the Construction Manager no later than 30 days prior to final acceptance.

-- End of Section --

# SECTION 27 05 13.00 10

# TWO-WAY RADIO DATA TRANSMISSION 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 142 | (2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2014) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| Motorola R56 | Standards and Guidelines for Communication Sites |

### 1.2 SYSTEM DESCRIPTION

#### 1.2.1 General

Contractor shall provide the two-way radio wireless data transmission for the monitoring of the C-43 reservoir Geotech Embankment and Pressure Relief System, 900Mhz, UHF, VHF, and using required Campbell Scientific CR1000 RTU's with associated AVW200 units or District approved equals. The Contractor shall work with District IT Microwave Services group on the test plan for the field RTU's back-to-S-470 Tower Base Station. See C43 RTU design spread sheet in drawing set. The system shall be compatible with the new two-way radio equipment shown on the drawings.

Contractor to give notice to SFWMD IT (12) months ahead of start/completion of RTU's, structures, etc. that require a licensed frequency to operate. This will give SFWMD IT the required amount of time to coordinate and license frequencies with coordinator and the FCC. Contractor will be required to give SFWMD IT the required information for applications and support in terms of information and documentation required for licensing, etc.

#### 1.2.2 Electrical Requirements

The equipment shall operate from the DC power system of the individual sites and of all gate structures, spillways, and Geotech Embankment and Pressure Relief System, 900Mhz, UHF, VHF, and standalone monitoring stations as detailed in the C43 RTU design spreadsheet and on the Drawings.

1.2.3 Antenna Cable Surge Protection

Provide antenna cable with surge protection for all the antennas shown in the C43 RTU design spreadsheet and on the drawing details for all Geotech Embankment and Pressure Relief System, 900Mhz, UHF, and VHF standalone stations.

1.3 SUBMITTALS

Technical data shall be coordinated with the requirements of Section 01 33 00 SUBMITTAL PROCEDURES while verifying RTU testing of Rx levels for base station and all RTU's. Use C43 RTU design spread sheet in drawing set to submit completed as-built data.~~.~~ Data delivered shall be identified by reference to the specification paragraph against which it is furnished. Data shall be organized and delivered as follows:

1.3.1 Group I Technical Data Package

1.3.1.1 System Drawings

The data package shall include the following:

a. RTU Data Transmission System block diagram. Geotech Embankment and Pressure Relief System Monitoring, 900Mhz, UHF, and VHF.

b. RTU Radio System component installation and wiring diagrams. Geotech Embankment and Pressure Relief System Monitoring, 900Mhz, UHF, and VHF

c. Details of RTU connections to power sources, including grounding.

d. Details of RTU surge protection device installation.

e. Details of RTU cable splicing and connector installations.

1.3.1.2 Equipment Data

A complete data package shall be delivered for all RTU materials, including field installation, configuration, and testing.

1.3.1.3 Transmission System Descriptions and Analyses

The Group I data package shall include complete system descriptions. Descriptions shall show how the equipment will operate as a system to meet the specified performance requirements.

1.3.1.4 Manufacturer's Certifications

Manufacturer's certifications shall be included with the Group I data package.

1.3.1.5 Training Data

Lesson plans and training data, in manual format, for the training phases, including type of training to be provided, with a list of reference material, shall be delivered for approval.

1.3.2 Group V Technical Data Package

The Group V technical data package shall consist of the system documentation. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems and of the nearest service representative for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies, bound in hardback loose-leaf binders, shall be delivered within 30 days after completion of the endurance test, and shall include all modifications made during installation, checkout, and acceptance. Manuals delivered shall include:

a. Hardware Manual: two copies.

b. Operator's Manual: six copies.

c. Maintenance Manual: two copies.

1.3.2.1 Hardware Manual

A manual describing equipment furnished, including:

a. General description and specifications.

b. Installation and checkout procedures.

c. Equipment electrical schematics and layout drawings.

d. Alignment and calibration procedures.

e. Manufacturer's repair parts list indicating sources of supply.

f. Interface definition.

1.3.2.2 Operator's Manual

The operator's manual shall fully explain procedures and instructions for operation of the system.

1.3.2.3 Maintenance Manual

The maintenance manual shall include descriptions of maintenance for all equipment including inspection, calibration, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

1.4 ENVIRONMENTAL REQUIREMENTS

Equipment to be utilized indoors shall be rated for continuous operation under ambient environmental conditions of 35 to 120 degrees F dry bulb and 10 to 95 percent relative humidity, noncondensing. All other equipment shall be rated for continuous operation under the ambient environmental

temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

## 1.5 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 NAMEPLATES

Nameplates shall have unique identifiers engraved. Permanently attach nameplates to enclosure panel doors and back plates. For each field mounted piece of equipment attach a plastic tag with equipment name and point identifier.

## 2.2 RADIO FREQUENCY COMMUNICATION EQUIPMENT (RFCE)

### 2.2.1 General

Provide all equipment needed for complete two-way radio system for the Geotech Embankment and Pressure Relief System Monitoring, 900Mhz, UHF, and VHF RTU units for wireless data transmission from all field RTU's to the associated base station located in the S470 Microwave shelter. The two-way radio data transmission systems shall consist of wireless RTUs, radios, communication links, antenna systems, communication links surge and overvoltage protection, and line power surge protection.

### 2.2.2 Contractor Furnished Equipment and Materials

Contractor shall furnish, install, configure, commission, and test each installed RTU unit.

All RTU's shall be furnished and installed by the Contractor in the Field. Contractor furnished RTU's shall provide data communication and be operational for testing of the completed RTU System.

The Contractor shall provide and install all RTU's as shown and as detailed on the C43 RTU design spreadsheet and BP4 Plans. The Contractor must submit for approval any deviation from the specified components before fabrication. Components included in the C43 RTU design spreadsheet and referenced plans.

1) The Prime Contractor shall be responsible for all wiring, adapters, connections, configuration, and commissioning for all Geotech Embankment Monitoring radios, 900Mhz, UHF, and VHF equipment listed in the C43 RTU design spreadsheet and plans for a complete working and functioning system. Please see below for the Geotech Embankment Monitoring radio, 900Mhz, UHF, and VHF spares requirements:

2) SFWMD IT Spare Requirements or District Approved Equal:

   a. Qty(6): (VHF)Aprisa SR+; 4RF; P/N: APSQ-R135-SSC-FD-22-ENAB; Protected Base Station VHF.

   b. Qty(6): (UHF)Aprisa SR+; 4RF; P/N: APSQ-R400-SSC-FD-22-ENAB; Protected Base Station VHF.

c. Qty(6): Aprisa SR+; 4RF; P/N: APST-XPSW-X22; 4RF SR+ Spare, Protection Switch, 2E2S.

d. Qty(6): P21 Master Station; GE; BCI Technologies ; P/N: P2111; MDS Protected Network Station with iNET-II radios 13.8 VDC.

e. Qty(6): AnywhereUSB/5 Gen; Digi International; P/N: AW-USB-5.

3) SFWMD FOC/SIMS RTU Spare Requirements or District Approved Equal:

a. Qty (5) Campbell Scientific RTU, P/N CR1000 Data Logger

b. Qty (5) Campbell Scientific RF500M, RF Modem Interface

c. Qty (5) Campbell Scientific AM16/32B, Multiplexer

d. Qty (1) Campbell Scientific CS100, Barometric Pressure Transducer

e. Qty (5) MDS Radio, Model MDS iNET II

f. Qty (5) Andrew Antenna, P/N DB583-Y

g. Qty (6) Ameresco 50-Watt solar panel, P/N 50J

h. Qty (3) Powersonic 12-volt 40 AH Battery, P/N PSC-12400

i. Qty (3) KPSI 355 Pressure Level Sensor, Titanium, P/N 355-65F-RC-1

j. Qty (15) Geokon Piezometer with 200' of cable, P/N 4500S

k. Qty (10) Geokon Surge Module, P/N 4999-12L/E LAB3

l. Qty (5) Geokon 2 Channel Vibrating-Wire Analyzer Module, P/N AVW200

## 2.3 ANTENNA SYSTEMS

Antenna system shall be as shown on the Drawings and included in the C43 RTU design spreadsheet. Note: Verify model numbers match drawings from spreadsheet. The antenna, when possible, shall be placed as shown on the Drawings. The antenna systems and cabling shall be furnished to provide adequate system gain per Contractor link budget that includes the manufacture specifications. See C43 RTU design spreadsheet for antenna model, height, and azimuth. The ~~antennas~~ antenna systems shall be capable of withstanding lighting strikes while meeting the wind load requirements of the Florida Building Code.

Any correspondence which show or describes the Network details and/or the process control system including any IP address shall have the following included in header (Footnote fine print is acceptable) and in the content of the correspondence (Bolded text should appear in any printed documents, electronic documents, Visio, PDF, emails, slides, ETC which carry the sensitive information): **"This information is exempt from public records disclosure and confidential under Section 119.071(3)(a)(1), Florida Statute".**

## 2.4 COMMUNICATION WIRING LINKS

Transmission line between the RTU and the antenna shall be as shown and detailed on the Drawings.

## 2.5 CONDUIT

Conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and as shown shall be furnished as required.

## 2.6 ENCLOSURES

Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the Manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures shall be NEMA Type as shown and detailed on the Drawings. Enclosures installed outdoors shall be NEMA Type 4 unless otherwise shown.

## 2.7 RADIOS

Radios shall be furnished, installed, and tested as described and shown on in the C43 RTU design spreadsheet and drawings and as specified herein. Refer to C43 RTU design spreadsheet and drawings for radio types and model numbers. The C43 RTU Design spreadsheet radio types and models shall take precedence over the drawings if conflicting.

# PART 3 EXECUTION

## 3.1 INSTALLATION

System components and appurtenances shall be installed in accordance with the Manufacturer's instructions and as shown and detailed on the drawings and provide as part of submittal for review and acceptance by District. Necessary lightning protection, interconnections, services, and adjustments required for a complete and operable wireless radio data transmission system shall be provided. Grounding shall be in accordance with Motorola R56 Standards and Guidelines for Communication and IEEE 142.

### 3.1.1 Antenna

Tubular radiator elements shall be plugged to prevent wind vibration fatigue. Vertical tubular elements shall have drain holes near the bottom. Outside connectors shall be snug, filled with silicone grease, and properly sealed with heat-shrink wrap suitable for ambient temperatures of minus 22 to plus 140 degrees F. Refer to drawings and RTU design spreadsheet for additional antenna requirements.

The Contractor shall work with the SFWMD IT Microwave Services group on radio configuration requirements so that each RTU Geotech Embankment radio, 900Mhz radio, UHF radio, and VHF radio can communicate properly with the associated Base station located in the S470 Microwave tower shelter that was installed in Package 3.

### 3.1.2 Interior Work

All interior electrical Work shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as shown.

## 3.2 ENCLOSURE PENETRATIONS

Enclosure penetrations shall be from the bottom and shall be sealed with rubber silicone sealant to preclude the entry of water.

## 3.3 IMPULSE SUPPRESSION SURGE ARRESTER GROUNDING

Impulse suppression surge arresters shall be grounded. Ground resistance shall be not more than 10 ohms. Notify District SCADA if unable to achieve this resistance limit. Connections to earth shall be made in the same manner as for secondary neutral ground rod. The aerial portions of surge arrester and secondary neutral ground conductors shall be separate from and independent of each other but both grounds shall be bonded together below grade at the ground rods, or to the ground counterpoise, as applicable and the ground rods shall be spaced a minimum of 20 feet apart.

## 3.4 TESTING

### 3.4.1 General

Demonstrate compliance of the two-way Radio Data Transmission System with the contract documents. Furnish personnel, equipment, instrumentation, and supplies necessary to perform site testing. Ensure that test personnel are regularly employed in the testing and calibration of radio data transmission systems. Testing shall include the field tests and the performance verification tests. Field tests shall be conducted by the Contractor to determine the system is completely operational. Performance verification test shall be a demonstration to the District to ensure properly recorded all base and RTU signal levels to verify calculated path engineering. See C43 RTU design spreadsheet for test information to be recorded.

### 3.4.2 Test Plan

Submit and obtain approval of the field test plan and performance verification test plan for each phase of testing before beginning that phase of testing. Provide to the District written notification of planned testing at least 30 days prior to test. Notification shall be accompanied by the proposed test procedures. In no case will the Contractor be allowed to start testing without written District approval of field test plan and performance verification test plan.

### 3.4.3 Contractor's Field Test

Verify the complete operation of the two-way radio data transmission system during the Contractor's Field Testing. The Contractor's Field Test shall include an error rate test.

The Contractor shall reference each RTU radio type/model such as Geotech Embankment radio, 900Mhz, UHF, and VHF radio manufacturers recommendations for testing and acceptance per latest manufacture manual.

Contractor shall configure each radio, align antenna for installation per C43 RTU design spreadsheet and test per Manufacture manual references, test the links to verify that they are operating correctly, test RSSI levels per Manufacture recommendations in manual, per manufacture manual connect the client or user interfaces as required.

Contractor shall perform Radio (RF) Measurements per Radio Manufacture latest manual per RTU site.

Contractor shall perform antenna system SWR and Transmitter Power Output per Radio Manufacture latest manual per RTU site.

3.4.4 Test Oversight

Tests are subject to oversight and approval by the District.

3.4.5 Field and Verification Test Reporting

Before scheduling the performance verification test, furnish field test documentation and written Certified Statement of Field Test Completion to the District for approval. The statement, certified by the two- way radio data transmission system provider, states that the installed system has been tested and is ready for the performance verification test. Do not start the performance verification test prior to receiving written permission from the District. During and after completion of the Field Tests, and again after the Performance Verification Tests, identify, determine causes, replace, or repair equipment that fails to meet the specification, and submit a written report to the District. Document all tests with detailed test results. Explain in detail the nature of each failure and corrective action taken. Provide a written report containing test documentation after the Field Tests and again after the Performance Verification Tests.

-- End of Section --

# SECTION 31 00 00

# EARTHWORK - EARTH DAM

## PART 1 GENERAL

Summary of Work: The Contractor shall furnish all labor, materials, and equipment necessary for construction of the earth dam, including but not limited to, the foundation soil preparation, embankment construction, the soil bentonite wall, seepage collection system, erosion protection and installation of geotechnical monitoring systems. Specifications for many of these elements are found elsewhere, as described in Section 1.1. This specification applies to the earthwork associated with embankment construction of the dam and adjacent areas as shown on the Drawings. Details are provided on the Drawings for the construction of earthworks, including those details for discontinuities in the dam, such as at Gap Closures and at construction Work Arounds. Those Drawings should be referred to in concert with implementation of the requirements of this specification. The importance of the earthwork construction, and documentation of it, cannot be overstated from a dam safety perspective.

Dam construction (including the Phase I Soil-Bentonite Wall) within the limits of stations 2020+00 (south baseline) clockwise to 1090+00 (north baseline), a distance of 11,000 feet, shall be carefully sequenced in light of the S-476 Temporary Irrigation By-Pass and the use of the existing LPDD PS-1 as a temporary drainage outfall for the project. No Gap Closures and/or Work Arounds shall be allowed in this reach of the dam. Additional pumping over the completed portions of the embankment may be required to maintain stormwater drainage at the site. Further, no dam construction may be completed in the area proximate to structure S-470 until such time as the excavation for S-470 is backfilled to finished subgrades on the northeast, southeast and southwest sides of the structure.

The Contractor shall anticipate that dewatering, pumping and surface water management will be necessary for the earthwork construction activities associated with this project.

### 1.1 RELATED SECTIONS

Related Sections include but are not necessarily limited to:

1. DIVISION 1 GENERAL REQUIREMENTS

2. Section 01 33 00 SUBMITTALS

3. Section 01 45 04 CONTRACTOR QUALITY MANAGEMENT SYSTEM

4. Section 01 45 08 GEOGRAPHIC INFORMATION SYSTEM DATA REQUIREMENTS - QUALITY CONTROL AND QUALITY ASSURANCE DATA

5. Section 31 09 00 GEOTECHNICAL INSTRUMENTATION AND MONITORING OF EARTHWORK

6. Section 31 23 13 SUBGRADE PREPARATION

7. Section 31 25 13 SLOPE PROTECTION WITH SLOPE PAVING

8. Section 31 52 10 DEWATERING AND COFFERDAM

9. Section 31 56 13.13 SOIL BENTONITE SLURRY WALL

10. Section 32 92 19 SEEDING AND SODDING

11. Section 33 11 53 MONITORING WELLS

12. Section 33 46 13 FOUNDATION DRAINAGE SYSTEM

13. Section 35 41 21 PRESSURE RELIEF SYSTEM

## 1.2 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C136/C136M | Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D1140 | (2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing |
| ASTM D1556/D1556M | (2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method |
| ASTM D1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D4253 | Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table |
| ASTM D2216 | Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass |
| ASTM D2974 | Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils |
| ASTM D5084 | Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter |
| ASTM D2487 | Soils for Engineering Purposes (Unified Soil Classification System) |

| | |
|---|---|
| ASTM D2937 | Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method |
| ASTM D4318 | Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D6938 | Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |
| ASTM D698 | (2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.)) |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Construction (latest edition) |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 1110-1-1904 | (1990) Settlement Analysis |
| EM 1110-1-1901 | (1993) Seepage Analysis and Control for Dams |
| EM 1110-2-1902 | (2003) Slope Stability |
| EM 1110-2-2504 | (1994) Design of Sheet Pile Walls |

ADDITIONAL REFERENCE MATERIAL

~~Existing geotechnical information can be found in the Geotechnical Site Characterization Report, which is part of the bid documents.~~

a. Geotechnical Site Characterization Report, Bid Package 4.

b. Generalized Excavation & Dewatering Plan, Bid Package 4 Structures. Note: the term "Generalized" as used in this specification, is intended to demonstrate that the excavation and dewatering plans have been thought through, developed and presented only to demonstrate their viability. The "generalized" plans and sequencing do not relieve the Contractor from developing his/her own plans for District review and approval before implementing them. The sheet pile sections shown in the Generalized Excavation & Dewatering Plan were determined based upon stability analyses. The Contractor shall perform their own stability and drivability analyses to determine the sheet pile sections required for accomplishing the work for each structure location.

## 1.3 DEFINITIONS

### 1.3.1 Embankment Fill

Embankment Fill shall consist of SANDS which shall be a granular material that contains not more than 15 percent passing the U.S. Standard No. 200 Sieve, has an organic content no greater than 2 percent, has a maximum size of 4 inches and includes not more than 15 percent retained on the U.S. Standard 1.5 inch sieve. Roots and branches in excess of ½-inch in diameter

and tree stumps shall be removed from Embankment Fill. Embankment Fill shall consist of any materials classified by ASTM D2487 as SP, SM, SP-SM, SC, SP-SC, SW, SW-SM and SW-SC. Embankment Fill shall include material excavated from the borrow areas, from the Perimeter Canal and/or from the Townsend Canal that meet the requirements described herein. Embankment Fill shall be placed where indicated on the Drawings. Note that experience gained during construction of the preload fills indicates that the development of materials for use as Embankment Fill may require hand picking and/or screening to remove roots and oversized materials, as well as remnant irrigation and drainage piping. Such materials shall be removed from the Embankment Fill.

1.3.2 Select Fill

Select Fill shall consist of SANDS containing not less than 25 percent passing the U.S. Standard No. 200 Sieve and/or CLAYS. It shall consist of sand-silt-clay material that is free from organic material (maximum 2 percent), clods, and rock pieces greater than 1.5 inches in maximum dimension. Select Fill shall contain not more than 10 percent retained on the U.S. Standard 3/4-inch Sieve. Select Fill shall have a Liquid Limit not less than 25, and a Plasticity Index not less than 10. Select Fill shall have a Unified Soil Classification System (ASTM D2487) Group Symbol of SC, CL or SC-CL. It shall have a permeability of not more than 1 x 10-6 cm/sec when tested in accordance with ASTM D5084. Select Fill shall be obtained by selective excavation from the borrow area and/or from the required perimeter canal excavation. Refer to the Geotechnical Site Characterization Report to identify locations that are expected to contain soils meeting the requirements for Select Fill. The excavated materials shall be mixed in a blending area until the Select Fill material achieves a reasonably uniform moisture content and gradation. The Select Fill material shall be tested for permeability and shall meet the permeability requirements as described above prior to placement within the dam. The permeability characteristics of the Select Fill may be (at Contractor option) modified using sodium bentonite blended uniformly into the Select Fill. Select Fill shall be placed where indicated on the Drawings.

1.3.3 Clean Sand

Clean Sand shall consist of non-calcareous SANDS containing not more than 5 percent passing the U.S. Standard No. 200 Sieve. It shall be free from organic material (maximum 2 percent), clods, and rock pieces greater than 3/4 inches in maximum dimension. Clean Sand shall be obtained by excavation from the borrow area and/or from the required perimeter canal excavation. Clean Sand shall be placed where indicated on the Drawings.

1.3.4 Filter Sand

Filter Sand shall consist of silica based SANDS meeting the requirements of FDOT 902-4 Filter Sand (Types I through IV), containing not more than 2 percent passing the U.S. Standard No. 200 Sieve. Filter Sand will need to be obtained from an off-site source. Filter Sand shall be placed where indicated on the Drawings.

1.3.5 Degree of Compaction

The degree of compaction will vary depending upon the material type being compacted. For Embankment Fill, the degree of compaction shall be based upon

the percentage of the maximum dry density determined in accordance with ASTM D1557 (i.e. Modified Proctor). For the Select Fill material, the degree of compaction shall be based upon ASTM D698 (Standard Proctor). Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedures described above, abbreviated as a percent of laboratory maximum density. For Clean Sand and Filter Sand, the degree of compaction shall be expressed as relative compaction, and shall be based upon the density obtained from ASTM D4253 (maximum density by vibratory table). The frequencies of Proctor sampling and testing are provided in Section 3.10.1 of this specification.

1.3.6 Proof of Concept

Demonstration by Contractor that means and methods utilized will yield a finished work product that meets the project specification requirements, meet the quality objectives of the project, and establish protocols for communication of schedule, inspections and documentation of the work.

1.3.7 Embankment Settlement

The embankments are expected to settle as a result of the consolidation of the foundation soils. The amount of such settlement has been predicted and is shown on the Drawings. The Contractor shall monitor the embankment settlement using temporary geotechnical instrumentation as described in Specification Section 31 09 00 GEOTECHNICAL INSTRUMENTATION AND MONITORING OF EARTHWORK and as shown on the Drawings, and provide the monitoring data to the District.

1.3.8 Waiting Periods

The foundation soils are expected to consolidate at a rate that will require waiting periods once the dam reaches elevation +47 feet and again at elevation +54 feet. Anticipated durations of waiting periods are shown on the Drawings. The Phase II portion of the soil bentonite wall may be constructed during the waiting period associated with elevation +47 feet. This is described in Specification Section 31 09 00 GEOTECHNICAL INSTRUMENTATION AND MONITORING OF EARTHWORK.

1.3.9 90 Percent Consolidation

This shall be determined by the Contractor's Civil/Geotechnical Engineer (and agreed upon by the District) as the following:

Milestone at which the excess pore water pressures measured in the clay in each of the three Temporary Piezometers at a given Monitoring Station has dropped to 10 percent or less of the theoretical pore water pressure increase resulting from instantaneous placement of the embankment load.

This milestone shall be checked using procedures described in the USACE EM 1110-1-1904 SETTLEMENT ANALYSIS.

1.3.10 Gap Closures and Work Arounds

Gap Closures are discontinuities in the embankment construction that are caused by the location of new conduits through the dam. Work Arounds are discontinuities in the embankment construction that are caused by existing

water features that remain in service for a portion of the duration of construction, and are more specifically described in Paragraph WORK AROUNDS of this specification. Details related to Gap Closures and Work Arounds are provided on the Drawings.

1.3.11 SIMDAMS

SIMDAMS is a geospatial data base to store and display quality data. It was developed by the Corps of Engineers for use on dam construction projects. Separate specifications (01 45 04 - Contractor Quality Management System and 01 45 08 - Geographic Information System Data Requirements - Quality Control and Quality Assurance Data) have been developed. These specifications provide the requirements of SIMDAMS data management system. The specification addresses the work items (e.g. foundation preparation, embankment construction, etc.), what information is to be gathered, and where that information is to be stored.

1.3.12 Unsuitable Soils

These are soils and/or materials that consist of organics, roots, construction demolition debris, tires, metals, plastics, or other similar materials that represent unsuitable conditions for the foundation of the dam and ancillary structures. Such materials were not found in borings drilled and/or test pits excavated by the District. However, for a project of this size, the Contractor shall anticipate finding at least some areas of the site where removal of unsuitable soils and materials will be required. Sands having an organic content in excess of ~~2~~ 5 percent shall be considered as unsuitable soils. Organic stained sands were found in borings drilled by the District. Such soils are not considered to be unsuitable.

1.3.13 Unstable Soils

Unstable soils consist of such materials having and retaining moisture contents too wet for compaction and/or for support of equipment and structures. Such soils are to be scarified, air dried or otherwise moisture conditioned to within the range of moisture contents prescribed in paragraph EMBANKMENT FILLING AND COMPACTION of this specification and shall be compacted as required. If this cannot be accomplished, the unstable soils shall be removed and replaced with Embankment or Select fill as appropriate, at no additional cost to the District.

1.3.14 Unclassified Backfill

Unclassified backfill may consist of any granular soils and/or sand-clay-silt mixtures having a maximum particle size of 8 inches, up to 50 percent passing the U.S. Standard No. 200 Sieve, and a maximum organic content of 5 percent. Unclassified backfill shall be placed in the locations shown on the Drawings, in lifts up to 3 feet thick. Dewatering of areas backfilled using Unclassified Backfill will not be considered a contract requirement. Compaction of Unclassified Backfill may be limited to routing of hauling equipment and tracking with a dozer to create a reasonably stable earth surface.

1.3.15 Borrow Areas

Borrow Areas are locations within the interior of the reservoir site where excavations are to be made for obtaining materials for construction of the

dam. The limits of Borrow Areas are shown on the Drawings. **No borrow excavations are to be made within 200 feet of the inside toe of the dam.**

1.3.16 Contractor's Civil/Geotechnical Engineer

Qualifications of Civil/Geotechnical Engineer: this individual shall be a State of Florida registered professional engineer, specializing in geotechnical engineering, and having not less than 10 years of design and construction experience including experience on at least 5 projects related to earth dams, levees and cofferdams.

1.3.17 Surface Water Management Plan

The Surface Water Management Plan shall include a description of the means and methods to be utilized to carry out the dewatering and methods to be utilized to verify the extent of groundwater lowering. The plan shall also include areas designated for on-site storage of dewatering effluent, design of impoundment berms, and methods used to move water through the site including outfalls.

1.3.18 Borrow and Site Materials Management Plan

This plan shall include a description of the Contractor's understanding of the locations of and availability of borrow soils, the types and depths of soils expected for those areas, and a general discussion related to optimization of haul distances for specific material types.

1.3.19 Erosion Control Plan

The Contractor shall submit an Erosion Control Plan for earthen slopes which describes and details the approach to managing soil slope erosion. Contractor is alerted to the potential for significant erosion of soil slopes due to frequent and heavy rainfall events typically occurring at the project site.

1.3.20 Work-Around Plan

A Work-Around Plan shall describe the methodology to be employed at locations where interruptions in the dam construction are required for the purpose of maintaining surface water flows through the project. Locations of Work-Arounds are shown on the drawings. Gap Closures are considered to be a specific type of Work-Around pertaining to locations where hydraulic structures pass through the dam. Elements of the Work-Around Plan are described in Section 3.8.2 of this specification.

1.3.21 Earthen Cofferdam Plan

The Contractor shall provide an Earthen Cofferdam Plan. Elements of the Earthen Cofferdam Plan shall include, but not be limited to, methods to be utilized to isolate, dewater, clean and backfill areas of the site where the dam crosses existing surface water bodies. The plan shall be signed and sealed by the Contractor's Civil/Geotechnical Engineer. A site specific plan shall be submitted for each major canal crossing (e.g. Header Canal, Roberts Canal, Banana Branch Canal), and a more generalized plan shall be submitted for other ditch and canal crossings. Earthen plugs and sheet pile walls shall be designed in accordance with USACE Engineer Manuals EM 1110-1-1901, EM 1110-2-1902, and EM 1110-2-2504. The Contractor shall coordinate the

submittal of the Earthen Cofferdam Plan with the requirements of Section 31 52 10.

1.3.22 Dewatering Plan

A Dewatering Plan detailing how surface and groundwater will be controlled throughout construction shall be submitted for District approval. Each excavation that requires dewatering shall be described in the plan, including typical dewatering efforts for ditches and canals, as well as specific excavations for hydraulic structure foundations and for reclamation of major canals (i.e. Header, Roberts and Banana Branch Canals) where the footprint of the dam crosses these features.

Acquire all permits required to discharge water and protect waterways from turbidity during the dewatering operation. Special permit conditions associated with the dewatering permit for the S-476 Pumping Station (Bid Package 2) stated that the maximum allowable elevation for the dewatering for that project was -30 feet NAVD. Contractors bidding this project should anticipate similar special conditions will apply to the construction dewatering permit for all Bid Package 4 excavations.

The Contractor shall demonstrate a minimum of ten (10) years of experience in the construction of dewatering systems including, but not limited to, sheet pile, pumping, well point installation and extraction, and earthen cofferdams. The dewatering system design engineer shall be a Florida licensed professional engineer with a minimum of ten (10) years of experience in performing similar work. Surface and/or groundwater control will likely require as a minimum the use of a single stage or multistage well point system, the use of temporary diversion ditches, deep wells, containment berms, and dewatering by the use of pumping and sumps may also be required to maintain a dry excavation. The information submitted in the dewatering plan shall be in accordance with all project permit requirements. The following information shall be included in the Dewatering Plan:

a. Qualifications of the design professionals responsible for design and operation of the dewatering system and safety inspection procedures. The dewatering plans and calculations for the dewatering system shall be signed and sealed by a registered professional engineer licensed in the State of Florida.

b. Site plan of the project component with a description of the dewatering system and equipment, well details including installation and removal procedures, layout including the location of sumps, well points, deep wells, backup pumps, temporary containment berms, cofferdams, or diversion ditches as necessary; details of pumped wells, monitoring wells and piezometers (i.e. depths and diameters); installation and removal methods; details for location, installation, construction, and abandonment of all piezometers; description and layout for the onsite water detention system; location of the proposed discharge points, discharge rates, and the associated water quality monitoring location; and re-watering procedures.

c. A detailed description of the sequence of construction and dewatering, including a description of control elevations during cofferdam/stability berm construction, and control elevations during construction. A description of the groundwater level monitoring plan shall also be provided.

d. The location and type of turbidity control devices and methods necessary to ensure State Water Quality will be met.

e. Calculations estimating the area of influence of dewatering, depth of dewatering, pumping rates, duration and volumes, and stability of system, consistent with planned construction activities.

f. A plan for construction of each temporary cofferdam system. The plan shall contain a description of the type of cofferdam, a list of materials to be used, and a detailed installation and removal sequence.

g. An operational plan, which demonstrates that the discharge to the receiving water body meets all applicable State Water Quality standards prior to discharge, and also contains the proposed sampling locations and daily turbidity measurements.

h. A contingency plan, which includes procedures for ceasing dewatering operations and corrective actions (to include a contingency plan in the event proper dewatering as per the Contractor's design is not achieved) until water quality standards are met. The contingency plan shall also include provisions for maintenance of dewatering systems such as cleaning dewatering components and responding to biofouling.

i. A plan for re-watering the site so that no adverse impacts to the structure and/or surrounding landform occur. At a minimum, include the proposed rate of groundwater level rise.

Earthwork operations shall not commence until the Dewatering Plan is approved. The Contractor shall allow 45 calendar days in the schedule for the District's review. No adjustments for time or money will be made if resubmittal of the Dewatering Plan is required dur to deficiencies in the plan. Additional requirements for dewatering with cofferdams are described in Specification Section 31 52 10 DEWATERING AND COFFERDAM.

1.3.23 Pre-Activity Meeting

A Pre-Activity Meeting shall be required prior to beginning the earthwork, and shall be attended by appropriate District, Engineer, Contractor, Subcontractor/Vendor, and QC personnel. The meeting would facilitate discussion of the contract requirements, work plans, coordination, and other expectations.

1.3.24 Sheet Pile Cofferdam

Either a steel sheet pile supported excavation or a braced excavation, used to facilitate dewatering for the purpose of creating a dry working area. The Contractor shall submit a Sheet Pile Cofferdam Plan for each sheet pile supported construction area. This plan shall contain a description of the type of cofferdam, a list of materials to be used, and a detailed installation and removal sequence. Sheet pile walls shall be designed in accordance with USACE Engineer Manuals EM 1110-1-1901, EM 1110-2-1902, and EM 1110-2-2504. The Contractor shall coordinate the submittal of the Sheet Pile Cofferdam Plan with the requirements of Section 31 52 10.

1.3.25 Over-Consolidated Clays

The subsurface components include a clay stratum which is described as somewhat over-consolidated. Some of the structures that require sheet pile supported cofferdams exist within the footprints of existing and/or former preload fills that were constructed as part of Bid Package 1. The Contractor shall be aware of the presence of the over-consolidated clays and the impacts of these materials in the selection of sheet pile sections and sheet pile driving equipment.

1.3.26 LOT

For this project, a LOT is defined as a volume of earthen construction materials, the volume of which varies with material type, having consistent physical characteristics such as moisture and organic content, grain size distribution, Atterberg Limits, and a moisture-density relationship (i.e. Proctor) curve. A LOT may be defined by a single set of qualifying test results or by a family of qualifying test results.

1.4 SYSTEM DESCRIPTION

Subsurface profiles are provided in the Geotechnical Site Characterization Report. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations. Groundwater levels shown on the subsurface profiles reflect groundwater conditions on the dates shown. Groundwater level fluctuations shall be expected resulting from variations in rainfall, recharge and agricultural operations control of surface water levels in on-site ditches and canals.

The dam has very specific components including, but not limited to, Embankment Fill, Select Fill, Chimney Drain, Blanket Drain, Toe Drain, Soil-Bentonite Wall, Soil Cement Slope Protection, Wave Wall, HPTRM, and grassed slopes. Owing to the size of the project, the quantities of these materials are significant. The Contractor shall develop plans to exercise extreme care in the placement of these materials such that they are placed only in their designated areas. The Contractor shall also protect the materials placed in their designated locations from the effects of erosion to limit the potential for contamination of these materials.

1.4.1 Classification of Excavation

Excavations will be made to produce Embankment Fill, Select Fill and Clean Sands. Select Fill and Clean Sand materials produced from such excavations shall be stockpiled in designated areas, processed for uniformity of grain size, moisture content and plasticity (for Select Fill), and qualified for placement in the dam as part of the Contractor's Quality Control Plan. Embankment Fill materials that are reasonably uniform in terms of gradation, moisture content and plasticity may be excavated from the borrow area and placed directly in the embankment. Additional processing may be required to remove roots and oversized materials and to blend the Embankment Fill to uniform conditions. Experience gained during the construction of the Preload fills for Bid Package 1 indicates that some excavations will produce materials with significant root content. These roots shall be removed from the Prepared Foundation soils, Embankment Fill, Select Fill, Clean Sands and from structure foundation excavation bottoms. For reference, roots, remnant piping and other unsuitable materials that were removed from the fill during construction of the Bid Package Preload at S-471 are shown in the photograph

in Attachment A. Nested and/or matted root zones shall be considered to be unacceptable.

1.4.2 Blasting

Blasting will not be permitted.

1.4.3 Embankment Construction

Earth fill placement for the construction of dams associated with the project, inclusive of Embankment Fill, Select Fill, Clean Sand and Filter Sand. All fill placed above the Prepared Foundation Grade shall be considered as Embankment Construction.

1.4.4 Summary of Proof of Concept

A written narrative with associated graphics as needed to summarize the means and methods utilized by the contractor for each aspect of the work, to demonstrate that the finished products meet the plan and specification requirements, achieve the quality objectives of the contract, and to document the work. Acceptance by the District of the Summary of Proof of Concept document shall be considered a necessary precedent to commencement of the Work.

1.4.5 Haul Roads

Haul roads shall be located and constructed as approved by the District within the project boundaries shown on the Drawings. Prior to the commencement of construction, submit for approval a Haul Road Plan detailing the location of all haul roads within the project limits. Haul roads shall be constructed to maintain the intended traffic, be free draining, and be maintained in good condition through the contract period. Any haul road which crosses a ditch or canal shall be constructed and maintained to not flood either upstream areas by restricting flows or flood downstream areas by the release of any stored water in the event that the crossing fails for any cause. Haul roads constructed during the contract duration shall be removed after work is completed and the impacted area restored to its preconstruction conditions. All costs associated with these haul roads shall be considered part to the contract lump sum price.

1.5 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES. (Minimum requirements for each submittal are defined elsewhere in this specification.)

SD-01 Preconstruction Submittals

Haul Road Plan

Surface Water Management Plan

Borrow and Site Materials Management Plan

Summary of Proof of Concept

Qualifications of the Contractor's Corps Validated Testing Laboratory

Settlement Monitoring Plan

Erosion Control Plan

Work-Around Plan

Qualifications of Dewatering Specialist

Qualifications of Civil/Geotechnical Engineer

Earthen Cofferdam Plan

Sheet Pile Cofferdam Plan

Dewatering Plan

LOT Testing Plan

SD-03 Product Data

Utilization of Excavated Materials

Filter Sand Quality Data

SD-06 Test Reports

Testing

In-Place Density Test Results

Laboratory Test Results

Determination of Waiting Period Duration

Foundation Inspection Checklist

SD-11 Closeout Submittals

As-Built Surveys

Canal Cross Sections

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

Filter Sand imported from an off-site source shall meet the requirements of FDOT 902-4 Filter Sand. Contractor shall submit Filter Sand Quality Data sheets on a weekly basis while this material is being imported.

2.2 REQUIREMENTS FOR ONSITE SOILS

Materials utilized for Embankment Fill, Select Fill, and Clean Sands may be obtained from on-site borrow excavations, and shall meet the requirements of

this specification as described in Section 1.3 DEFINITIONS. Contractor shall submit gradations and other laboratory test results of excavated materials for use in the project for every 20,000 cubic yards of Embankment Fill material, and for every 10,000 cubic yards of Select Fill and Clean Sand material, as described in Section 3.10.1 of this specification.

## PART 3 EXECUTION

Prior to starting the Work, The Contractor shall submit a statement of Qualifications of the Contractor's Corps Validated Testing Laboratory. The statement must list the Corps Validation for each of the laboratory testing procedures anticipated to occur over the life of the construction project. The Contractor's QC Laboratory facilities shall be located on the project site.

The Contractor shall also submit a Borrow and Site Materials Management Plan. This plan shall include a description of the Contractor's understanding of the locations of and availability of borrow soils, the types and depths of soils expected for those areas, and a general discussion related to optimization of haul distances for specific material types. This plan shall also provide narrative descriptions of the stockpiling of materials needed for production of soil cement, as well as management of and mixing of stockpiled materials for use as Embankment Fill and/or Select Fill.

### 3.1 STRIPPING OF TOPSOIL

See Section 31 23 13 SUBGRADE PREPARATION.

### 3.2 GENERAL EXCAVATION

All borrow excavations below the prevailing groundwater level, excavations made to reclaim existing 10th Row Ditches, canals and other existing water features, and structural excavations shall be made in accordance with the Contractor's Surface Water Management Plan. The Surface Water Management Plan shall include a description of the means and methods to be utilized to carry out the dewatering and methods to be utilized to verify the extent of groundwater lowering. Dewatering shall be performed in accordance with Section 3.2.4 of this specification and applicable sketches and notes shown on the drawings. The Surface Water Management Plan shall be prepared by the Contractor's Dewatering Specialist. Qualifications of Dewatering Specialist: a civil/geotechnical engineer having not less than 10 years of construction dewatering experience including experience on at least 5 projects related to dams and levees.

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport excavated materials consisting of Select Fill and Clean Sand and place in temporary stockpiles for processing and qualification prior to placement within the embankment limits of the work. Dispose surplus excavated material not required for fill or embankment in areas approved for surplus material storage or designated waste areas. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated.

The Contractor shall develop a LOT Testing Plan for each material type. The LOT Testing Plan shall include a narrative description of sampling and testing frequencies for each material type, and specific methodologies that will be utilized for identification of the appropriate set(s) of qualifying test results for each LOT.

### 3.2.1 Temporary Fill Stockpiles

Place excavated materials in temporary, designated stockpiles for Select Fill and Clean Sand. The stockpiles are to be utilized for processing of the materials in order to develop uniform grain size, moisture content and plasticity. Each stockpile of material is to be qualified in writing by the Contractor, with supporting laboratory testing documentation, and approved by the District prior to placement in the embankment. Embankment Fill may be excavated and placed directly in the dam, provided the materials are reasonably uniform and meet the gradation and organic content requirements for Embankment Fill. Moisture conditioning, blending, disking, hand picking and/or screening of materials to remove roots and oversized materials, and other efforts necessary shall be performed in-place when Embankment Fill is directly hauled from the borrow. The amount of effort necessary to accomplish this work may vary depending on the location of the on-site borrow source(s) the Contractor elects to use and haul from. Final acceptance of the Embankment Fill materials shall be made at the embankment placement areas.

### 3.2.2 Drainage Structures

Make excavations to the lines, grades, and elevations shown on the Drawings. The District shall have authority to direct changes to excavation limits. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete or masonry is to be placed, except as noted on the drawings where over-excavation is required for placement of flowable fill.

### 3.2.3 Drainage

The Contractor shall submit a Surface Water Management Plan that describes means and methods for handling surface waters on the project site while utilizing the Work Arounds described on the Drawings. The Surface Water Management Plan shall be consistent with the Dewatering Plan. The Surface Water Management Plan shall provide for the collection and disposal of surface and subsurface water encountered during construction. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. The Contractor shall manage site surface water during 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 working platforms for equipment operation and support for subsequent construction features become unstable due to excess moisture, scarify, dry and recompact materials, or remove unstable material to 12 inches deep or

the depth required based upon field conditions existing at the time of removal, and provide new soil material as specified herein. The horizontal limits of the soil removal and replacement shall be determined by the Contractor with approval by the District based upon site conditions existing at the time of removal. This work shall be completed at no additional expense to the District. It is the responsibility of the Contractor to assess the soil and groundwater conditions presented by the plans, specifications and supporting geotechnical site characterization and to employ dewatering measures surface water drainage necessary such that the construction may proceed.

### 3.2.4 Dewatering

Control groundwater flowing toward or into excavations to facilitate reclamation of 10th Row Ditches and canals, to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Dewatering ditches shall be located not closer than 200 feet from the reservoir side toe of the dam, and no closer than the footprint of the Perimeter Canal on the land side toe of the dam. While the excavation is open, maintain the water level continuously at least 3 feet below the working level. Other aspects of dewatering shall comply with the requirements of Specification 31 52 10.

### 3.2.5 Pipe Trench Excavation Requirements

Excavate the pipe trench as recommended by the Manufacturer of the pipe to be installed. Shore trench walls more than 4 feet high, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Shore vertical trench walls more than 4 feet high. Give special attention to slopes that may be adversely affected by weather or moisture content. Do not exceed the trench width below the pipe top of 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter, and do not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures by the Contractor.

#### 3.2.5.1 Pipe Trench Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 1 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

#### 3.2.5.2 Removal of Unyielding Material

Where rock is encountered in the bottom of pipe trenches, remove such material 6 inches below the required grade and replaced with suitable materials as provided in paragraph EMBANKMENT FILLING AND COMPACTION. During pre-trenching for discovery and removal of existing buried conduits, excavation shall terminate vertically when non-excavatable limestone in found. Non-excavatable limestone is defined in Specification 31 23 13.

3.2.5.3 Removal of Unstable Material

After the bottom of the proposed trench has been reached through excavation, and where unstable material is encountered in the bottom of the trench, remove such material to a depth of at least 12 inches, for the full width of the bottom of the excavation or 3 feet, whichever is larger, and replace it to the proper grade with Embankment Fill material as provided in paragraph EMBANKMENT FILLING AND COMPACTION.

3.2.5.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or loose debris, and cut to a firm surface either level or stepped, to allow for better compaction of backfill. Remove loose rock. 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.

3.2.6 Foundation Inspection Checklist

Contractor shall provide written Foundation Inspection Checklist for each segment of the dam and/or structure footprint. The checklist shall include confirmation of at least the following items: lines and grades, stripping, pre-trenching, removal of buried conduits, dewatering and reclamation of 10th Row Ditches and canals, proof rolling, removal and replacement of unsuitable foundation soils, and densification of and testing of foundation soils to meet specification requirements.

3.3 SELECTION OF BORROW MATERIAL

The District completed a borrow study, the results of which are provided in the Geotechnical Site Characterization Report. Limits of the areas available for borrow are shown on the Drawings. Borrow areas shall be stripped and pre-trenched for removal of buried conduits as described in Specification 31 23 13. **No borrow excavations are to be made within 200 feet of the inside toe of the dam.**

The Contractor shall utilize their approved LOT Testing Plan to select appropriate set(s) of qualifying test results for each LOT in accordance with the requirements of Section 3.10.1 of this specification.

3.4 BORROW STOCKPILE AREAS

Clear, grub, and seal by rubber-tired equipment the ground surface at stockpile locations; separately stockpile Select Fill, Clean Sand and Filter Sand materials. Protect stockpiles of these materials from contamination that may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles and any material becomes unsuitable for its intended use, remove and replace such material with satisfactory material from approved sources at no cost to the District.

3.5 GROUND SURFACE PREPARATION

Refer to Section 31 23 13 SUBGRADE PREPARATION for the ground surface preparation requirements.

## 3.6 UTILIZATION OF EXCAVATED MATERIALS

Embankment construction may proceed using materials from the borrow site or from a qualified, documented stockpile that contains materials consistent with the intended embankment location (e.g. Select Fill and Clean Sand). Embankment Fill materials may be excavated from the borrow areas and placed in the embankment, provided the materials meet the specification requirements. Hand picking and/or screening of the borrow soils to remove roots and oversized materials shall be anticipated. Direct hauling of Select Fill and Clean Sand without stockpiling will not be allowed.

## 3.7 EMBANKMENT FILLING AND COMPACTION

Place Embankment Fill, Clean Sand, or Filter Sand in successive horizontal layers of loose material not more than 12 inches in depth. Lift thickness for Select Fill materials shall be not more than 8 inches in depth. Embankment Fill materials having Unified Soil Classification System (ASTM D2487) Group Symbols of SC and/or SM shall not be placed within 10 feet (measured horizontally) from the finished earth slopes of the dam. Compact each lift of fill materials to the following moisture-density requirements:

Embankment Fill - All Embankment Fill material shall be within the range of -3 to +3 percent of optimum moisture content at the time of compaction, and shall be compacted to at least 95 percent of the maximum dry density determined in accordance with Modified Proctor (ASTM D1557).

Select Fill - All Select Fill material shall be within the range of -1 to +2 percent of optimum moisture content at the time of compaction, and shall be compacted to at least 98 percent of the maximum dry density determined in accordance with Standard Proctor (ASTM D698). The moisture content of previously placed Select Fill, that is left unworked for a period of one day or more, shall be verified by in-place moisture content testing to be within the specified range for Select Fill prior to placement of subsequent lifts of either Select Fill or Embankment Fill. Frequency of such moisture content testing shall be one per 10,000 square feet per lift, but at least one test per lift of Select Fill per shift shall be provided by the Contractor. The Contractor shall demonstrate that the methods for placement, compaction and scarifying lifts Select Fill does not result in lamination of the soil materials.

Select Fill and/or Embankment Fill shall be placed adjacent to structure walls only after the concrete has achieved 80 percent of its design strength, and only after the top of the structure wall has been structurally connected to the opposite wall. The backfill shall be placed adjacent to the structure walls using lifts sloping out and down away from the structure walls on a slope of 6H:1V. Fill shall be brought up in lifts evenly on both sides of the structure with no more than 2 feet difference in elevation on opposing sides of the structure.

Clean Sand and Filter Sand materials are to be compacted to not less than 90 percent Relative Compaction determined in accordance with ASTM D4253.

At the beginning of each work day, the previously placed and compacted earth lift shall be scarified to a depth not less than 6 inches, and the scarified surface shall be moisture conditioned to meet the specification requirements. The initial lift of fill for each work day shall be 6 inches thick. Subsequent lifts shall be no greater than 12 inches thick (8 inches for Select Fill), and the surface of subsequent lifts shall be scarified to a depth of 3 inches to promote bonding between lifts.

Filling slopes along penetrations through the embankment shall be cut to provide an overall average slope of 4 horizontal to 1 vertical (4H:1V), and the sideslopes shall be benched in one-foot vertical intervals to facilitate compaction of the backfill soils on the slopes. This is especially important at Gap Closures. Slopes at Work Arounds such as those at major canal crossings shall be cut to provide an overall average slope of 6H:1V, and shall be benched as described above. Excavation slopes to remove unsuitable soils, for repair of embankment erosion, and for other cuts in the embankment shall have an overall slope no steeper than 4H:1V and shall be benched as described above. Temporary slopes outside of the dam footprint may be cut steeper than 4H:1V, provided such cut slopes are evaluated by the Contractor's Civil/Geotechnical Engineer.

## 3.8 SPECIAL REQUIREMENTS

### 3.8.1 Waiting Periods

The foundation soils are expected to consolidate at a rate that will require waiting periods once the dam reaches elevation +47 feet and again at elevation +54 feet. The predicted durations of the waiting periods for various reaches of the dam are shown on the Drawings. Contractor shall submit the Settlement Monitoring Plan for District review and approval, and gather settlement data in accordance with the approved plan. The Settlement Monitoring Plan shall include a written narrative describing the means and methods the Contractor shall utilize to acquire data, process and QC data, and engineering analyses methods that will be used to determine the Waiting Period Duration for a given section of the dam. Construction of the dam above elevation +47 feet cannot resume until the foundation soils have reached at least 90 percent consolidation as determined by the temporary geotechnical instrumentation. Construction of the soil-cement cannot commence until the temporary geotechnical instrumentation shows that the foundation soils have achieved 90 percent or more consolidation after the dam reaches elevation +54 feet.

The Contractor shall submit the document, Determination of Waiting Period Duration, for each reach of the dam shown on the Drawings entitled Temporary Geotechnical Instrumentation. This document is to be prepared by and signed and sealed by the Contractor's Civil/Geotechnical Engineer, and shall include as a minimum the following information:

Station to Station limits of area under consideration

Elevation of Waiting Period, and Relevant Dates such as beginning of embankment construction and date when elevation of Waiting Period is achieved

Duration of Waiting Period, and Relevant Dates such as beginning of embankment construction and date when elevation of Waiting Period is achieved.

Calculations for 90 Percent Consolidation

Relevant piezometer and settlement plate data plots

Methods to be employed to protect slopes from erosion, and remedial action plans for events and locations where erosion exceeds the limitations described in this specification.

3.8.2 Work Arounds

Work-Arounds are defined as discontinuities in embankment construction that exist for more than three calendar weeks. Several work-arounds are planned and required for existing water features that must remain in service for a portion of the duration of construction.

Details related to work-arounds are provided on the Drawings. For each work-around (planned or unplanned), the Contractor shall submit a Work-Around Plan for District approval and shall allow time required for District review in accordance with Specification 01 33 00. Each Work-Around Plan shall be signed and sealed by the Contractor's Civil/Geotechnical Engineer. Elements of the Work-Around Plan shall consist of, but not be limited to, the following:

A. A written narrative and associated drawings describing

1. Means and methods to be used to determine the geometry of and integrity of the features described in item B below as they exist at the time of the work stoppage.

2. The required amount of overlap of critical design features listed in item B.

3. How the contractor will establish an appropriate overlap of critical design features.

4. Geotechnical instrumentation to adequately monitor seepage at the area of the work around.

5. Testing and inspection of previously placed dam embankment elements

6. As-built survey data describing limits of overlap of critical dam features.

B. Critical dam features shall consist of (at least) the following:

1. Prepared foundation grade

2. Phase I SB Wall work pad

3. Phase I SB Wall installation

4. Embankment construction to El 47 feet

5. Chimney, Blanket and Toe drains

C. A remedial plan in the event of observed seepage at the location of the Work-Around during the period of first filling. (estimated to be one year).

### 3.8.3 Sheet Pile Cofferdams

Earthwork construction may require the use of sheet pile supported excavations to facilitate dewatering and construction in a dry condition. All sheet pile supported excavations shall be constructed in accordance with approved Sheet Pile Cofferdam plans and the requirements of Section 31 52 10.

## 3.9 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 above design water surface elevations within 0.1 foot of the grades and elevations indicated. For below water slopes and canal bottom levels, provide degree of finish within 0.5-foot of design grades. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

## 3.10 TESTING

The Contractor shall perform testing by a Corps validated commercial testing laboratory located on the project site. Submit qualifications of the Corps validated commercial testing laboratory. Work requiring testing shall not be permitted to begin until the Contractor's laboratory facilities have been inspected, Corps validated, and approved by the District.

a. Determine field in-place density in accordance with ASTM D6938 and ASTM D2937. Establish calibration curves for each nuclear gauge using the results from ASTM D6938 and ASTM D1556/D1556M. Every tenth field in-place density test using the Nuclear Gauge shall be made with a corresponding field density test using the Sand-Cone Method (ASTM D1556/D1556M). Adjust results from the nuclear gauge using the calibration curve that results from the corresponding tests. The Drive Cylinder Method (ASTM D2937) may be used only for Select Fill materials.

b. When test results indicate that compaction is not as specified, moisture condition and re-compact the material in place, or remove the material, replace and re-compact to meet specification requirements.

c. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional Civil/Geotechnical 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 number of tests for each material type are provided in Paragraph IN-PLACE DENSITIES of this Specification. These test frequencies, if performed at the appropriate time, will be the minimum acceptable for each type operation.

d. Field In-Place Density Test Results and Laboratory test results are to be provided to the District within 48 hours of conclusion of physical tests. Field and Laboratory test results are to be provided to the District in a format consistent with the requirements of Specifications 01 45 04 CONTRACTOR QUALITY MANAGEMENT SYSTEM and 01 45 08 GEOGRAPHIC INFORMATION SYSTEM DATA REQUIREMENTS - QUALITY CONTROL AND QUALITY ASSURANCE DATA.

e. Acceptance of test results provided by QC and QA forces shall be in accordance with the requirements described in the FDOT Standard Specifications for Road and Bridge Construction, Section 120-10 Acceptance Program. Material descriptions shall be in accordance with ASTM nomenclature in lieu of AASHTO. Discrepancies between QC and QA provided test results (including density test results) shall be reconciled in accordance with the criteria set forth in the FDOT specification. Densities greater than 105% of applicable Proctor shall also be vetted using the criteria established in the FDOT specification.

### 3.10.1 Fill Material Qualifications

During fill placement, Contractor shall provide one set of qualifying tests per 20,000 cubic yards of Embankment Fill, and 10,000 cubic yards of Select Fill material. For Embankment Fill, the qualifying tests shall be submitted at the time of fill placement using materials sampled from the placement areas. For the Select Fill, the qualifying test results shall be submitted prior to hauling these materials from the stockpile to the fill placement areas.

For Embankment Fill and Select Fill, each set of tests shall include the following:

Classification of material in accordance with the Unified Soil Classification System (ASTM D2487)

Gradation of material in accordance with ASTM C136/C136M

Organic content of the material in accordance with ASTM D2974

Atterberg Limits of the material in accordance with ASTM D4318 (Select Fill only; not required for Embankment Fill)

Moisture Content of the material in accordance with ASTM D2216

Proctor of the material in accordance with ASTM D1557 or ASTM D698

Note: See Section 3.10.4 for additional requirements for Select Fill.

For the Clean Sand and Filter Sand, provide one set of qualifying tests per 10,000 cubic yards of material. These tests shall include:

Gradation of material in accordance with ASTM C136/C136M

Maximum Density in accordance with ASTM D4253

Organic Content in accordance with ASTM D2974 (for Clean Sand only; not required for Filter Sand)

3.10.2 In-Place Densities

| Material Type | Location of Material | Test Frequency |
|---|---|---|
| Embankment Fill | Dams and Adjacent to Structures | 1 test per 1,000 cubic yards |
| Select Fill | Dams and Adjacent to Structures | 1 test per 500 cubic yards |
| Clean Sand | Beneath Dam Slope Protection and Blanket Drain | 1 test per 2,000 cubic yards |
| Filter Sands | Embankment Drains, Beneath Dam Slope Protection and Pressure Relief System (Blanket Drain only) | 1 test per 2,000 cubic yards |
| Note: Each In-Place Density test shall be accompanied by the laboratory test for Amount of Material in Soils Finer than the No. 200 Sieve (ASTM D1140). | | |

3.10.3 Moisture Contents

In Select Fill stockpiles, perform a minimum of two tests per day that material is being placed during stable weather conditions. During wet weather periods, perform tests as needed to verify uniform moisture content conditions, and that moisture contents are within 2 percent of the optimum for compaction for the specific materials.

3.10.4 Permeability Testing

Materials to be utilized for Select Fill shall be tested for the parameters and at the frequencies shown in Section 3.10.1 of this specification. Further, representative samples for these uses shall be tested for permeability in accordance with ASTM D5084, at a frequency of one test per 10,000 cubic yards.

3.11 DISPOSITION OF SURPLUS MATERIAL

Place surplus materials in areas as shown on the Drawings. Surplus materials shall be graded to elevations that are no higher than the elevations of the original ground surface at the subject location.

3.12 EROSION CONTROL

The Contractor shall be responsible for maintaining temporary and permanent slopes and controlling erosion of these slopes on a continuous basis for the duration of the contract. This will be especially important during the Waiting Periods required when the dam reaches elevation +47 and +54 feet. The Contractor shall submit an Erosion Control Plan for these slopes which describes and details the approach to managing soil slope erosion.

Methods that may be considered for erosion control include, but are not limited to, grassing, use of runoff barriers, and over-build and cut. No erosional rill or gully may exceed 18 inches deep without regrading of the slope in the area of the erosion. All slopes that are to be seeded shall be finish graded immediately prior to placement of topsoil, seed mix, and

mulch. All slopes to receive HPTRM are to be finish graded (including repair of erosional rills and gullies) immediately prior to placement of the HPTRM. All slopes that are to receive soil cement slope protection shall be graded and compacted prior to placement of the Clean Sand and/or Filter Sand layers, which are also to be compacted immediately prior to placement of the soil cement. Densification of these soils is to follow the requirements of this specification.

The Contractor shall protect the Chimney Drain, Blanket Drain and Toe Drain from erosion and the potential for contamination of these features with other soil types and materials. The Contractor shall also protect the Soil Bentonite Wall from erosion.

CONTROL OF EROSION AND MITIGATION OF IMPACTS TO CONSTRUCTION RESULTING FROM EROSION IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR, AND SHALL NOT FORM THE BASIS OF A CHANGE IN CONTRACT PRICE OR TIME. THE EROSION AND SEDIMENT CONTROL REQUIREMENTS STATED IN THE DRAWINGS AND SPECIFICATIONS REPRESENT THE MINIMUM ANTICIPATED EFFORT REQUIRED AND SHALL BE SUPPLEMENTED AS REQUIRED.

## 3.13 BACKFILLING ADJACENT TO CONDUITS

The Contractor shall monitor and control elevations of backfills on opposite sides of conduits such that no side shall be more than three feet higher that the opposite side, or the differential shall be not more than half the conduit height, whichever is less.

## 3.14 MONITORING GROUNDWATER LEVELS

The Contractor shall monitor groundwater levels along the south boundary using monitoring wells that are to be installed at the locations shown on the Drawings. Frequency and reporting protocols are also provided on the Drawings. The Contractor shall dewater project works in such manner that groundwater levels in the monitoring wells do not drop below elevation 23.5 feet. If necessary, the South Perimeter Canal may need to be excavated in the wet, and surface water may need to be introduced to the excavation to reduce the potential for influencing groundwater levels at this boundary condition.

## 3.15 AS-BUILT SURVEY

The Contractor shall be responsible for providing signed and sealed As-Built Surveys to include, but not be limited to, the following for the earth dams and canals of the project:

1) Canal Cross Sections at a maximum of 200 feet on center

2) Structure top of slab elevations

3) Conduit Inverts

4) Bridge Structures

5) Earth Dam Cross Sections at a maximum of 200 feet on center

6) Locations and elevations of instrumentation

7) Other features as required in the Drawings and Specifications.

-- End of Section --

SECTION 31 00 00

EARTHWORK - EARTH DAM

ATTACHMENT A

UNSUITABLE MATERIALS REMOVED FROM FILL DURING
CONSTRUCTION OF BID PACKAGE PRELOAD AT STRUCTURE S-471

# SECTION 31 05 19

# GEOTEXTILE

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish materials, equipment and labor to install the geotextile (also referred to as filter fabric) as part of the soil cement slope protection, rip rap and miscellaneous drainage applications. Geotextile requirements for other components can be found in the specifications for those components.

### 1.2 RELATED REQUIREMENTS

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D4354 | (2012) Sampling of Geosynthetics for Testing |
| ASTM D4355/D4355M | (2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus |
| ASTM D4491/D4491M | (2015) Standard Test Methods for Water Permeability of Geotextiles by Permittivity |
| ASTM D4533/D4533M | (2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles |
| ASTM D4632/D4632M | (2015a) Grab Breaking Load and Elongation of Geotextiles |
| ASTM D4751 | (2016) Standard Test Method for Determining Apparent Opening Size of a Geotextile |
| ASTM D4759 | (2011) Determining the Specification Conformance of Geosynthetics |
| ASTM D4873/D4873M | (2016) Identification, Storage, and Handling of Geosynthetic Rolls and Samples |
| ASTM D6241 | (2014) Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe |

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Geotextile Layout Plan

Installation Plan

SD-03 Product Data

Thread

Manufacturer's Quality Control Manual

SD-04 Samples

Samples

SD-06 Test Reports

Manufacturer's Quality Control Tests

Quality Control Test Results

SD-07 Certificates

Manufacturer's Certificate of Compliance

Geotextile

### 1.4.1 Geotextile Layout Plan

The Contractor shall submit a geotextile layout plan with the proposed size, number, position and sequencing of geotextile rolls and direction of all field seams prior to delivery of the product to the site. Submit the layout plan not less than 60 calendar days prior to installing the geotextile.

#### 1.4.1.1 Installation Plan

The Contractor shall submit the proposed installation plan, which may include the Manufacturer's recommended installation procedure.

## 1.5 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle geotextile in accordance with ASTM D4873/D4873M.

### 1.6.1 Delivery

Notify the District a minimum of 24 hours prior to delivery and unloading of geotextile rolls packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, immediately rewrap rolls with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Label each roll with the Manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

### 1.6.2 Storage

Protect rolls of geotextile from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, either elevate rolls off the ground or place them on a sacrificial sheet of plastic in an area where water will not accumulate. Refer to manufacturer's requirements for protecting the geotextile fabric.

### 1.6.3 Handling

Handle and unload geotextile rolls with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

## PART 2 PRODUCTS

## 2.1 RAW MATERIALS

A minimum of 7 days prior to scheduled use, submit Manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. For needle punched geotextiles, the Manufacturer shall also certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile Manufacturer.

### 2.1.1 Geotextile

The geotextile shall meet the material properties specified in either Table 1 or Table 2, depending on the application. Geotextile used as a filter below the bedding stone below the riprap shall be a non-woven fabric. The minimum values in the tables represent minimum average roll values (MARV) in the weakest principal direction. Values for Apparent Opening Size (AOS) represent the required average roll values.

| TABLE 1<br>PHYSICAL REQUIREMENTS FOR GEOTEXTILE FOR ALL APPLICATIONS EXCEPT PLACEMENT BETWEEN THE TOP OF THE SAND RELIEF COLUMNS (WITHIN THE INTAKE CANAL) AND THE BEDDING STONE | | | |
|---|---|---|---|
| **PROPERTY** | **UNITS** | **ACCEPTABLE VALUES** | **TEST METHOD** |
| MINIMUM GRAB STRENGTH | LBS | 320 | ASTM D4632/D4632M |
| MINIMUM SEWN STRENGTH | LBS/INCH | 200 | ASTM D4632/D4632M |
| MINIMUM STATIC PUNCTURE STRENGTH | LBS | 800 | ASTM D6241 |
| MINIMUM TRAPEZOID TEAR | LBS | 125 | ASTM D4533/D4533M |
| APPARENT OPENING SIZE | U.S. SIEVE | 100 | ASTM D4751 |
| PERMITTIVITY | SEC -1 | 0.7 | ASTM D4491/D4491M |
| ULTRAVIOLET RESISTANCE | PERCENT | 50 AT 500 HRS | ASTM D4355/D4355M |

| TABLE 2<br>PHYSICAL REQUIREMENTS FOR GEOTEXTILE FOR PLACEMENT BETWEEN THE TOP OF THE SAND RELIEF COLUMNS (WITHIN THE INTAKE CANAL) AND THE BEDDING STONE | | | |
|---|---|---|---|
| **PROPERTY** | **UNITS** | **ACCEPTABLE VALUES** | **TEST METHOD** |
| MINIMUM GRAB STRENGTH | LBS | 90 | ASTM D4632/D4632M |
| MINIMUM POROSITY | PERCENT | 30 | N/A |
| MINIMUM STATIC PUNCTURE STRENGTH | LBS | 260 | ASTM D6241 |
| MINIMUM TRAPEZOID TEAR | LBS | 40 | ASTM D4533/D4533M |
| APPARENT OPENING SIZE | U.S. SIEVE | 50 | ASTM D4751 |
| PERMITTIVITY | SEC -1 | 2.0 | ASTM D4491/D4491M |
| ULTRAVIOLET RESISTANCE | PERCENT | 50 AT 500 HRS | ASTM D4355/D4355M |

2.1.2 Thread

A minimum of 7 days prior to scheduled use, submit proposed thread type for sewn seams along with data sheets showing the physical properties of the thread. Construct sewn seams with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the geotextile.

2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. A minimum of 7 days prior to scheduled use, submit Manufacturer's quality control manual. Documentation describing the quality control program shall be made available upon request. Perform manufacturing quality control sampling and testing in accordance with the Manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D4759. Contractor shall provide results from the manufacturer's quality control tests. Tests

not meeting the specified requirements will result in the rejection of applicable rolls.

# PART 3 EXECUTION

## 3.1 FIELD QUALITY CONTROL AND SAMPLING

### 3.1.1 Quality Control Sampling

The Contractor shall collect samples upon delivery to the site. The frequency of sampling shall be one per 50,000 square feet. At a minimum the Contractor shall test 1 roll per lot or 1 roll per 11 rolls whichever is less. The intent is to test, at a minimum, 1 roll per 11 consecutive rolls. Identify samples with a waterproof marker by manufacturer's name, product identification, lot number, roll number and machine direction. The date and a unique sample number shall also be noted on the sample. Discard the outer layer of the geotextile roll prior to sampling a roll. Samples then shall be collected by cutting the full width of the geotextile sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

### 3.1.2 Quality Control Testing

The Contractor shall provide quality control samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements specified in Table 1 or Table 2, depending on application. Quality Control test results shall be supplied to the District. Rolls not meeting the test requirements will result in the rejection of applicable rolls.

A. Should a roll fail the testing the Contractor shall use the following methodology (using a fictitious roll numbering system) to identify subsequent rolls that do not meet the specified requirements:

a. Assume the failed test role is roll number 25.

b. Then test roll numbers 23 and 27.

c. Should rolls 23 and 27 pass then discard roll numbers 24, 25 and 26.

d. Should roll number 23 fail then test roll number 21.

e. Should roll number 27 fail then test roll number 29.

f. Should rolls 21 and 29 pass then discard roll numbers 22, 23, 24, 25, 26, 27 and 28.

g. Continue testing every other roll following the pattern established above until the rolls pass. Discard all rolls whose roll number falls within the passing roll numbers.

## 3.2 INSTALLATION

### 3.2.1 Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. The Contractor will provide

a geotextile layout plan detailing proposed size, number, position, and sequence of geotextile rolls and direction of all field seams subject to District approval before commencement of Geotextile installation. Subgrade materials and compaction requirements shall be in accordance with Section 31 00 00.

3.2.2 Placement

Notify the District a minimum of 48 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, lay the geotextile with the machine direction of the fabric parallel to the slope direction.

a. Install geotextiles in accordance with the approved Installation Plan and in accordance with the Drawings.

b. Place the fabric so that the upstream strip of fabric overlaps the downstream strip.

c. When placed on slopes the fabric shall be placed on the entire slope, continuous from top to bottom, without any joints or splices.

d. Damaged geotextiles shall be repaired per the Manufacturer's requirements at no additional cost to the District.

e. For underwater placement of the geotextile follow Manufacturer's recommendations.

3.3 SEAMS

Sew all geotextile joints. Factory and field seams shall be continuously sewn on all slopes steeper than 1 vertical on 4 horizontal. The stitch type used shall be a 401 locking chain stitch or as recommended by the Manufacturer. For field and factory seams which are sewn, provide at least a 2-meter sample of sewn seam before the geotextile is installed. For seams that are field sewn, the seams shall be sewn using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, provide samples of seams from both directions. Provide Quality Assurance seam samples to the District at the request of the District. Seam strength shall meet the minimum requirements specified in either Table 1 or Table 2, depending on application. The thread at the end of each seam run shall be tied off to prevent unraveling. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a minimum of 18 inches of overlap.

Horizontal joints on slopes are not acceptable.

3.4 PROTECTION

As a minimum the following protection must be provided:

a. Protect the geotextile during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as

directed. Use adequate ballast (e.g. sand bags) to prevent uplift by wind.

b. Geotextile shall not be exposed to daylight more than 7 calendar days.

c. Any rolls or partial rolls that may be installed must be protected from sunlight, erosion, weather and anything else that may harm the integrity of the geotextile.

d. Protect the geotextile from erosion being allowed beneath the installed geotextile.

## 3.5 REPAIRS

Repair torn or damaged geotextile. Clogged areas of geotextile shall be removed. Perform repairs by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 12 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Remove and replace geotextile rolls which cannot be repaired. Repairs shall be performed at no additional cost to the District.

## 3.6 PENETRATIONS

Construct engineered penetrations of the geotextile by methods recommended by the geotextile Manufacturer.

## 3.7 COVERING

Do not cover geotextile prior to inspection and approval by the District. Place ballast or soil cement in a manner that prevents material from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, ballast or soil cement shall be placed from the bottom of the slope upward. Cover soil shall not be dropped onto the geotextile from a height greater than 3 feet. No equipment shall be operated directly on top of the geotextile without approval of the District. Use equipment with ground pressures less than 7 psi to place the ballast on the geotextile. Equipment placing ballast shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding5 mph.

-- End of Section --

# SECTION 31 09 00

# GEOTECHNICAL INSTRUMENTATION AND MONITORING OF EARTHWORK

## PART 1 GENERAL

### 1.1 SCOPE

This section covers furnishing and installing piezometers, settlement plates and survey monuments installed at the locations indicated on the Drawings.

Related Sections include but are not necessarily limited to:

1. DIVISION 1 General Requirements
2. Section 01 33 00 SUBMITTALS
3. Section 02 33 00 STANDARD PENETRATION TEST
4. Section 31 23 13 SUBGRADE PREPARATION
5. Section 31 25 13 SLOPE PROTECTION WITH SLOPE PAVING
6. Section 33 11 53 MONITORING WELLS
7. Section 35 41 21 PRESSURE RELIEF SYSTEM
8. Section 27 05 13.00 40 TWO WAY RADIO DATA TRANSMISSION SYSTEMS
9. Section 40 95 00 PROCESS CONTROL

Existing geotechnical information can be found in the Geotechnical Site Characterization Report, which is part of the bid documents.

Geotechnical Instrumentation and Monitoring of Earthwork shall consist of Temporary Geotechnical Instrumentation and Permanent Geotechnical Instrumentation as described in Section 1.3 DEFINITIONS. Piezometers shall be equipped with vibrating wire data loggers.

### 1.2 APPLICABLE PUBLICATIONS

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C150 | (2017) Standard Specification for Portland Cement |
| ASTM D1557 | (2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D1586 | Test Method for Penetration Test and Split-Barrel Sampling of Soils |

| | |
|---|---|
| ASTM F480 | (2014) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80 |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 1110-1-1904 | (1990) Settlement Analysis |
| ER 1110-1-1807 | (2014) Drilling in Earth Embankment Dams and Levees |

## 1.3 DEFINITIONS

### 1.3.1 Temporary Geotechnical Instrumentation

This shall consist of piezometers and settlement plates that are installed prior to embankment construction, and are utilized to monitor the magnitude of and time rate of consolidation of the foundation soils.

### 1.3.2 Permanent Geotechnical Instrumentation

This shall consist of piezometers and survey monuments that are constructed after completion of the embankments and are used to monitor the long term performance of the dam and ancillary facilities.

### 1.3.3 Clay Layer

Clay foundation soil found at somewhat variable depths and thicknesses around the reservoir site. The Clay Layer is considered to be part of the foundation soils for the dams and structures of the project.

### 1.3.4 Monitoring Station

A cross section whose location is shown on the Drawings, and includes geotechnical instrumentation for both temporary and permanent monitoring.

### 1.3.5 Embankment Settlement

The magnitude of compression of the foundation soils measured using the Temporary Geotechnical Instrumentation. The estimated magnitude of the embankment settlement is shown on the Drawings.

### 1.3.6 Waiting Periods

A duration of time required at specific elevations when no additional fill shall be placed within the limits of the dam that are governed by the waiting periods. There are two Waiting Periods, one at Elevation +47 feet and one at Elevation +54 feet. The limits of each section and the corresponding waiting periods are shown on the Drawings.

### 1.3.7 Ninety (90) Percent Consolidation

This shall be determined by the Contractor's Geotechnical Engineer as the following:

Milestone at which the excess pore water pressures measured in the clay in each of the three Temporary Piezometers at a given Monitoring Station has dropped to 10 percent or less of the theoretical pore water pressure increase resulting from instantaneous placement of the embankment load.

This milestone shall be checked using procedures described in the USACE EM 1110-1-1904 SETTLEMENT ANALYSIS.

1.3.8 Belt Piezometers

These are piezometers associated with structures that pass through the dam and are to be positioned at locations shown on the Drawings.

1.3.9 Strain Gauges

Strain gauges are to be installed by the District ~~forces~~ at Structures S-471 and S-473. Contractor shall provide conduits for routing conduits associated with the strain gauges as shown on the Drawings. Contractor shall coordinate with District for work associated with installation of the gauges.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Temporary Piezometer Installation and Monitoring Plan

Settlement Plate Installation and Monitoring Plan

Permanent Piezometer Installation Plan

Survey Monument Installation Plan

SD-03 Product Data

Settlement Plates

Filter Sand Quality Data

Boring Logs

Piezometer Type

SD-06 Test Reports

Piezometer Completion Report

SD-11 Closeout Submittals

As-Built Surveys

## 1.5 QUALIFICATIONS

The Contractor shall utilize the services of a certified water well driller licensed by the State of Florida for the construction of the piezometers. The Contractor shall provide the piezometer installation work under the direct supervision of a geotechnical engineer registered in the State of Florida (i.e. licensed Florida P.E.). The Contractor shall utilize the services of a Professional Survey Mapper (PSM) for the survey of piezometer, settlement plate and survey monument locations and elevations.

## 1.6 RESPONSIBILITIES

The Contractor shall submit work plans and other shop drawings as follows:

### 1.6.1 Temporary Piezometer Installation and Monitoring Plan

This is to include a narrative description of the methodologies to be utilized for the following work items:

Drilling methods

Selection of the temporary piezometer tip elevations

Installation methods to be used for the temporary piezometer

Reporting protocols for piezometer data

Determination of Waiting Period Duration

### 1.6.2 Settlement Plate Installation and Monitoring Plan

This is to include a narrative description of the methodologies to be utilized for the following work items:

Survey techniques to be utilized for determination of settlement data

Reporting protocols for settlement data

Determination of Waiting Period Duration

### 1.6.3 Permanent Piezometer Installation Plan

This is to include a narrative description of the methodologies to be utilized for installation of permanent piezometers,including drilling methods.

### 1.6.4 Survey Monument Installation Plan

This is to include a narrative description of the methodologies to be utilized for the installation of Survey Monuments.

### 1.6.5 Boring Logs

At the locations shown on the Drawings for Temporary Geotechnical Monitoring, submit results of SPT Borings drilled to 75 feet deep. SPT samples shall be obtained at vertical intervals not exceeding 2.5 feet and in accordance with Specification Section 02 33 00 STANDARD PENETRATION TEST.

The submittal shall include the method of drilling (i.e. hollow stem auger, mud rotary, Sonic, etc.) and note specific zones of drilling fluid loss and magnitude of loss within that zone. Submittal shall include surveyed locations (to nearest 1 foot) and elevations (to nearest 0.1 feet) of the boring locations, and boring logs in gINT format. Surveyed locations and elevations shall be submitted to the District. The submittal shall include final tip elevations for the temporary piezometers determined by the Contractor's Geotechnical Engineer. The three piezometer tip elevations at each cluster are to be within the upper, middle and lower portions of the Clay Layer.

1.6.6 Settlement Plates

At the locations shown on the Drawings, submit the locations (to nearest 1 foot) and elevations (to nearest 0.1 foot) of the settlement plate locations. Surveyed locations and elevation shall be submitted to the District.

1.6.7 Prepared Foundation Grade Status Report

This submittal, prepared as part of Section 31 23 13 SUBGRADE PREPARATION, should be coordinated with the work described in this specification for Temporary Geotechnical Instrumentation.

1.6.8 Piezometer Completion Report

A summary of each piezometer installation with details related to installation methods, depths of materials and quantities of materials used.

The Contractor shall provide necessary manpower and equipment to install the following work items.

1.6.8.1 Temporary Piezometers

A. Each piezometer (PZ) installation shall consist of a vibrating wire piezometer, cable, grout, cable leads and data logger as shown on the Drawings. Each piezometer cluster shall consist of three individual piezometers. The positions of the piezometers within each cluster are shown on the Drawings.

B. Piezometer installation shall conform to all applicable regulations, and follow the requirements described in this specification as well as Section 33 11 53 Monitoring Wells. The Contractor shall submit an installation plan to the District for all piezometers prior to installation.

C. The Contractor shall drill one Standard Penetration Test boring to 75 feet deep at each Temporary Monitoring Station shown on the Drawings. SPT samples shall be obtained at vertical intervals not exceeding 2.5 feet and in accordance with Specification Section 02 33 00 STANDARD PENETRATION TEST. The Contractor shall use the information from the borings to finalize/confirm the temporary piezometer tip elevations shown on the Drawings. The piezometers designated as A, B, and C are to have tip elevations within the upper one third, middle third, and bottom third of the clay layer, respectively.

D. The Contractor shall be responsible for installation of the vibrating wire piezometers, cables and data loggers, and calibration of piezometers

and data loggers. Contractor shall also be responsible for collection of an initial data set for each piezometer, daily, for a period not less than two weeks for each monitoring station prior to initiation of embankment filling at that location. Contractor shall provide calibrations and two-week history of data to the District and meet with District personnel at the project site to share information technology.

E. Vibrating Wire Piezometers not considered to be fully functional shall be replaced by the Contractor prior to initiation of embankment fill placement.

1.6.8.2 Settlement Plates

The Contractor shall furnish, install and protect settlement plates and riser pipes as shown on the Drawings, and shall provide for monitoring of the settlement plates in accordance with this specification.

1.6.8.3 Permanent Piezometers

A. Each piezometer (PZ) installation shall consist of a vibrating wire piezometer, cable, grout, cable leads and data logger as shown on the Drawings. Each piezometer cluster shall consist of three individual piezometers. The positions of the piezometers within each cluster are shown on the Drawings. Contractor shall verify that the permanent piezometer locations do not conflict with the seepage collection piping. If any such conflicts occur, permanent piezometer locations shall be adjusted to avoid the seepage collection piping.

B. Piezometer installation shall conform to all applicable regulations. The Contractor shall submit an installation plan to the District for all piezometers prior to installation.

C. The Contractor shall obtain all necessary well construction permits from the District (SFWMD Consumptive Use Permitting Authority).

D. The Contractor shall be responsible for installation of the vibrating wire piezometers, cables and data loggers, and calibration of piezometers and data loggers. Contractor shall also be responsible for collection of an initial data set for each piezometer, daily, for a period not less than two weeks for each monitoring station. Contractor shall provide calibrations and two-week history of data to the District, and meet with District personnel at the project site to share information technology.

E. Vibrating Wire Piezometers not considered to be fully functional shall be replaced by the Contractor prior to initiation of embankment fill placement.

1.6.8.4 Permanent Survey Monuments

The Contractor shall furnish, install, and protect survey monuments as shown on the Drawings.

1.7 CERTIFICATIONS

The Contractor shall provide certified copies of all applicable instrumentation calibration data to the District for approval prior to installation of the equipment.

## 1.8 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide 72 hours notice in advance of its intention to begin new Work activities.

## 1.9 WARRANTY

Vibrating Wire Piezometers, cables, and Data Loggers shall be warrantied for a period of not less than 1 year from the date of purchase.

# PART 2 PRODUCTS

## 2.1 PIEZOMETERS

A. All materials for the piezometer shall be new and shall conform to the following requirements.

B. PVC Piezometer Pipe

ASTM F480 Schedule 40, flush threaded joints

C. PVC Piezometer Screen

ASTM F480 Schedule 40, flush threaded joints. Slot width of 0.010 inch

D. Filter Pack: Washed silica sand (#20/40). Contractor shall submit Filter Sand Quality Data test results providing verification that the materials to be used as filter pack meet the requirements of this specification.

E. Bentonite pellets: 1/4 inch diameter

F. Cement Grout: A neat slurry of cement (ASTM C150, Type I, I/II, or II) and water (clean and free of deleterious substances), 5 to 6 gallons of water per bag of cement, and containing 2 percent bentonite.

G. Piezometer Protective Casing: See General Contract Information Plans, Volume I

H. Pressure Transducers, Data Loggers, & Cables:

1. Temporary: Vibrating wire type, GEOKON Model 4500DP, or equivalent.

2. Permanent: Vibrating wire type, GEOKON Model 4500, or equivalent.

3. For both Temporary and Permanent, Contractor shall submit product data sheets for Piezometer Type, demonstrating verification that the piezometer type to be used meets the requirements of this specification.

I. Cable as needed to extend from data logger to ground surface and to Remote Terminal Unit (RTU) as shown on the Drawings.

J. Concrete bollards (as shown on Drawings)

K. All PVC flush threaded monitoring pipe shall be supplied in standard lengths.

L. To prevent ultraviolet degradation of the PVC and to reduce contamination, all pipe and screen shall be stored indoors by the manufacturer. Screen and casing shall be wrapped after cleaning and prior to shipment.

M. The finished pipe and screen must be received in visibly clean condition, free of oil, grease, dirt, and markings other than those specified.

## 2.2 SETTLEMENT PLATES

All PVC flush threaded monitoring pipe shall be supplied in standard lengths.

The products and materials required are indicated on the Drawings. The Contractor shall submit to the District any changes in design for review and approval prior to installation of the settlement plates. All iron riser pipes and fittings shall be fabricated from standard weight stock, and all PVC pipe and fittings from Schedule 40 stock. Materials shall be accepted on the basis of a visual inspection. All PVC flush threaded monitoring pipe shall be supplied in standard lengths.

## 2.3 SURVEY MONUMENTS

The products and materials required are indicated on the Drawings. The Contractor shall submit to the District any changes in design for review and approval prior to installation of the survey monuments.

# PART 3 EXECUTION

## 3.1 PIEZOMETER INSTALLATION

### 3.1.1 DRILLING METHODS

Piezometers are to be installed using Hollow Stem Auger, Sonic and/or rotary wash with casing methodologies. Contractor is cautioned in the use of rotary wash methods using the information described in paragraph TEMPORARY PIEZOMETERS of this specification. Contractor shall submit a Piezometer Installation Plan prior to initiation of the Work.

### 3.1.2 SAND FILTER PACK INSTALLATION

The filter pack shall be introduced uniformly and continuously around the piezometer screen and pipe by gravity through a tremie pipe. The pipe shall terminate 3 feet above the bottom of the hole or above the level of the filter pack already placed in the hole. It shall be lifted gradually and sections removed as the level of the filter pack is installed. The Contractor shall record and report to the District the borehole diameter and the quantity of filter pack used in each piezometer installation. A bentonite seal shall be placed above the sand filter pack as indicated on the Drawings. The bentonite seal shall be sufficiently hydrated with potable water and allowed to set approximately 30 minutes prior to installation of the grout seal.

### 3.1.3 GROUTING PROCEDURE

The annular space between the borehole and PVC casing above the screen shall be grouted to the surface. The grout shall be placed in one continuous operation. A grout pipe shall be extended to the bottom of the annular space initially and must remain submerged in grout for the entire time grout is being placed. The grout shall be placed by tremie and/or low pressure pumping methods in a manner that does not disturb the bentonite seal. The grout pipe shall be removed at the completion of the grouting.

### 3.1.4 PIEZOMETER DEVELOPMENT

After installation and initial grout set, piezometer shall be pumped to remove sediments for at least 60 minutes and until the development water achieves a constant pH, temperature, conductivity, turbidity and color with increased pumping time. This section does not apply to Temporary Piezometers.

### 3.1.5 PIEZOMETER COMPLETION REPORTS

After installation of each and every piezometer, both temporary and final, a report shall be submitted that describes the following information at a minimum:

Method of drilling

Indications of drilling fluid loss, depths experienced, and amount of loss

Tip elevations

Pipe diameter and type (for permanent piezometers)

Depth of screened interval (for permanent piezometers)

Depth of and quantity of sand pack (for permanent piezometers)

Material gradation for sand pack (for permanent piezometers)

Depth of grout interval and amount of grout used

Any unusual circumstances related to the piezometer installation

The Piezometer Completion Reports are to be submitted by the Contractor's geotechnical engineer as a signed and sealed document.

## 3.2 TEMPORARY PIEZOMETERS

A. The following section refers to the Drawings for Temporary Geotechnical Instrumentation.

B. Each piezometer shall be installed in accordance with the details indicated on the Drawings. Each piezometer shall be installed using hollow stem auger, Sonic and/or rotary wash drilling with temporary casing as needed to maintain an open hole. If mud rotary methods are used, the drilling mud shall consist of Revert to limit the potential for development of filter cake on the sides of the borehole. Contractor shall take all

necessary precautions (such as evaluate and monitor drilling fluid pressures) to avoid hydraulic fracture of the dam foundation soils during piezometer installation. If rotary wash drilling methods are used, the Contractor shall describe drilling methodologies in the Temporary Piezometer Installation and Monitoring Plan, in accordance with the requirements of ER 1110-1-1807.

C. In accordance with the piezometer schedules shown on the Drawings, piezometer installation will include the construction of clusters with various depths and elevations. Tip elevations provided on the Drawings are based upon site geology. These elevations shall be confirmed in the field by the Contractor using soil borings as described below.

D. A soil boring shall be drilled at each Geotechnical Monitoring Station and the lithology logged by a qualified Geotechnical Engineer. Tip elevations for all piezometers shall be selected by the Contractor's geotechnical engineer based on the lithology determined at the boring locations. Piezometer tip elevations will be approved by the District prior to installation by the Contractor. Temporary casing shall be installed as the drilling progresses if required to prevent sloughing or caving of the natural formation. Temporary casing, if any, shall be removed and shall remain the Contractor's property. All soil borings are to be filled with neat cement grout in a bottom to top manner upon completion of each boring.

E. Drilling equipment and temporary casing (if any) shall be thoroughly cleaned prior to use.

F. Piezometers (i.e. Geokon Model 4500DP) are to be pushed or driven into the clay strata using the drilling rods and with the cable leads threaded through the drilling rods. Each piezometer shall be connected to the Data Logger and monitored during the pushing or driving process. If piezometer measured pressures approach or reach the calibrated range (1 MPa or 10 tsf) during the pushing or driving process, Contractor shall stop the process and allow the pressures to dissipate prior to continuing. Once the piezometer is set into the clays, the drilling rods are to be retrieved from the borehole and the boring is to be filled with grout.

G. The piezometers shall be installed from the prepared foundation grade to the designated tip elevation. Cable leads shall extend from the vibrating wire piezometer to the ground surface, then in an earth backfilled trench to the Data Logger for each Monitoring Station. Trench backfill shall consist of the materials excavated from the trench, placed in 8-inch thick loose lifts, and each lift shall be compacted to not less than 95 percent of the maximum dry density determined in accordance with ASTM D1557. Each cable lead shall be clearly identified such that it can be uniquely associated with the corresponding vibrating wire piezometer.

H. Each vibrating wire piezometer shall be calibrated by the Contractor in accordance with the information provided in the Geokon Instruction Manual for Model 4500 Series Vibrating Wire Piezometers.

I. Each Temporary Geotechnical Monitoring station shall be instrumented with a Campbell Scientific CR 6 Data Logger, or equivalent, capable of supporting up to eight individual vibrating wire cable leads. The data loggers shall be installed, grounded, powered, and calibrated in accordance with the instrumentation manufacturer's instructions manual.

J. A Florida registered Professional Survey Mapper (PSM) shall survey actual piezometer locations and the ground surface elevation at the piezometer locations within 7 days following installation of the piezometer. This certified survey information shall be submitted to the District.

K. The ground surface at each piezometer location shall be leveled to +/- 0.1 feet or better. Elevations shall be determined using datum NAVD 1988.

L. The Contractor shall install bollards around each Data Logger as shown on the Drawings. The bollards shall be painted with fluorescent yellow paint and maintained. Contractor is responsible for repairing or replacing any Data Loggers and associated cable leads damaged by it.

M. Piezometer Tip Elevations are shown on the Instrumentation Elevation Schedule shown on the Drawings. These tip elevations are to be modified as appropriate based upon the results of the specific SPT boring drilled for each Monitoring Station.

N. The Contractor shall monitor the pore pressures developed in the piezometers during fill placement and Waiting Periods, and provide the data to the District in Excel file format at a frequency of once per week. The piezometers are to be programed to read at a frequency of hourly.

3.3 SETTLEMENT PLATES

A. The Contractor shall prepare the foundation grades in a coordinated effort with installation of the settlement plates. The Contractor shall make an excavation from the prepared foundation grade slightly larger than the settlement plate, and deep enough to reach undisturbed soil (i.e. 8 to 12 inches deep). The bottom of the excavation shall be level.

B. The Contractor shall place the settlement plate and the initial length of iron riser pipe in the excavation ensuring that the bottom of the plate is in full bearing on the foundation soils, and that the initial length of riser pipe is plumb. With the plate and initial riser pipe in place, wrap the lower 6 inches of riser pipe with oakum and slip one section of casing pipe over the riser pipe, then lower the casing to uniformly encase the oakum seal while seating the casing on the plate. The oakum should not have any type of mesh covering (plastic or other synthetic material). With initial riser pipe and casing centered with respect to each other and maintained in a vertical position, backfill the excavation by hand using the excavated materials for backfill and thoroughly compact by hand to match surrounding grades.

C. As the embankment fill is placed, the Contractor shall add additional riser pipes and casings as needed to maintain top of riser and casing elevations above the level of the fill. Fill placed within 5 feet of the riser pipes and casings shall be compacted using hand held or hand led equipment.

D. The Contractor shall provide for the services of a PSM to determine the locations of the settlement plates with a horizontal accuracy within one foot. The PSM shall also determine the elevation of the settlement plate and the top of the initial riser pipe prior to embankment filling using an accuracy of 0.01 feet. The top of the initial riser pipe prior to filling shall become the base elevation for determination of future settlements.

E. The Contractor shall provide a PSM to determine the elevation of the top of the riser pipe as the fill materials are placed. The frequency of measurements shall be twice weekly during fill placement, or more often with special attention given to those times when additional riser pipe and casing must be added to maintain the top of riser and casing elevations at least two feet above the elevation of the adjacent fill. Prior to the addition of riser pipe, the elevation of the top of the current riser pipe shall be determined. Immediately following the addition of the next section of riser pipe, the new elevation of the top of the riser pipe shall be determined. This procedure shall continue until the fill reaches its final elevation.

F. The Contractor PSM shall record field survey data in a standard format within field books, and shall provide survey data on a weekly basis to the District using an Excel file format. The settlement plate data for each settlement plate shall be summarized by the PSM and provided to the District as a certified document.

G. The measurement of the settlement plate riser pipes shall be made weekly during the Waiting Periods.

H. The duration of the Waiting Periods shall be defined as the time required, once prescribed elevation is obtained, until the clay layer achieves 90 percent consolidation, as determined by the Contractor's geotechnical engineer. This duration will be verified using the pore pressure dissipation results from the Temporary Piezometers and the Settlement Data Plots. The District will review the Contractor's submittal and provide notice of validation that the Waiting Period for a specific section has elapsed, or providing direction for an additional waiting period. Anticipated durations of waiting periods are shown on the Drawings. The Phase II portion of the soil bentonite wall may be constructed during the waiting period associated with elevation +47 feet.

I. The Contractor shall take precautions necessary to keep the settlement plate riser pipes and casings in a vertical position at all times during the life of this Contract. Operate equipment in a manner to ensure that settlement plate assemblies are not damaged or displaced laterally. Clearly mark and flag each assembly as needed. Repair or replace riser pipes and/or casings that deviate from the vertical position, become uncoupled or are broken, at no expense to the District.

## 3.4 PERMANENT PIEZOMETERS

A. The following section refers to the Drawings for Permanent Geotechnical Instrumentation.

B. Each piezometer shall be installed in accordance with the details indicated on the Drawings. Each piezometer shall be installed using hollow stem auger, Sonic and/or rotary wash drilling with temporary casing as needed to maintain an open hole. Contractor shall take all necessary precautions to avoid the potential for hydraulic fracture of the dam and/or foundation materials, as previously described in paragraph TEMPORARY PIEZOMETERS of this specification.

C. In accordance with the piezometer schedules shown on the Drawings, piezometer installation will include the construction of clusters with various depths and elevations.

D. Piezometers (i.e. Geokon Model 4500) are to be set in monitoring wells to the prescribed elevations shown on the Drawings.

E. The piezometers shall be installed from the crest of the dam and/or adjacent to the Toe Road as shown on the Drawings. Cable leads shall extend from the vibrating wire piezometer to the ground surface, then in an earth backfilled trench to the Data Logger for each Permanent Monitoring Station. Trench backfill shall consist of the materials excavated from the trench, placed in 8-inch thick loose lifts, and each lift shall be compacted to not less than 95 percent of the maximum dry density determined in accordance with ASTM D1557. Each cable lead shall be clearly identified such that it can be uniquely associated with the corresponding vibrating wire piezometer.

F. Each vibrating wire piezometer shall be calibrated by the Contractor in accordance with the information provided in the Geokon Instruction Manual for Model 4500 Series Vibrating Wire Piezometers.

G. Each Permanent Geotechnical Monitoring station shall include an RTU Data Logger as shown on the Drawings, capable of supporting up to eight individual vibrating wire cable leads. The data loggers shall be installed, grounded, powered, and calibrated in accordance with the instrumentation manufacturer's instructions manual.

H. A Florida registered PSM shall survey actual piezometer locations and the ground surface elevation at the piezometer locations within 7 days following installation of the piezometer. This certified survey information shall be submitted to the District.

I. The ground surface at each piezometer location shall be leveled to +/- 0.1 feet or better. Elevations shall be determined using datum NAVD 1988.

J. The Contractor is responsible for repairing or replacing any Data Loggers and associated cable leads damaged by it.

K. Piezometer Tip Elevations are shown on the Instrumentation Elevation Schedule shown on the Drawings.

L. The Contractor shall monitor the pore pressures developed in the piezometers for a period of two weeks after installation, and provide the data to the District in Excel file format. The piezometers are to be programed to read at a frequency of twice per day.

M. Piezometers on the crest of the dam shall be finished with below grade hand holes and be covered with Soil Cement Slope Protection. Piezometers at the Toe Road, and Belt Piezometers shall be finished with hand hole covers as shown on the Drawings.

N. A Standard Penetration Test (SPT) boring shall be drilled at each permanent piezometer cross section, in accordance with the procedures described in Specification 02 33 00. Each SPT boring for this purpose shall be located on the Toe Road, within 10 to 15 horizontal feet of the permanent piezometers at each location. Depths of SPT borings will vary, and shall be no less than that required to reach the lowest piezometer tip elevation for each monitoring station as shown on the Drawings. Along the Townsend Canal, the SPT borings shall be located adjacent to alternating piezometer locations, resulting in a spacing between borings of 1,000 feet. Logs of

the SPT borings shall be surveyed and submitted in accordance with the requirements previously described for the temporary piezometers.

## 3.5 SURVEY MONUMENTS

Contractor shall install Survey Monuments in accordance with the details shown and at the locations shown on the Drawings.

## 3.6 STRAIN GAUGES

Contractor shall provide and install conduits for cables associated with strain gauges. Install conduits in accordance with the details shown and at the locations shown on the Drawings. District shall be responsible for providing and installing strain gauges and cables, and for pulling cables through conduits. If cables cannot be pulled through conduits for any reason, Contractor shall take all action needed to allow cables to be pulled at no additional expense to the District. Contractor shall place and compact Embankment and/or Select Fill materials as required around the conduit riser pipes. Backfilling and compaction within 3 horizontal feet of the riser pipes shall be with hand held equipment only. The backfill around the riser pipes shall be placed such that the surface of one side of the fill is not higher than one foot above the surface of the opposite side. The Contractor shall assist the District with extending the riser pipes and associated cables upward as the fill is placed.

## 3.7 AS-BUILT SURVEYS

At the conclusion of the work, Contractor shall submit As-Built Surveys for all Temporary and Permanent Geotechnical Instrumentation. The As-Built Surveys shall be prepared by the Contractor's PSM, and shall include locations and elevations for piezometers, piezometer tips, settlement plates and survey monuments. Accuracy of locations shall be to the nearest one foot. Accuracy for elevations shall be to the nearest tenth of a foot, with the exception of the survey monuments, which shall be to the nearest hundredth of a foot.

-- End of Section --

# SECTION 31 11 00

# CLEARING AND GRUBBING

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of work: The Contractor shall furnish all labor, equipment, and materials for clearing and grubbing the project site.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sequence Plan

Burn Permits

### 1.4 SEQUENCE PLAN

Contractor shall submit a sequence plan that details the sequence of Work and describes the planned method of clearing and land preparation activities. Plan shall include coordination with Florida Power & Light (FPL) and include/make reference to an erosion and sediment control plan and environmental protection plan. Submit plan a minimum of 15 working days in advance of start of clearing and grubbing activities.

The Contractor should be aware that concurrent with this contract there will be ongoing construction activities related to other features of the overall reservoir project including but not limited to the S-470 pump station and internal haul roads.

## PART 2 PRODUCTS

Not Applicable.

# PART 3 EXECUTION

## 3.1 PROTECTION

### 3.1.1 Environmental measures

### 3.1.2 Roads and Other Facilities

The Contractor shall conduct its operations and the removal of cleared materials to ensure minimum interference with existing access roads and other adjacent occupied or used facilities.

Keep roads and walks free of dirt and debris at all times.

The Contractor shall not block or otherwise obstruct access roads or other occupied or used facilities without permission from the District. Where blockage is allowed, the Contractor shall provide safe alternate routes around closed or obstructed traffic ways.

The Contractor may commence clearing or land preparation within portions of the project falling within the limits of temporary construction easements or utility Right-of-Way only with specific permission from the District for each activity and location. All requirements stated above apply within these limits.

For work within FPL easements, the Contractor shall coordinate with FPL that equipment and procedures for the work are approved by FPL.

### 3.1.3 Trees, Shrubs, and Existing Facilities

Provide protection in accordance with Section 01 35 40 ENVIRONMENTAL PROTECTION. Trees that are to remain are those along Congen Road that are beyond the limits of work. Prior to the removal of any trees along Congen Road the Contractor shall flag existing trees that are adjacent to or within 100 feet of and outside the limits of construction along Congen Road. The District shall review the trees that are to remain along Congen Road. The Contractor shall not remove any trees along Congen Road prior to the review and approval of the District.

Protect trees and vegetation to be left standing from damage incidental to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.

### 3.1.4 Utility Lines

Protect existing utility lines that are indicated to remain from damage. Notify the District immediately of damage to or an encounter with an unknown existing utility line. The Contractor is responsible for the repair of damage to existing utility lines that are identified, located, indicated, or otherwise made known to the Contractor. When utility lines which are to be removed are encountered within the area of operations, notify the District in ample time to minimize interruption of the service.

## 3.2 CLEARING

Except where indicated otherwise in the Drawings or Specifications, all site clearing and grubbing shall be done in accordance with FDOT Specification Section 110.2 - Standard Clearing and Grubbing.

Clear, grub and strip topsoil (nominal depth of 8 inches) within limits of excavations, fills, and borrow areas.

Clear only within the project limits of construction.

With the exception of the Townsend Canal, all canals and ditches within areas that are to receive fill shall be dewatered, cleared, grubbed, and stripped of topsoil, vegetative matter and associated root systems, and shall be over-excavated as shown on the Drawings. The Townsend Canal shall be cleared, grubbed, and stripped of topsoil, vegetative matter and associated root systems. The side slopes of the canals and ditches shall be graded to the slope as shown on the Drawings, prior to backfilling in accordance with Section 31 00 00 EARTHWORK.

The flows in the Townsend Canal must not be impeded by construction operations. The Contractor shall prevent trees, vegetation and debris from entering the Townsend Canal. Should trees, vegetation or debris enter the Townsend Canal the Contractor shall immediately remove and dispose of.

Clearing and land preparation shall proceed sufficiently ahead of earthwork activities to minimize disruption and to allow time for determination of the adequacy of the procedure.

Clearing also consists 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. Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work. 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.

Clear and remove to offsite any garbage, construction debris or concrete debris encountered during the clearing and grubbing operation.

### 3.2.1 Tree Removal

Unless indicated otherwise all standing and fallen trees and brush greater than 4 feet in height and stumps shall be removed from areas within the designated construction limits. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. At completion of the work no trees, either standing or felled, are to remain within the reservoir. Trees shall be disposed of as specified in paragraph DISPOSAL OF MATERIALS.

### 3.2.2 Grubbing

Grubbing consists of the removal and disposal of stumps, roots larger and matted roots. Remove material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, to a depth

of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Fill depressions made by grubbing with suitable material and compact to make the surface conform with the original adjacent surface of the ground.

Grub (remove) from within limits of excavations, fills, borrows areas, and canals and ditches to be filled all stumps, roots, root mats, logs, and other organic matter and debris encountered.

## 3.3 SPECIAL CONSIDERATION

See Section 31 23 13 Subgrade Preparation for additional clearing requirements relative to the foundation preparation for the embankment construction.

Remove all irrigation and drainage piping and other man-made and unsuitable materials encountered from within the footprints of the proposed embankments and borrow areas and miscellaneous items as directed by the District. The District shall observe and the Contractor shall record the locations of any existing underground irrigation and drainage piping that is discovered by the Contractor. The location alignment, material type, size, and condition shall be noted on the as-built drawings. Ends of the remaining pipes are to be surveyed and the coordinates shall also be noted on the as-built drawings. See foundation preparation requirements.

Previous soil contamination surveys detected areas within the reservoir limits that were contaminated with copper. These areas are delineated on the drawings. These areas are being mitigated by others. In the event contaminated soils are suspected or detected during the execution of this contract the Contractor shall notify the District immediately. The District will conduct a contamination survey and have any contaminated soils mitigated by others. Do not disturb any suspected or detected contaminated soils without direction from the District.

During the construction contract period the Contractor shall make provisions for deterring birds from nesting within the construction limits. Deterrents may include noise machines, plastic predators, and maintaining the vegetation close to the ground. Contractor shall not harm, harass or endanger any nesting birds. Nesting species shall include a construction buffer to protect the identified species as required. See environmental protection plan requirements.

## 3.4 DISPOSAL OF MATERIALS

The Contractor may burn woody vegetation from the clearing and grubbing operations on the site with the written approval of the District and with permission of the local authorities. The Contractor shall comply with all local ordinances or regulations for burn locations and methods, including methods for preventing uncontrolled spread of the burn. The Contractor shall provide the District with copies of burn permits prior to burning.

Burn locations shall not be located within 200 feet of FPL transmission lines or within 200 feet of FPL distribution lines. Burning will not be allowed within any FPL easements.

Burn locations shall not be located within 200 feet of the limits of any utility right-of-way without the written permission of the controlling agency.

The Contractor is responsible for coordinating with FPL and obtaining any permits or permission as necessary to work within their easements.

The Contractor shall not interfere with the operations of any irrigation facilities including, but not limited to, pump stations, culverts, valves, canals and ditches. This does not apply to the drip irrigation pipe.

Work shall be conducted, in full accordance with the conditions of the permits.

All cleared material and debris except the burned vegetation shall be moved from the project and disposed of at an approved land fill or disposal site. Remove all items that are not fully burned.

Disposal of all materials shall be in accordance with all local, County and State laws and regulations.

-- End of Section --

# SECTION 31 23 13

# SUBGRADE PREPARATION

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work: The Contractor shall furnish all labor, materials, and equipment necessary for complete and proper site preparation and foundation soil preparation within the areas shown on the Drawings and specified herein and observe permit conditions. This specification applies to the foundation soil preparation within the footprint of the dam and adjacent areas, hydraulic structures within the footprint of the dam, hydraulic structures outside of the dam, borrow areas, as shown on the Drawings. Details are provided on the Drawings for treatment of foundation soils, especially as related to reclamation of existing ditches and canals. Those Drawings should be referred to in concert with implementation of the requirements of this specification. The importance of treatment of and reclamation of existing ditches and canals cannot be overstated from a dam safety perspective. The requirements of this specification shall be used in light of the requirements stated in related specifications such as Section 31 00 00 EARTHWORK - EARTH DAM, and Section 31 52 10 DEWATERING AND COFFERDAM.

Related Sections include but are not necessarily limited to:

1. Division 1 GENERAL REQUIREMENTS
2. Section 01 33 00 SUBMITTAL PROCEDURES
3. Section 01 45 08 GEOGRAPHIC INFORMATION SYSTEM DATA REQUIREMENTS - QUALITY CONTROL AND QUALITY ASSURANCE DATA
4. Section 02 41 00 DEMOLITION
5. Section 31 00 00 EARTHWORK - EARTH DAM
6. Section 31 09 00 GEOTECHNICAL INSTRUMENTATION AND MONITORING OF EARTHWORK.
7. Section 31 11 00 CLEARING AND GRUBBING
8. Section 33 03 00 TURBIDITY CONTROL AND MONITORING
9. Section 01 35 40 ENVIRONMENTAL PROTECTION
10. Section 31 52 10 DEWATERING AND COFFERDAM

### 1.2 REFERENCES

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C136/C136M | (2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |

| | |
|---|---|
| ASTM D1140 | (2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing |
| ASTM D1557 | (2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D2974 | (2014) Moisture, Ash, and Organic Matter of Peat and Other Organic Soils |
| ASTM D2487 | (2017) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) |
| ASTM D6938 | (2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (FDEP)

| | |
|---|---|
| FDEP | Standard Regulations and Permit Conditions |

ADDITIONAL REFERENCE MATERIAL

Existing geotechnical information can be found in the Geotechnical Site Characterization Report, which is part of the bid documents.

## 1.3 DEFINITIONS

### 1.3.1 Foundation Soil Preparation

Includes stripping, pre-trenching, backfilling and compaction of pre-trenching, reclamation of existing 10th Row Ditches, reclamation of canals, compaction of subgrades, mapping of prepared foundation grades, and documentation of all of the above.

### 1.3.2 Stripping

Removal of existing topsoil, sand with roots, roots and branches having a diameter larger than ½-inch and other vegetative matter within the limits of the foundation soil preparation.

### 1.3.3 Pre-Trenching

Exploration for and removal of existing buried irrigation and drainage (and all other) conduits within the limits of the foundation soil preparation. Dimensions of the pre-trenches shall be as shown on the Drawings. Pre-trenching excavations shall remain open until such time as the District completes the Foundation Soil Mapping. Backfilling of Pre-Trenches shall not occur until approval for such is provided by the District.

### 1.3.4 10th Row Ditches

Existing irrigation and drainage ditches associated with the former citrus grove operations.

1.3.5 Prepared Foundation Grade

Ground surface resulting from stripping to remove vegetation and root systems, excavation for removal of buried conduits, excavation to subgrade levels upon which dam materials are to be constructed, and excavation (and associated dewatering) to clean existing 10th Row Ditches, canals and other pre-existing excavations in the footprint of the dam and to the lateral extent shown on the Drawings.

1.3.6 Proof of Concept

Demonstration by Contractor that means and methods utilized will accomplish the intended goals of the project, meet the quality objectives of the project, and establish protocols for communication of schedule, inspections, and documentation of the work.

1.3.7 Prepared Foundation Soil Segment

An area of the embankment foundation soil having a length along the baseline of the dam of 500 feet. Width of segment shall extend 50 feet beyond toe of dam on reservoir side, and ~~20 feet~~ beyond the Toe Road as shown on the contract drawings. The Prepared Foundation Soil Segments shall be sequentially prepared in an organized manner.

1.3.8 Foundation Soil Mapping

This effort shall be completed by the District once a Segment is considered by the District to be satisfactorily prepared and is ready for inspection. Contractor shall provide survey targets (including coordinates and elevations) and staked/stringed grid lines for each 500-foot segment.

1.3.9 SIMDAMS

SIMDAMS is a geospatial data base to store and display quality data. It was developed by the Corps of Engineers for use on dam construction projects. A separate specification (01 45 08 GEOGRAPHIC INFORMATION SYSTEM DATA REQUIREMENTS - QUALITY CONTROL AND QUALITY ASSURANCE DATA) has been developed to address the requirements of SIMDAMS data management system. The specification ~~will~~ addresses the work items (e.g. foundation preparation, embankment construction, etc.), what information is to be gathered, and where that information is to be stored.

1.3.10 Unsuitable Soils

These are soils and/or materials that consist of organics, roots, construction demolition debris, tires, metals, plastics, or other similar materials that represent a non-uniform condition for the foundation of the dam and ancillary structures. The Contractor shall anticipate finding areas of the site where removal of unsuitable soils and materials will be required. Sands having an organic content in excess of ~~2~~ 5 percent when tested in accordance with ASTM D2974 shall be considered as unsuitable soils. Organic stained sands were found in borings drilled by the District. Such soils are not considered to be unsuitable.

1.3.11 Non-Excavatable Limestone

This is defined as limestone having a minimum unconfined compressive strength of 125 pounds per square inch.

1.3.12 Pre-Activity Meeting

A Pre-Activity Meeting shall be required prior to beginning the subgrade preparation, and shall be attended by appropriate District, Engineer, Contractor, Subcontractor/Vendor, and QC personnel. The meeting would facilitate discussion of the contract requirements, work plans, coordination, and other expectations.

1.3.13 District Lead Engineer

This person is the District's Engineer having ultimate authority for review and acceptance of prepared foundation grade segments.

1.4 SUBMITTALS

SD-01 Preconstruction Submittals

Prepared Foundation Grade Plan

Proof of Concept Plan

Dewatering Plan

Summary of Proof of Concept

Surveys for Mapping

SD-06 Test Reports

Prepared Foundation Grade Status Report

Foundation Inspection Checklist

1.5 QUALIFICATIONS

Not Used

1.6 RESPONSIBILITIES

The Contractor shall have all erosion and sediment control and environmental protection measures in place and the project signage on site prior to beginning any construction.

The Contractor shall make all excavations for the demolition/removal of piping and appurtenant structures in any material encountered to the depth and grades required, shall backfill such excavations and dispose of excess or unsuitable materials from the excavation, and shall provide, place and compact necessary borrow material to properly backfill excavations, all as indicated on the drawings, specified herein, or as directed by the District.

Excavation, dewatering, sheeting and bracing required shall be carried out so as to prevent any possibility of undermining or disturbing the

foundations of any existing structure or work, and so that all work may be accomplished and inspected in the dry, except as directed by the DISTRICT. Aqueous construction may be performed only with prior approval of the District.

The Contractor shall submit work plans and other submittals as follows:

### 1.6.1 Prepared Foundation Grade Plan

A written narrative with associated graphics as needed to describe the contractors technical approach for accomplishing the work, meeting the safety and quality objectives of the work, and describing the processes for documentation of the work.

### 1.6.2 Proof of Concept Plan

A written narrative with associated graphics as needed to summarize the means and methods utilized by the contractor for each aspect of the work, to achieve the quality objectives of the contract, and to document the work.

### 1.6.3 Prepared Foundation Grade Status Report

A written report to be submitted by the Contractor on a weekly basis, that summarizes the areas where embankment foundation grades were prepared during the previous week, a cumulative log of all areas of the project where the embankment foundation soils have been prepared to date, and a three-week look ahead that forecasts where embankment foundation soil preparation activities are anticipated.

### 1.6.4 Dewatering Plan

The Dewatering Plan shall include a description of the means and methods to be utilized to carry out the dewatering and methods to be utilized to verify the extent of groundwater lowering. The Dewatering Plan shall be prepared by the Contractor's Dewatering Specialist, an individual having not less than 10 years of construction dewatering experience related to dams and levees projects. More detailed and specific information related to the requirements of the Dewatering Plan are provided in Specification Section 31 00 00 EARTHWORK - EARTH DAM and 31 52 10 DEWATERING AND COVVERDAM.

### 1.6.5 Surveys for Mapping

Surveys of each Prepared Foundation Soil Segment shall be submitted to the District at the time of inspection of each segment. The surveys shall be prepared by the Contractor's Professional Survey Mapper, and shall include locations and elevations of the following key elements: corners of segments, targets, 10th Row Ditch bottoms at 100 feet on center, Pre-Trenching bottoms at 100 feet on center, major canal crossings (i.e. Header, Roberts, Banana Branch Canals) and stripped ground surface on 50-foot grid. Each segment shall be dated and sequentially numbered.

### 1.6.6 Summary of Proof of Concept

A written narrative with associated graphics as needed to summarize the means and methods utilized by the Contractor for each aspect of the work, to achieve the quality objectives of the contract, and to document the work.

Acceptance by the District of the Summary of Proof of Concept document shall be considered a necessary precedent prior to beginning the work.

1.6.7 Foundation Inspection Checklist

Contractor shall provide written Foundation Inspection Checklist for each segment of the dam and/or structure footprint. The checklist shall include confirmation of at least the following items: lines and grades, stripping, pre-trenching, removal of buried conduits, dewatering and reclamation of 10th Row Ditches and canals, proof rolling and compaction, removal and replacement of unsuitable foundation soils and densification of and testing of foundation soils to meet specification requirements.

1.6.8 Foundation Mapping

District personnel shall complete inspection of prepared foundation grades for dam and structure footprints. Contractor shall make available to District personnel making these inspections the following equipment with equipment operators to aid in performing excavations for test pits, sampling, inspection and cutting fresh surfaces for inspection and mapping:

a. Excavating equipment - Backhoe with smooth edge bucket and bulldozer.

b. Proof Roller - Vibratory Roller Compactor.

c. Hand tools - Shovels, hand augers, picks.

1.7 CERTIFICATIONS AND TESTINGS

Contractor shall provide services of an independent soils laboratory holding USACE validations in all requisite test methods. The soils laboratory is to be located on the project site.

Contractor shall provide the services of a Professional Survey Mapper for construction staking and preparation of each segment of foundation soils for foundation mapping.

Test Methods: All test methods related to this section are described in Specification 31 00 00 EARTHWORK - EARTH DAM.

1.8 INSPECTION COORDINATION

Contractor shall advise District at least 24 hours in advance that a specific area (minimum 500-foot long segment) is ready for foundation mapping.

1.9 WARRANTY

Not Used

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PROOF OF CONCEPT

The limits of the work completed for Proof of Concept are to become part of the permanent work. It shall be at least 1,500 feet long, and be split into 500-foot long segments along the baseline of the dam. Completion of (by Contractor) and acceptance of (by the District) the Proof of Concept shall be a necessary precedent prior to Notice to Proceed for the balance of the subgrade preparation work.

3.2 EROSION CONTROL

The Contractor shall prevent and control erosion and water pollution per Florida Department of Environmental Protection (FDEP) regulations and permit conditions.

The Contractor shall comply with the conditions described in Section 33 03 00 TURBIDITY CONTROL AND MONITORING.

The Contractor shall prevent and control dust.

3.~~1~~ 3 STRIPPING

The Contractor shall remove topsoil and all sand with roots and other vegetative matter from the subgrade soils to the limits shown on the Drawings. The Contractor shall be prepared to remove topsoil to the depth required to reach sand subgrade that is free of roots larger than ½-inch in diameter and/or finely divided organic matter. The Contractor shall anticipate that stripping depths in some areas will exceed 8 inches. Remnant wetland areas may require additional stripping to remove organic laden soils. Nested or matted root zones and all tree stumps shall be removed entirely from the footprint of the dam and to the lateral extent shown on the drawings. Hand picking and/or screening of materials to remove root materials shall be anticipated. Areas designated for borrow shall be stripped as described herein, and oversized materials shall be removed as needed to render the materials acceptable for use as borrow, consistent with the requirements of Specification 31 00 00. For reference, roots, remnant piping and other unsuitable materials that were removed from the fill during construction of the Bid Package Preload at S-471 are shown in the photograph in Attachment A.

Should unsuitable soils be exposed at stripped and/or subgrade levels, such materials shall be over-excavated and replaced as described in Paragraph REMOVAL OF UNSUITABLE SOILS of this specification. Areas to be used for borrow shall also be stripped as described in this specification.

3.~~2~~ 4 REMOVAL OF BURIED CONDUITS

The Contractor shall perform pre-trenching along the lines shown on the Drawings for exploration of and removal of existing buried irrigation and drainage (and all other) conduits within the limits shown on the Drawings. The Contractor shall document removal of all conduits using survey control with an accuracy of one foot horizontal and 0.1 foot vertical. Pre-trenching and removal of buried conduits shall also be accomplished within all borrow areas.

The bottom of excavations made to remove buried conduits shall be compacted in the manner described in Paragraph PROOF-ROLLING AND COMPACTION of this specification.

~~3.3 EROSION CONTROL~~

~~The Contractor shall prevent and control erosion and water pollution per Florida Department of Environmental Protection (FDEP) regulations and permit conditions.~~

~~The Contractor shall comply with the conditions described in Section 33 03 00 TURBIDITY CONTROL AND MONITORING.~~

~~The Contractor shall prevent and control dust.~~

3.~~4~~ 5 RECLAMATION OF CANALS AND 10TH ROW DITCHES

Before beginning excavation of the existing canals and 10th Row Ditches associated with the former citrus grove, dewatering shall be provided and maintained by the Contractor to allow for excavations and inspection of the excavations in a dry condition. The Contractor shall excavate to remove all vegetation, roots, and soft sediments from the existing canals and 10th Row Ditches. The excavations are to be completed in the manner shown on the Drawings. The Contractor shall ~~notify~~ give the District at least 24 hours advance notification that the excavations are ready for inspection.

The bottom of excavations made to reclaim canals and ditches shall be compacted in the manner described in Paragraph PROOF-ROLLING AND COMPACTION of this specification.

The Contractor shall backfill the inspected and approved excavations with Embankment Fill as described in Specification 31 00 00 EARTHWORK - EARTH DAM. If the Contractor is unable to achieve the requisite density of ditch or canal backfill soils, owing to excess moisture conditions at that level, the Contractor shall increase dewatering efforts to provide for a stable ditch or canal bottom, at no additional expense to the District.

Ditch sideslopes shall be cut to provide an overall average slope of 4 horizontal to 1 vertical (4H:1V), and the sideslopes shall be benched in one-foot vertical intervals to facilitate compaction of the backfill soils on the ditch/canal slopes. Major canal (i.e. Header, Roberts and Banana Branch Canal) crossing sideslopes shall be cut to provide an overall average slope of 6H:1V, and shall be benched as described above.

~~3.5 PROOF OF CONCEPT~~

~~The limits of the work completed for Proof of Concept are to become part of the permanent work. It shall be at least 1,500 feet long, and be split into 500-foot long segments along the baseline of the dam. Completion of (by Contractor) and acceptance of (by the District) the Proof of Concept shall be a necessary precedent prior to Notice to Proceed for the balance of the subgrade preparation work.~~

3.6 PROOF ROLLING AND COMPACTION

Stripped grades or excavated subgrades shall be proof rolled using a self-propelled vibratory roller compactor having a minimum centrifugal force of

50,000 pounds, operating at a maximum rolling speed of 2 miles per hour. Each pass of the roller shall overlap at least 20 percent on the previous pass. Each section of the prepared foundation grade shall receive not less than 4 passes of the roller. The subgrade shall be inspected during proof rolling. Soft or pumping subgrade areas shall be excavated and replaced with Embankment fill.

If stripped grades represent subgrade for the dam, stripped grades shall be compacted to a dry density not less than 95 percent of the maximum dry density achieved in accordance with ASTM D1557, to a depth of at least 12 inches below stripped grades. If additional excavation is needed below stripped grades to reach subgrade levels, compaction of stripped grades shall be waived, and the compactive efforts described above shall be implemented once the subgrade level is achieved. Canal, ditch and pre-trenched excavation bottoms shall be compacted such that the excavation bottom soils achieve a density not less than 95 percent of the maximum dry density determined in accordance with Modified Proctor (ASTM D1557). Frequency of density testing is described in paragraph IN-PLACE DENSITY TESTING of this specification.

## 3.7 PREPARED FOUNDATION SOIL SEGMENT

Only whole segments shall be considered by the District as complete. Each segment shall be field marked by the Contractor with stakes located 50 feet on center. The stakes shall be referenced to the project baseline of stationing.

## 3.8 FOUNDATION SOIL MAPPING

The Contractor shall give the District at least 24 hours advance notification that a segment is ready for inspection, and shall allow 2 additional working days for the District to complete its inspection of the segment under review. The Contractor shall provide appropriate support to District staff during the foundation soil inspection and mapping period. Soils and materials considered to be adequate for the foundation of the dam shall consist of materials having Unified Soil Classification Group Symbols (ASTM D2487) of SP, SP_SM, SM, SP-SC, and SC. Contractor shall provide laboratory testing of soil gradation in accordance with ASTM C136/C136M to confirm classification of foundation soils using a frequency of one test per segment per soil type. Limestone shall also be considered to be adequate foundation material.

Unsuitable foundation soils are described in Paragraph REMOVAL OF UNSUITABLE SOILS of this specification, and treatment of such soils shall be as described in Paragraph REMOVAL OF UNSUITABLE SOILS of this specification. Other criteria considered in the review and acceptance process shall include thoroughness of stripping to remove roots, presence of organic materials, remnant pipe removal, density of stripped grades, cleanliness of and dewatering of 10th Row Ditches and other relic drainage ditches and canals. Each segment of the work shall be reviewed by District staff and accepted by the District Lead Engineer prior to the Contractor proceeding with embankment construction of any kind, including backfilling of pre-trenches, canals and/or 10th Row Ditches. Dewatering efforts related to this work shall continue until such time as the pre-trenches, canals and 10th Row Ditches are accepted and backfilled at no additional cost to the District.

## 3.9 PREPARED FOUNDATION GRADE STATUS REPORT

A written report to be submitted by the Contractor on a weekly basis, that summarizes the areas where embankment foundation grades were prepared during the previous week, using project Station-Offset and agreed upon (by the District) geo-spatial reference system. The report shall include prepared foundation soil elevation data on a 50-foot grid, a description of buried pipe removal, 10th Row Ditch and Canal dewatering and cleaning, and in-place density test results. The report shall also include a cumulative log of all areas of the project where the embankment foundation soils have been prepared to date. Lastly, the report shall provide a three-week look ahead that forecasts where embankment foundation soil preparation activities are anticipated.

## 3.10 TEMPORARY GEOTECHNICAL INSTRUMENTATION

Coordinate installation of Temporary Geotechnical Instrumentation as described in Section 31 09 00 GEOTECHNICAL INSTRUMENTATION AND MONITORING OF EARTHWORK prior to filling embankment.

## 3.11 REMOVAL OF UNSUITABLE SOILS

Unsuitable soils and materials that are identified during foundation preparation and mapping shall be excavated from the footprint of the dam, and to horizontal limits that extend to at least 50 feet beyond the toe of the dam. Removal of such materials shall be accomplished within a dewatered excavation where the groundwater level is maintained at least 2 feet below the excavation bottom. Excavation sideslopes shall be cut to provide an overall average slope of 4H:1V, and the sideslopes shall be benched in one-foot vertical intervals to facilitate compaction of the backfill soils on the excavation slopes. (Note that excavation slopes for canal and ditch cleaning are to be cut to an overall slope of 4H:1V, while excavation slopes for the cleaning of the Header, Roberts and Banana Branch Canals shall be cut to an overall slope of 6H:1V). Once the excavation bottom and slopes are determined by the District to be free of unsuitable soils, the excavation bottom shall be compacted in the manner described in paragraph PROOF-ROLLING AND COMPACTION of this specification. The Contractor shall backfill the inspected and approved excavations with Embankment Fill as described in Specification 31 00 00 EARTHWORK - EARTH DAM. If the Contractor is unable to achieve the requisite density, owing to excess moisture conditions at that level, the Contractor shall increase dewatering efforts to provide for a stable excavation bottom, at no additional expense to the District.

The horizontal and vertical limits of the excavation for removal of unsuitable soils shall be surveyed by the Contractor's Professional Survey Mapper, photographed and documented all as part of the Contractor's QC Plan implementation.

## 3.12 STRUCTURE FOUNDATION SOIL PREPARATION

### 3.12.1 Dewatering and Cofferdam

Structures requiring dewatering and cofferdam (either sheet pile supported or earthen cofferdam) shall be constructed in accordance with the Specification Section 31 52 10 DEWATERING AND COFFERDAM. Structure foundation soils shall be compacted and tested by the Contractor as

described in the following sections, and inspected by the District prior to foundation construction.

3.12.2 Hydraulic Structures

Foundation soils for hydraulic structures both within the footprint of the dam and outside of the footprint of the dam shall be treated and compacted in accordance with notes shown on the Drawings and in accordance with this specification. Flowable Fill shall be utilized for foundation grade for portions of some structures as called for in the Drawings. Densification of the foundation soils in areas to receive Flowable Fill shall be accomplished prior to placement of the Flowable Fill, and with respect to the subgrade elevation at the base of the Flowable Fill. These foundation soils shall be compacted to a depth of at least 12 inches below the subgrade levels, and to the density requirements for Embankment Fill and/or Select Fill, as described in the Specification Section 31 00 00 EARTHWORK - EARTH DAMS. Where soft or pumping foundation soils are revealed at foundation excavation bottoms, such materials shall be over-excavated to a depth of 2 feet below structure bottom levels and shall be replaced with Embankment Fill and/or Select Fill depending upon location, as shown on the Drawings.

3.12.3 Miscellaneous Structures

For Control Buildings, RTU foundations and other miscellaneous structures, the structure foundation soils shall be compacted to not less than 95 percent of the maximum dry density determined in accordance with ASTM D1557 to a depth of 12 inches below the foundation grade.

3.12.4 Final Foundation Preparation

Prior to placement of forms, reinforcing steel concrete and/or flowable fill, Contractor shall clean/remove foundation excavation bottom of all loose or soft soils, debris or other non-mineral materials, and shall verify that the foundation soils are compacted and tested for compaction as required in the plans and specifications. Contractor shall arrange for the safe access to foundation excavation bottoms by District forces for inspection purposes. Areas requiring remedial work as determined by the District shall be remedied by the Contractor to the satisfaction of the District at no additional cost to the District.

3.13 IN-PLACE DENSITY TESTING

Compaction of prepared foundation grade shall be verified by the Contractor using In-Place Density testing in accordance with ASTM D6938. Frequency of the testing shall be as follows:

A. Stripped Grades - one test per 10,000 square feet

B. Ditch/Canal Reclamation - one test per 200 lineal feet of ditch/canal in the bottom of the excavation, and one test per lift per 200 lineal feet of ditch/canal, with minimum of one test per ditch/canal.

C. Pre-Trench - one test per 200 lineal feet of Pre-Trench in the bottom of the excavation, and one test per lift per 200 lineal feet of pre-trench, with minimum of one test per pre-trench.

D. Structure Foundations - one test per 10,000 square feet of structural footprint, but at least one test per structure.

E. Each In-Place Density test shall be accompanied by the laboratory test for Amount of Material in Soils Finer than the No. 200 Sieve (ASTM D1140).

3.14 BACKFILLING DEWATERING DITCHES

Dewatering Ditches that are located beyond 200 feet to the reservoir side of the upstream toe of dam and beyond the limits of the Perimeter Canal on the downstream side of the dam shall be backfilled with Unclassified Backfill.

-- End of Section --

SECTION 31 23 13

SUBGRADE PREPARATION

ATTACHMENT A

Unsuitable Materials Removed from Fill during
Construction of Bid Package Preload at S-471

# SECTION 31 23 23

# EXCAVATABLE FLOWABLE FILL

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

This SECTION specifies the requirements for excavatable flowable fill used for trenches, support for pipe structures, culverts, utility cuts and other works where cavities exist and where firm support is needed for pavements and structural elements. Flowable fill may also be used to fill water and sewer lines, and fuel tanks placed out of service, and at other locations approved by the District.

### 1.2 REFERENCES

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C403/C403M | (2008) Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance |
| ASTM C939/C939M | Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method) |

F.D.O.T. Standard Specifications for Road and Bridge Construction

### 1.3 DEFINITIONS

Not Used

### 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Flowable Fill mix design

SD-06 Test Reports

Strength test data

### 1.5 QUALIFICATIONS

Not Used

### 1.6 INSPECTION AND COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide 48 hour advance notice of its intention to begin new Work activities.

## 1.7 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 MATERIALS

The Contractor shall furnish materials conforming with the requirements specified in Division III of the F.D.O.T. Standard Specifications for Road and Bridge Construction, latest edition, and herein. Specific references are as follows:

1. Portland Cement (Types I, II or III) Section 931.

2. Fly Ash, Slag and other Pozzolanic Materials for Portland Cement Concrete Section 929.

3. Fine Aggregate (Sand)* Section 902.

4. Water Section 923.

* Any clean sand with 100 percent passing 3/8" sieve and not more than 10% passing with 200 mesh may be used.

## 2.2 MIX PROPORTIONS

The Contractor shall be responsible for producing a flowable mixture using these guidelines and by adjusting his mixture design as called for by circumstances or as may be directed by the District.

Flowable fill material shall be proportioned to produce a 28-day compressive strength of approximately 50-100 psi.

General mix quantities are as follows. Also see Standard Specifications Section 121.

| Components | Pounds per Cubic Yard |
|---|---|
| Cement | 75-100* |
| Fly Ash or Granulated Blast Furnace Slag | 0-600 |
| Fine Sand | 2,750 (Adjust to yield one cubic yard of flowable fill) |
| Water | 500 (Maximum) |

* The percentage of cement may be increased above these limits only when early strength is required and future removal is unlikely.

Weights for fine aggregate and water shall be adjusted according to cementitious content. The mix proportions shall be adjusted for removability, pumpability and flowability. Submit mix design and strength test data shall be provided prior to usage.

If required by the District, the flowability can be measured by afflux time determined in accordance with ASTM C939/C939M and shall be 30 seconds +/-5 seconds as measured on mortar passing the No. 4 sieve. The equipment required to perform this test shall be provided by the Contractor.

## PART 3 EXECUTION

### 3.1 PRODUCTION AND PLACING

Flowable fill shall be produced and delivered using concrete construction equipment. Placing flowable fill shall be done by chute, pumping or other methods approved by the District.

### 3.2 CONSTRUCTION REQUIREMENT

The flowable fill shall be placed to the designated fill line without vibration or other means of compaction. Placement shall be avoided during inclement weather, e.g. rain or ambient temperatures below 40 degrees F. The Contractor shall take all necessary precautions to prevent any damages caused by the hydraulic pressure of the fill during placement prior to hardening. Also, necessary means to confine the material within the designated space shall be provided by the Contractor.

### 3.3 ACCEPTANCE

The flowable shall be proportioned and placed as specified herein. In general, the strength desired is the maximum hardness that can be excavated at a later date using conventional excavating equipment. No curing protection is required.

The fill shall be left undisturbed until material obtains sufficient strength. Sufficient strength is 35 psi penetration resistance as measured using a hand held penetrometer, in accordance with ASTM C403/C403M. The penetrometer shall be provided by the Contractor.

All flowable fill areas subject to traffic loads must have a durable riding surface.

-- End of Section --

# SECTION 31 25 13

# SLOPE PROTECTION WITH SOIL-CEMENT

## PART 1 GENERAL

### 1.1 SUMMARY

#### 1.1.1 Section Includes

Furnishing all plant, material, labor, and equipment necessary for the manufacturing, transporting, placing, compacting, finishing, jointing, and curing of soil-cement for use in the proposed construction. All work shall conform to the lines, grades, thickness, and cross sections shown in the Drawings.

### 1.2 RELATED SECTIONS

Related Sections include but are not necessarily limited to:

Bidding Requirements, Contract Forms, and Conditions of the Contract.

Division 01 - General Requirements.

Section 01 33 00 SUBMITTAL

Section 31 00 00 EARTHWORK.

Section 31 05 19 GEOTEXTILE.

Section 33 46 13 FOUNDATION DRAINAGE SYSTEM

### 1.3 QUALITY ASSURANCE

#### 1.3.1 Reference Standards (Note: Use latest edition for reference standards)

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C150/C150M | (2018) Standard Specification for Portland Cement |
| ASTM C42/C42M | (2018) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| ASTM C566 | (2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying |
| ASTM C94 | Standard Specification for Ready-Mix Concrete |
| ASTM D1140 | Amount of Material in Soils Finer than the No. 200 Sieve |

| | |
|---|---|
| ASTM D1293 | (2012) Standard Test Methods for pH of Water |
| ASTM D1556/D1556M | (2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method |
| ASTM D1557 | Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) |
| ASTM D1632 | (2007) Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory |
| ASTM D1633 | Standard Test Methods for Compressive Strength of Soil-Cement Cylinders |
| ASTM D2216 | Laboratory Determination of Water (Moisture) Content of Soil and Rock |
| ASTM D2937 | Density of Soil in Place by the Drive-Cylinder Method |
| ASTM D2974 | (2014) Moisture, Ash, and Organic Matter of Peat and Other Organic Soils |
| ASTM D422 | Particle Size Analysis of Soils |
| ASTM D4253 | Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table |
| ASTM D4318 | Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D4832 | Standard Test Methods for Preparation of Testing of Controlled Low Strength Materials (CLSM) Test Cylinders |
| ASTM D4959 | Determination of Water (Moisture) Content of Soil by the Direct Heating Method |
| ASTM D558 | Moisture-Density Relations of Soil-Cement Mixtures |
| ASTM D559 | Wetting and Drying Compacted Soil-Cement Mixtures |
| ASTM D5982 | Determining Cement Content of Fresh Soil-Cement (Heat of Neutralization Method) |
| ASTM D6938 | Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA 600/4-79/020 | (1983) Methods for Chemical Analysis of Water and Wastes |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| CRD-C55 | Handbook for Concrete and Cement with Designated Quarterly Supplement for Mixer Performance Test |

ADDITIONAL REFERENCE MATERIAL

Existing geotechnical information can be found in the Geotechnical Site Characterization Report, which is part of the bid documents.

## 1.4 SUBMITTALS

SD-01 Preconstruction Submittals

Soil-Cement Placement Plan

Summary of Proof of Concept

Qualifications of the Contractor's USACE Validated Testing Laboratory

Erosion Control Plan

SD-03 Product Data

Mill Certification for Cement

Mixing Plant Equipment Calibration Results

Soil-Cement Mix Design Results

Non-Woven Geotextile Data Sheets

SD-06 Test Reports

In-Place Density Test Results

Laboratory Test Results

Soil Cement Coring Results

See Section 01 33 00 SUBMITTAL PROCEDURES

## 1.5 SUBMITTAL REQUIREMENTS

The Contractor shall submit a Soil-Cement Placement Plan of proposed equipment and methodology including, but not limited to, the following:

a. Showing location of mixing plant and material storage areas.

b. Hauling Equipment: A description of the equipment proposed for transporting soil-cement mixture from the central mixing plant to the placing equipment.

c. Placing Equipment: A description of the equipment proposed for the laydown or placing of the soil-cement mixture and method of control.

d. Compaction Equipment: A description of the rollers proposed for use. The description shall include manufacturer s literature and manufacturer s certified results of tests made on the rollers and plate compactors to be used showing the frequency and amplitude of vibration, operating weight, drum dimensions, and pounds per lineal foot of the vibratory roller; and the number of wheels, tire pressures, and gross weight of rubber-tired roller. Documentation certifying that the frequency and amplitude requirements have been tested and met shall be submitted prior to commencement of the soil-cement construction.

e. Placing and Spreading: If soil-cement is to be placed in or exposed to hot or cold weather conditions, a description of the placing and protection methods proposed, prior to construction of the test section.

f. The Soil-Cement Placement Plan shall also include remedial measures that are to be taken by the Contractor in the event the QC data (or QA data) reveal that areas of the work do not meet the specification requirements. The remedial work shall include (but not be limited to) coring and compressive strength testing to determine the limits of the work not meeting specification requirements, and measures to be taken to bring the subject area into conformance with the plan and specification requirements. Remedial work shall be provided by the Contractor at no additional cost to the District.

The Contractor shall submit a Summary of Proof of Concept, which is a demonstration by Contractor that means and methods utilized will yield a finished product that meets the project specification requirements, meet the quality control aspects of the project, provides the minimum thickness of soil cement required, and establish protocols for communication of schedule, inspections and documentation of the work. This shall include (but not be limited to) the following items: soil cement mix design, placement moisture content range, lift thickness, spreading and compacting equipment and number of passes required to achieve required density, thickness of finished product, curing, unconfined compressive strength, QC testing and other information required by contract. Proof of Concept for this work item shall also include a demonstration of the means and methods utilized to obtain wave wall anchorage into the soil cement surface in accordance with contract requirements.

Qualifications of the Contractor's USACE Validated Testing Laboratory. The Contractor shall submit verification that the QC laboratory meets the validation requirements for each specific test as required by the USACE.

Erosion Control Plan. The Contractor shall submit an Erosion Control Plan for all slopes which describes and details the approach to managing soil slope erosion. The elements of this plan are described in Section 31 00 00.

Mixing Plant Equipment Calibration Results: The Contractor shall provide calibration results for all on-site mixing plant scales, flow meters and other materials measurement equipment.

Soil-Cement Mix Design Results: The Contractor shall submit the results of laboratory testing for each stockpile proposed for use as aggregate for soil-cement.

Non-Woven Geotextile Data Sheets. The Contractor shall submit a product data sheet for the non-woven geotextile to be placed beneath the soil-cement.

The Contractor shall submit In-Place Density Test Results and Laboratory Test Results for the work described in this section.

1.5.1 Miscellaneous Submittals

Mill Certification for Cement.

Placing Operation: A detailed plan showing intended methods of constructing the soil-cement shall be submitted. This shall include, but not be limited to, showing the number of separate concurrent placement areas, area or length of sections to be placed prior to starting compaction operations, and proposed schedule, i.e., hours per day and days a week.

Curing and Protection: A detailed plan indicating the number and type of watering equipment to be used; proposed method that will be used to keep surface continually moist until subsequent layer of soil-cement is placed (where applicable); and methods to cure permanently exposed surfaces.

Construction Joints: A detailed plan shall be provided indicating the method of preparing and tying into construction joints.

1.6 DESCRIPTION

1.6.1 General

Soil-cement shall be constructed at locations shown on the drawings.

A Pre-Activity Meeting shall be required prior to beginning the soil cement, and shall be attended by appropriate District, Engineer, Contractor, Subcontractor/Vendor, and QC personnel. The meeting would facilitate discussion of the contract requirements, work plans, coordination, and other expectations.

The Contractor shall notify the District at least 5 days in advance of the date of commencement of construction. The soil-cement construction will include only flat plate placement methods. The initial 500-foot long section of soil-cement placement shall be utilized as a test section, and shall be considered Proof of Concept. The test section shall be completed from the toe of slope (including the toe drain) up to elevation 47 feet. Alternatively, the Contractor may utilize existing preload fills, provided they are on 3 horizontal to 1 vertical slopes, and have an area equivalent to that described above. The purpose of the soil-cement test section is to provide the Contractor the opportunity to develop and demonstrate to the satisfaction of the District the proposed techniques of mixing, hauling, placing, compacting, finishing, and curing, and the preparation of

construction joints. Additionally, the Contractor shall demonstrate the laydown method and rate, rolling patterns, joint preparation, and rolling method for both fresh and cold construction joints, start-up and finishing procedures, testing methods, and plant operations. Variable amplitudes of the roller shall be used as approved in different areas to identify the optimum amplitude. Rolling pattern of the vibratory and rubber- tired rollers may be varied as approved to determine the best pattern.

The soil-cement shall be placed in proportions as described in this specification. The Contractor shall vary the water content, as necessary, to arrive at the appropriate water content, subject to the approval of the District. The mixing plant shall be operated and calibrated prior to placing the initial section of soil-cement.

Subgrade preparation, soil-cement production, placing, compacting, curing, construction of joints, and all testing shall be in accordance with the applicable sections of the specifications.

### 1.6.2 Flat-Plate Soil-Cement

The flat-plate soil-cement shall be constructed to match the configuration of the flat-plate soil- cement shown on the Drawings. This is to include placement and compaction of soil-cement materials in a single lift, provided the materials meet the density requirements for the full thickness of the lift, with a sloped surface of 3 horizontal to 1 (3H:1V).

Placement of soil cement on the crest of the dam shall be made in accordance with the lines and grades shown on the drawings, and within the horizontal and vertical tolerances prescribed in the paragraph GRADE CONTROL.

The toe section shall be placed in two bonded lifts having approximately equal thickness and having a total thickness of 18 inches. Limits of and dimensions of the toe section shall be as indicated on the drawings.

All soil-cement shall be placed above a 10-ounce non-woven geotextile, in accordance with Table 1 in Section 31 05 19 GEOTEXTILE.

## 1.7 PLANTS AND EQUIPMENT

All plants, equipment, tools, and machines used in the work shall be maintained in satisfactory working conditions at all times.

### 1.7.1 Mixing Plant(s)

#### 1.7.1.1 Location of Mixing Plant(s)

The mixing plant shall be located on project site.

#### 1.7.1.2 Type of Mixing Plant(s)

a. The mixing plant shall be designed and operated to produce a soil-cement mixture within the specified tolerances. The plant shall be a stationary-type plant having a twin-shaft pug mill mixer and may be either weigh-batch type or continuous type and shall have a minimum capacity of 200 tons per hour. The plant shall be equipped with positive means for maintaining the time of mixing constant and maintaining the speed of rotation of the pug mill shafts constant.

b. The Contractor shall conduct a Mixer Performance test in accordance with CRD-C55.

1.7.1.3 Percent of Cementitious Material

a. Satisfactory means, incorporating either weighing or volumetric measurements shall be provided to separately batch or feed the required percentage of cementitious material in the mixture within tolerances specified. Silos and feeders shall be equipped and operated so that no caking of material or variation in feed will occur, including use of any necessary air pressure or vacuum vents on the silos.

1.7.1.4 Soil Aggregate Bin

a. A bin shall be provided for soil aggregate storage and shall be of sufficient capacity to supply the mixer continuously operating at full capacity. Unless the soil aggregate in the bin is readily visible to operating personnel, the soil aggregate bin shall be equipped with mechanical or electrical telltales to indicate when the soil in the bin is below level to permit accurate proportioning to mixing unit. The bin shall be constructed or equipped so that a representative sample may be readily and safely obtained from the bin discharge during plant operations.

1.7.1.5 Water Measurement

a. Satisfactory means incorporating either weighing, metering, or volumetric measurements shall be provided to batch or feed the required quantity of water in the mixture within tolerances specified.

1.7.1.6 Feeding Tolerances

a. Feeding shall conform to the mixture proportions directed within the following tolerances:

| **FEEDING TOLERANCES** | |
|---|---|
| Material | Plant(s) |
| Cementitious material | Zero to plus 2.0 percent |
| Water optimum | Minus 1% to plus 2 percent |
| Soil aggregate | Plus or minus 3.0 percent |
| These percentages are based on the weight of the design mix materials. | |

b. For continuous feeding plants, the variation is in percent by weight from the mixture proportions of each material designed to be in total timed sample obtained from a designated location in the plant.

c. A variable speed belt or a remotely operated gate, calibrated to accurately deliver any specified quantity of material, shall control the soil aggregate feed rate. The feed rate shall be readily adjustable from the control panel to compensate for changes in the moisture content of the soil or to change soil aggregate proportions when blending is required and separate bins are utilized. The combined aggregate belt feeding the mixer shall be equipped with an approved belt scale. The belt scale shall operate automatic controls, which will govern the proportions of cementitious

material and water as ratios of the total soil aggregate, with provisions for ready changing of the proportions.

d. When a continuous mixing plant with a fixed soil aggregate feed rate system is used, the belt shall travel at a constant speed. The feed system shall continuously deliver aggregate to the mixer at a constant feed rate, calculated on a dry weight basis, at any locked gate setting. The feed system shall be mechanically interlocked with all other feed devices. The soil aggregate feed monitoring system shall provide and record the rate of and total quantity of soil aggregate fed into the mixture.

e. Mixing shall be sufficient to secure a homogeneous, intimate, uniform mixture of the soil, and water within the specified tolerances. Soil and cementitious material shall be mixed sufficiently to prevent cementitious balls from forming when water is added.

f. All scales, flow meters and other materials measurement devises associated with the mixing plant shall be calibrated on-site prior to plant start up. The equipment shall be regularly calibrated during plant operations in accordance with the equipment manufacturer recommendations and any time that the equipment exhibits abnormal readings or fluctuations.

1.7.2 Transportation

Equipment for transporting the soil-cement mixture shall have clean, smooth beds and protective covers for use in unfavorable weather.

1.7.3 Spreading Equipment

The equipment for spreading the soil-cement mixture shall be suitable for the purpose and shall be capable of discharging the mixture in layers to produce reasonable smooth uniform surfaces. The equipment shall be controllable so as to produce layers, which when compacted, will each be approximately of the specified thickness and will meet all of the requirements of these specifications. Under no condition shall tracked vehicles be operated on other than fresh uncompacted soil-cement. Appropriate crossings that fully protect the soil-cement shall be used whenever equipment must cross the soil-cement.

1.7.4 Compaction Equipment

The compaction shall be accomplished by tamping rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment well suited to the material being compacted. The equipment shall provide uniform compaction across the width of the equipment for each pass.

1.7.5 Other Compaction Equipment

Light, walk-behind, or similar sized vibratory rollers and mechanical tampers shall be furnished for use in compacting areas inaccessible to the large rollers. The rollers shall compact the soil-cement to the required densities and shall be so demonstrated prior to the start of soil-cement construction. Rollers shall have independent speed and vibration controls and shall be capable of a wide range of speed adjustments.

### 1.7.6 Water Curing Equipment

Water curing equipment consisting of pumps, water tanks, sprinklers, or other approved equipment shall be furnished by the Contractor. Adequate equipment, subject to the approval of the District, shall be available at all times to provide water as required for curing and protection of permanently exposed slopes and for moistening compacted surfaces that are to receive an overlaying later of soil-cement. Water trucks or sprinklers for applying water to in-place layers of soil-cement shall be equipped with fog-type sprayers.

## 1.8 ACCESS TO PLANT AND EQUIPMENT

The District shall have access at all times to all parts of the mixing plant(s) operations for checking adequacy of equipment in use; for inspecting operation of the plant; and for verifying weights, proportions and character of materials.

# PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Portland Cement

The Portland cement shall conform to the requirements of ASTM C150/C150M, Type I. Cement shall be stored in a manner to prevent the absorption of moisture. All cementitious material shall be furnished in bulk.

When bulk cementitious material is not unloaded from primary carriers directly into weather tight hoppers at the batching plant, transportation from the railhead, mill, or intermediate storage to the batching plant shall be accomplished in adequately designed weather-tight conveyors or other means that will protect the cementitious material completely from exposure to moisture.

Immediately upon receipt at the site of the work, cementitious materials shall be stored in a dry and properly ventilated structure. All storage facilities shall be subject to approval and shall be such as to permit easy access for inspection and identification. Sufficient cementitious materials shall be in storage to sustain continuous operation of the mixing plant while the soil-cement is being placed. All storage facilities shall be empty and clean when brought to the site. To prevent cement from becoming unduly aged after delivery, any cement that has been stored at the site for 60 days or more shall be used before cement of lesser age.

### 2.1.2 Water

On-site water sources have been tested by the District and found to be acceptable for use in batching soil-cement. On site water may be utilized provided source conforms with the requirements of ASTM C94 and is clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the hardening of the soil-cement and shall be subject to approval by the District.

2.1.3 Aggregates

2.1.3.1 Source of Materials

a. Soil aggregate material for use in soil-cement shall be produced by the Contractor from the reservoir interior and/or from the existing Preload fills. Only material that meets the requirements of Embankment Fill as described in Section 31 00 00 EARTHWORK shall be used, with the exception that the aggregate shall meet the gradation requirements described in Section 2.1.3.2 of this specification, and shall have a maximum organic content of 1 percent. Note that experience gained during construction of the preload fills indicates that the development of aggregate for use in soil-cement will require screening to remove roots and oversized materials from the aggregate.

b. Contractor shall sample and test stockpiled material to confirm material is suitable.

c. Soil aggregate shall be stored at the site of the mixing plant in such a manner as to avoid segregation, or contamination by foreign materials.

d. Soil aggregate shall remain in free-draining storage for at least 24 hours immediately prior to use.

e. Sufficient soil aggregate shall be maintained at the site at all times to permit continuous, uninterrupted operation of the mixing plant at the time soil-cement is being placed.

f. Soil aggregate shall be handled in a manner to prevent segregation or degradation. Vehicles used for stockpiling or moving soil aggregate shall be kept clean of foreign materials.

2.1.3.2 Soil-Cement Gradation

a. Soil aggregate for use in soil-cement construction, when tested in accordance with ASTM D422, shall conform to the gradation indicated below and shall be free of any deleterious materials.

| **Standard Sieve Size** | **Percent Passing by Weight** |
|---|---|
| 3/8-inch | 100 |
| No. 10 | 70-100 |
| No. 40 | 50-97 |
| No. 100 | 5-50 |
| No. 200 | 0-10 |

b. Soil aggregate for soil-cement shall not contain clay/silt lumps, and have a maximum organic content of 1 percent.

# PART 3 EXECUTION

## 3.1 MIX DESIGN PROCEDURE

### 3.1.1 Samples for Mix Design Development

The District has determined that the required unconfined compressive strength for the soil-cement shall be a minimum of 800 psi at 28 days, and that the soil-cement shall have a weight loss of not greater than 4 percent when tested for durability at 12 wet-dry cycles. The District has estimated that 11 percent cement is required for this strength and durability. The Contractor shall demonstrate that the mix design utilized for each stockpile for this project meets the strength and durability requirements determined by the District.

Samples will be taken by the Contractor from four different locations determined by the District (with close coordination with the Contractor's field personnel) within each approved stockpile created by the Contractor. Sample locations are to result in samples that are representative of the materials contained in each stockpile. Each stockpile shall have a minimum volume of 100,000 cubic yards (cy). Samples will be obtained by cutting into the exterior face of the stockpile at five elevations on a vertical line such that the stockpile is sampled from top to bottom at one location. This procedure shall be completed at 4 locations around the stockpile, and each sample shall be tested for organic content and gradation. If the test results indicate that the materials are similar, the four samples will be combined into a composite mixture, representative of the entire stockpile, and shall be used to prepare moisture density and compressive strength specimens. If the individual samples differ, then each sample will be used to prepare moisture density and compressive strength specimens.

### 3.1.2 Moisture-Density Tests

For each stockpile, the Contractor shall perform optimum moisture-maximum density relationships for a range of cement contents (at least 3), in accordance with ASTM D558. Moisture-density relationships will be determined for each of the cement contents.

### 3.1.3 Compressive Strength Tests

After determination of optimum moisture and maximum density for each cement content, the Contractor shall prepare four sets of compressive strength test specimens at 98 percent of the ASTM D558 maximum density for testing at ages 1, 3, 7, and 28 days for each stockpile and for each cement content, and test them in accordance with ASTM D1633. The compression test specimens prepared for each of the cement percentages shall be prepared at between optimum to 2 percent above optimum moisture content as determined by ASTM D558. At least two compression tests shall be performed at each age interval.

### 3.1.4 Wetting and Drying Tests

After determination of optimum moisture and maximum density, the Contractor shall also prepare three sets of test specimens at 98 percent of the ASTM D558 maximum dry density for testing at the various cement contents for each stockpile, and test them for wetting and drying in accordance with ASTM D559. The wetting and drying test specimens prepared for each of the cement

percentages shall be prepared at between optimum to 2 percent above optimum moisture content as determined by ASTM D558.

### 3.1.5 Availability of Mix Design Test Results

The mix design test results shall be made available to the District within 50 days from the time each stockpile is sampled.

### 3.1.6 Soil Cement Coring

The Contractor shall obtain cores of the finished soil cement using a high-speed rotary drill and 4-inch diameter core barrel. The cores shall be oriented normal to the slope, and shall be full depth, but not cutting through or otherwise disturbing the filter fabric beneath the soil cement. The coring machine shall be anchored to the surface of the soil cement prior to beginning the coring operations at a given location. At least one core shall be made per 1,000 feet of dam at a location agreed upon by the District. Each core shall be measured for length, and the lengths reported to the District. Additional cores shall be obtained (at no additional cost to the District) should in-place density testing results not meet the specification requirements. The number of and location of such additional cores shall be determined by the District. All cores shall be labeled and stored in the Contractor's laboratory facility.

At 100-foot centers, 1-inch diameter cores of the finished soil cement shall be obtained using a percussion drill. The cored holes shall be used to measure the thickness of the soil cement. Thickness measurements shall be reported to the District daily.

Locations and elevations of the cored holes shall be determined by survey with accuracy to the nearest one foot horizontally and 0.1-foot vertically.

The cored hole locations shall be backfilled with sand-cement grout having a moisture content of at least 20 percent, rodded or tamped in place in three equal lifts. The grout shall have a minimum unconfined compressive strength not less than 800 psi.

## 3.2 MIXTURE PROPORTIONING

### 3.2.1 General

The Contractor shall determine the mix proportions of the aggregate, cement and water, and shall furnish soil-cement conforming to that mix design for each stockpile. The job-mix design with the supporting test results will be made available to the District prior to incorporating any of the material into the work.

### 3.2.2 Composition

Soil-cement shall be composed of cementitious material, water, and aggregates. The cementitious materials shall be Portland cement. Admixtures shall not be used unless demonstrated by the Contractor to be beneficial and approved in writing, including batch mix test data provided by the Contractor's QC laboratory.

### 3.2.3 Cementitious Material Content

The total cementitious material content is expected to be 335 pounds per cubic yard (assuming 115 pcf maximum dry density, 98 percent compaction, 11 percent cement). The Contractor may vary cement content to achieve required material strength and durability, provided the mix design test results for each stockpile clearly demonstrate that the strength and durability requirements described in Section 3.1.1 of this specification can be achieved.

## 3.3 STOCKPILED MATERIAL

### 3.3.1 General

Soil aggregates shall be stockpiled on firm ground drained and leveled, free of debris, trash, organic material, and other objectionable or deleterious material. Stockpiles shall be constructed in layers not exceeding 3 feet in thickness. Ramps formed for the construction of stockpiles shall be made of the same material as that being stockpiled, and will be considered a part of the stockpile. Aggregates taken from the stockpile for soil-cement production shall be removed from the stockpile in such a manner that material from several layers of the stockpile are combined in each sample and the gradation of the aggregate obtained is representative of that used in the mix design tests. During construction of stockpiles to be utilized in the production of soil-cement, the Contractor shall be solely responsible for monitoring the uniformity of the material to assure conformance with the gradation requirements.

## 3.4 DRAINAGE

Adequate drainage shall be provided during the entire construction period to prevent water from collecting or standing on the area to be stabilized or on the mixed or partially mixed material.

## 3.5 SURFACE SMOOTHNESS REQUIREMENTS

Soil-cement shall be reasonably smooth, and true to grade and cross-section.

## 3.6 GRADE CONTROL

Lines and grades shown on the Drawings for the soil-cement shall be established and maintained by means of line and grade stakes. Finished surface grade lines and elevations shown shall be established and controlled at the site of work by the Contractor. The surface of the underlying material shall be finished to the necessary grade such that when the required thickness of soil-cement is placed, the finished surface will meet the indicated grade. Finished and completed soil-cement sections shall conform to the lines, grades, and dimensions indicated to a tolerance of +/- 0.25 feet, with the exception of cross-section thickness. Soil-cement cross-sections thickness shown on the Drawings shall be the absolute minimum thickness. On the crest of the dam, finished grades on the surface of the soil cement shall be within 0.1 foot of the design grades.

## 3.7 SUBGRADE PREPARATION

Previously constructed underlying material shall be conditioned as specified in Section 31 00 00 EARTHWORK, and as required by the Drawings. In all

cases prior to placing soil-cement, deficiencies in the underlying material (e.g. soft or pumping subgrade, rills and gullies, excessively wet areas, excessive fines content, etc.) shall be corrected, resulting in a restored compacted subgrade to 95 percent of maximum density ASTM D1557, and the surface shall be cleaned and moistened, as directed. Protection of and maintenance of slopes leading up to placement of the soil-cement shall be in accordance with Section 31 00 00 EARTHWORK - EARTH DAM.

Once the subgrade is compacted and approved, the slope protection underdrain materials shall be placed as shown on the Drawings. Clean Sands and Filter Sands shall be placed and compacted in 12-inch thick lifts, and each lift shall be compacted to 90 percent Relative Compaction determined in accordance with ASTM D4253. The surface of the underlying drain material will be approved by the District prior to placing geotextile material. Any dewatering necessary to place the soil-cement shall be considered incidental to the construction of the soil-cement.

The Contractor shall verify that sands having not more than 5 percent passing the U.S. Standard No. 200 Sieve exists within the zone 2 feet (normal thickness) beneath the soil-cement above elevation 35 feet, and shall be responsible for placement of and maintenance of FDOT Filter Sand within the zone 2 feet (normal thickness) beneath the soil-cement below elevation 35 feet as shown on the Drawings.

Construction sequencing shall be established such that the soil-cement materials are placed immediately following preparation of the subgrade and drainage materials and placement of the filter fabric. Erosion of earthen slopes shall be considered by the Contractor in preparation of cost estimates and scheduling. Methods that may be considered for erosion control include, but are not limited to, grassing, use of runoff barriers, and over-build and cut. No erosional rill or gully may exceed 18 inches deep without regrading of the slope in the area of the erosion. All slopes that are to receive soil cement slope protection shall be graded and compacted prior to placement of the Clean Sand and/or Filter Sand layers, which are also to be compacted immediately prior to placement of the soil cement. Densification of these soils shall follow the requirements of this Specification Section 31 00 00 EARTHWORK - EARTH DAM.

CONTROL OF EROSION AND MITIGATION OF IMPACTS TO CONSTRUCTION RESULTING FROM EROSION IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR, AND SHALL NOT FORM THE BASIS OF A CHANGE IN CONTRACT PRICE OR TIME. THE EROSION AND SEDIMENT CONTROL REQUIREMENTS STATED IN THE DRAWINGS AND SPECIFICATIONS REPRESENT THE MINIMUM ANTICIPATED EFFORT REQUIRED AND SHALL BE SUPPLEMENTED AS REQUIRED.

## 3.8 BATCHING, MIXING, AND TRANSPORTING

The plant shall be operated to produce a uniform and homogeneous mixture. The proportions shall be as furnished to the Contractor. All materials used in the mixture shall be batched or fed separately.

### 3.8.1 Mixing

a. The aggregates and cementitious materials shall be conveyed to the mixer in proportions, as required. The water content may be varied at frequent intervals as necessary and as considered appropriate because of placing and compacting operations and shall in general be based on the action of the rollers on the freshly placed materials, and on the field density test

results obtained in the soil-cement and on the surface texture being produced. Such changes shall be made with approval of the District.

b. The proportions may be changed by the District as necessary to adjust for variations in materials and plastic and hardened properties. Adjustments to mix proportions other than water can be as frequent as once per shift. The Contractor shall make the appropriate plant adjustments immediately.

c. With a continuous mixer, mixing time shall be not less than 15 seconds and as much longer as may be required to obtain a homogeneous mixture. Shaft speed of the pug mill shall be maintained at the speed recommended by the manufacturer. Soil-cement shall not extend above the tips of the paddles of the pug mill mixer when paddles are in vertical position. Mixer and mixer paddle surfaces shall be kept free of hardened soil-cement and other contamination. Mixer paddles worn down more than 10 percent from new paddles of the same type and manufacture shall be replaced.

### 3.8.2 Transporting

a. Soil-cement shall be hauled from the mixer to the placing site in clean equipment equipped with protective covers for use in unfavorable weather. The equipment shall dump directly onto the final location or as near the final location as possible. Deliveries shall be scheduled so that soil-cement will be spread and rolled within the time limit specified in paragraph COMPACTION and spreading and rolling of all mixture prepared for 1 day's run can be completing during daylight unless adequate artificial lighting is provided. Loads that have crusts of partially hardened material or have become wet by rain will be rejected. Soil-cement shall not free fall more than 5 feet during dumping or be piled higher than 5 feet. Any damage resulting to previously compacted layers from such operation shall be repaired at the expense of and by the Contractor.

b. The Contractor shall take all necessary precautions to prevent damage to completed soil-cement by the equipment and to prevent the deposition of raw earth or foreign materials between layers of soil-cement. Earth ramps crossing completed soil-cement must have at least a two-foot compacted thickness.

## 3.9 PLACING AND SPREADING

Soil-cement mixtures shall be placed and distributed in such a manner as to produce a reasonably smooth uniform surface in layers of such uncompacted thickness that when compacted, the finished slope protection flat plate section shall not be less than 12 inches in thickness. Thicker soil-cement section shall be placed on the crest of the dam as shown on the Drawings. The Contractor is encouraged to place and compact the soil-cement as rapidly as possible.

### 3.9.1 Weather Limitations

a. Placing During Cold Weather: Placement shall be discontinued when the air temperature reaches 45 degrees F and is falling and shall not be resumed until the air temperature reaches 40 degrees F and is rising. No soil-cement shall be placed on any surface containing frost or frozen material. Provision shall be made to protect the soil-cement from freezing during the specified curing period. Covering and other means shall be provided for

maintaining the soil- cement at a temperature of at least 50 degrees F for not less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. Soil-cement damaged by freezing shall be removed and replaced as directed.

b. Placing During Hot Weather: The soil-cement shall be placed at the coolest temperature practicable, and in no case shall the temperature of the soil-cement when placed exceed 90 degrees F unless prior approval by the District. The finished surfaces of the newly laid soil-cement shall be kept damp by applying a water fog or mist, not streams, or flowing water, with approved spraying equipment. When heat or wind is determined excessive by the District (i.e. daytime temperatures in excess of 90 degrees F, and sustained wind speeds exceed 30 miles per hour), the Contractor shall immediately take such additional measures as necessary to protect the soil-cement surfaces. If these measures are not effective, placement shall be immediately stopped until satisfactory conditions exist.

c. Placing During Rain: Soil-cement shall not be placed during rainfall of more than 0.2 inches per hour. During periods of lesser rainfall, placement of soil-cement may continue if in the opinion of the District no damage to the surface is observed. Work shall commence only after the surface water has dried. Surfaces shall be cleaned to break up and remove any latency and/or mud like coating on the surface.

## 3.10 COMPACTION

### 3.10.1 General Requirements

a. The in-place density tests performed by the Contractor and verified by the District shall demonstrate that the soil-cement materials are compacted to not less than 98 percent of the maximum dry density obtained by ASTM D558.

b. At the start of compaction, the mixture shall be in a uniform, loose condition throughout its full depth. No section shall be left undisturbed for longer than 30 minutes during compaction operations. Compaction of each layer shall be done in such a manner as to produce a dense surface, free of compaction planes, in not longer than 1-1/2 hours from the time cement is added to the mixture.

## 3.11 FINISHING

After compaction to the required lines and grades, the soil-cement surface shall be reasonably smooth. Finishing of the soil-cement shall be conducted at the completion of each day's production. Any trimming to remove loose soil-cement, or as shown on the drawings must be completed within 3 hours from the time of mixing.

### 3.11.1 Exposed Surfaces

a. Temporarily exposed surfaces of soil-cement that will be in contact with succeeding layers of soil-cement shall be kept continuously moist by moist curing or until placement of the subsequent layer. Curing of permanently exposed surfaces shall begin immediately after compaction and shall continue for at least 7 days. Soil-cement shall be cured and protected from premature drying, extremes in temperature, rapid temperature change, freezing, mechanical damage, and exposure to rain or flowing water. The

Contractor shall have all equipment needed for adequate curing and protection on hand and ready to install before actual placement begins. The District will approve the curing medium and method, or the combination of mediums and methods used. All soil-cement shall be protected from the damaging effects of rain for 8-hours and flowing water for 7 days.

3.11.2 Curing

a. All permanently exposed soil-cement surfaces are to be moist cured for a minimum of 7 days. Water for curing shall comply with paragraph MATERIALS. Traffic should be kept off the soil-cement during the curing period. Curing compounds may be utilized provided they are part of the Proof of Concept work and documentation.

3.11.3 Truck Applications

a. Water trucks may be used, to keep surfaces wet at all times. The water truck shall be supplemented, as necessary, by mists from hand-held hoses. The truck operator shall be positioned so he is capable of seeing the spray at all times. All spray nozzles both on the trucks and the hand-held hoses shall produce a true fog spray without any concentrated streams of water. The mist shall not be applied in a channelized or pressurized manner that erodes the surface of the soil-cement. It shall also be applied at a rate that does not cause ponding at the surface.

3.11.4 Sprinkler System

a. An approved sprinkler system consisting of pipelines and rotating or other approved type of sprinklers may be used. Sprinklers shall deliver a fine mist of water and shall not cause any erosion to the surface of the soil-cement. The sprinkler system shall cover all portions of the soil-cement surface and keep the surface wet at all times.

3.12 JOINTS

Construction joints shall be made to ensure continuity in smoothness and grade between old and new sections of soil-cement, as specified hereinafter. All joints shall have the same texture, full-depth density, and smoothness. Regardless of age, contact surfaces of previously constructed strips that have become coated with dust, sand, or other objectionable material shall be cleaned by power bushing or other methods approved by the District.

3.12.1 Construction Joints:

a. At the end of each day's work, or whenever construction operations are interrupted for more than 2 hours, a transverse construction joint shall be formed by cutting back into the completed work to form a full-depth near vertical face as directed by the District. If construction joints are formed at more than one layer, the construction joint for each layer shall be staggered at least 8 feet horizontally from the construction joint of the layer below.

b. Whenever the Contractor's operations are interrupted such that the subsequent lift cannot be placed within 2 hours, dry cement or cement slurry bonding agent shall be applied in accordance with paragraph SOIL-CEMENT BONDING AGENTS, the surface shall be scarified to a depth of at least 1 inch with a spike-toothed harrow prior to placement of the subsequent lift. The

scarified surface shall then be cleaned using high pressure air or other method approved by the District to completely free the surface of all loose material prior to the placement of the subsequent lift.

## 3.13 SOIL-CEMENT BONDING AGENTS

### 3.13.1 General

a. The Contractor shall furnish and place bonding agents between adjacent lifts of soil-cement.

b. The cement slurry-bonding agent shall consist of a combination of Portland cement and water uniformly mixed and placed in accordance with this Section.

c. The equipment required for mixing and placing the cement slurry shall be suitable for producing the required product. A meter for measuring the discharge of the slurry shall be provided by the Contractor.

### 3.13.2 Proportioning and Mixing

The cement and water for the cement slurry shall be accurately measured and conveyed into the mixture in the proportionate amounts necessary to meet the specified requirements. The cement and water shall be mixed long enough to suspend all cement and to ensure a uniform and homogeneous mixture in appearance as determined by the District. The water-cement ratio shall be 0.70. The total elapsed time from the addition of water to the cement to the application of the cement slurry shall not exceed 30 minutes.

### 3.13.3 Placing

a. The cement slurry shall be applied uniformly across the width of the soil-cement lift. The application rate shall be 1 pound of dry cement per 1 square yard of surface area. The method of application shall be approved by the District.

b. The surface of the soil-cement lift shall be cleaned off and wetted immediately prior to placement of the cement slurry or dry cement bonding agents. The cement slurry or dry cement shall be applied immediately ahead of the spreading operation but may extend no further ahead of the spreader than the distance covered by one truck (hauling unit) load of soil-cement mixture spread into the lift being constructed. The total elapsed time from application of the bonding agent to the spreading of the overlying soil-cement shall not exceed 30 minutes. The Contractor shall minimize equipment travel and other disturbances on the treated surface.

c. Temperature. The cement slurry bonding agent shall not be mixed or placed when the air temperature is above 90 Degrees F. The cement slurry or dry cement shall not be placed if in the judgment of the District weather conditions are unsuitable.

## 3.14 MAINTENANCE

The Contractor shall be required to maintain the soil-cement in good condition until all work is completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be

done by the Contractor at his own expense and repeated as often as necessary.

## 3.15 QUALITY CONTROL PROGRAM

### 3.15.1 Inspection and Tests:

The Contractor shall be responsible for all quality control (QC), inspections and testing associated with the work. The District with assistance and cooperation from the Contractor will perform independent quality assurance (QA) inspection and testing. Based upon the results of the QC inspections and tests, the Contractor shall take actions necessary to correct any items that are not in compliance with these specifications.

### 3.15.2 Inspection Details and Frequency of Testing:

Calibration of Mixing Plant(s). Whenever it is found that either the weighing or the batching accuracy does not comply with specification requirements, the plant shall be shut down until necessary adjustments or repairs have been made. Discrepancies in recording shall be corrected immediately.

Continuous-Mixing Plants. Accuracy of proportioning of the continuous-mixing plant shall be checked by the Contractor in the presence of the District for the cementitious material every 2 shifts, and for each aggregate at the beginning of construction and after every 5 shifts. The accuracy of proportioning shall be checked by simultaneously securing timed samples of the cementitious materials and the aggregate as they are fed to the mixer and weighing each as appropriate.

Preparation for Placing: The District will inspect construction joints prior to each lift of soil-cement placement. The Contractor shall obtain approval from the District prior to placing soil-cement at the start of each shift and at previously placed joints.

a. The placing foreman shall not permit placing to begin until he has verified that adequate equipment, manned by competent operators, is available for compacting the soil-cement. Placing shall be temporarily discontinued if any lift is inadequately compacted until such time as that lift has been reworked, retested, and meets the density requirements.

Inspection During Placing: The Contractor shall be responsible for measuring and recording soil-cement temperature, ambient temperature, weather conditions, time of placement, and method and location of placement.

a. The District shall be notified whenever the soil-cement temperature during the period of protection falls below 50 degrees F or is above 90 degrees F.

b. Cold-Weather Placing: At least once during each shift, an inspection shall be made of all areas subject to cold-weather protection. Deficiencies shall be noted. During removal of protection, the soil-cement and ambient temperature shall be measured at least hourly.

c. Hot Weather Placing and Initial Curing at All Times: When the maximum daily air is likely to exceed 90 degrees F, the Contractor shall record the temperature of the soil-cement mixture at 30-minute intervals during placement and stop placement when the soil-cement mixture exceeds 90 degrees F. The surface of the subgrade shall be inspected to assure that it is sprinkled with water immediately before the soil-cement is placed and any deficiencies noted. Regardless of ambient temperature, the finished soil-cement shall be inspected to assure that it is kept damp until the curing medium is applied and any deficiencies noted. Immediate steps shall be taken by the Contractor to correct any deficiencies.

d. Curing Operation: The curing operation shall be inspected to assure that the surface of the permanently exposed soil-cement is kept very moist (or wet) continuously until the end of the curing period. All temporary exposed soil-cement shall be kept moist.

e. The District shall be notified when any soil-cement surface is allowed to dry before the end of the curing period, and immediate steps shall be taken to correct the situation.

Field Density Testing

a. Three calibration blocks for the Nuclear Density Gauge shall be fabricated by the Contractor with soil-cement materials and proportions representative of those to be used during construction. The blocks shall be used each day before placement begins to calibrate the full-depth readings of the nuclear density gauges used by the Contractor. The blocks shall be fabricated before the soil-cement construction begins. The block size shall be a minimum of 24 inches by 24 inches by the maximum thickness of one lift, plus 1 inch. If the flat-plate soil-cement is to be placed in a single lift, then separate blocks shall be constructed with thickness of the total section thickness, plus 1 inch.

b. The blocks shall be compacted to at least 98 percent of the maximum dry density, which will be determined by the Contractor in accordance with ASTM D558. The moisture content of the soil-cement used to fabricate the blocks may be increased just enough to facilitate compaction of the mixture, as long as the proportions of the dry materials remain constant and the required density is achieved. The blocks shall be measured and weighed to determine the actual density (unit weight) and shall be used to check the calibration of the nuclear density gauge. After drilling a hole in the block to accommodate the nuclear density gauge probe, three full depth nuclear density gauge readings shall be compared with the measured unit weight of the blocks and the difference used as a correction factor for all readings taken that day. All measuring and weighing of the test blocks shall be performed in the presence of a representative of the District. Calibration checks of the density gauge shall be made by the District at the beginning of construction every day. The calibration block shall be available for use by the District as needed.

c. Field Density and Moisture Testing: Field density test shall be performed by the Contractor on the soil-cement in accordance with ASTM D2937 or D6938 as soon as possible, but within 30 minutes, after the completion of vibratory rolling. Dry density and moisture content

shall be used for evaluation. The ASTM D6938 test shall be performed using a single probe nuclear density gauge operating in the direct transmission mode so density of the full depth of the soil-cement can be measured. Every tenth field in-place density test using the Nuclear Gauge and/or Drive Cylinder Method shall be made with a corresponding field density test using the Sand-Cone Method (ASTM D1556). Adjust results from the nuclear gauge using the calibration curve that results from the corresponding tests. The dry density of the soil-cement shall be at least 98 percent of the maximum dry density determined in accordance with ASTM D558. The moisture content of the soil-cement shall be within 1 percent dry and 2 percent wet of the moisture content optimum for compaction.

d. During the construction of the Test Section, the Contractor shall obtain a sample of the soil cement from each Nuclear Gauge density test location and test for oven-dried moisture content (ASTM D2216) to check the variation between the two methods. Such comparison shall be checked throughout the project at a frequency of once per 10 field in-place density test locations.

Frequency of Field Density, Moisture Content and other QC related testing shall be as follows:

| **Test Method** | **Test Type** | **Frequency** | | |
|---|---|---|---|---|
| | | **Borrow** | **Soil Cement** | **Water** |
| ASTM D422 | Gradation of Aggregate | Per Source | Every 1,500 CY or 1 per shift | |
| ASTM D558 | Moisture-Density Curve | | Every 1,500 CY or 1 per shift | |
| ASTM D559 | Wet-Dry Durability | | Every 15,000 CY or 1 per shift | |
| ASTM C566 | Moisture of Aggregate | | Every 1,500 CY or 1 per shift | |
| ASTM D1632 | Making and Curing Soil Cement Specimens | | Every 1,500 CY or 1 per shift | |
| ASTM D1633 | Compressive Strength of Soil Cement Specimens | | Every 1,500 CY or 1 per shift | |
| ASTM D5982 | Cement Content of Soil Cement | | Every 750 CY or 2 per shift | |
| ASTM D2974 | Organic Content of Aggregate | Per Source | Every 1,500 CY or 1 per shift | |
| ASTM D1293 | pH of Water | Per Source | Every 1,500 CY or 1 per shift | |
| EPA 600/4-79/020 | Water Quality | | Every 1,500 CY or 1 per shift | Per Source |
| ASTM D6938 | In-Place Density (Nuclear Methods) | | Every 500 CY or 1 per shift | |
| ASTM D2937 | In-Place Density (Drive Sleeve Methods) | | Every 5,000 CY or 1 per shift | |

| Test Method | Test Type | Frequency | | |
|---|---|---|---|---|
| ASTM D4959 | Moisture Content of Soils | | Every 5,000 CY or 1 per shift | |
| ASTM C42/C42M | Soil Cement Coring | | 4" Diameter - One per 1,000' of dam;<br>1" Diameter - One per 100' of dam | |

3.15.3 Reporting:

All results of field density tests, laboratory tests, Soil Cement Coring Results or other QC testing performed by the Contractor conducted at the project site shall be reported daily and shall be delivered to the District. During periods of cold weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failure and the action taken shall be confirmed in writing in the routine reports. The District has the right to examine all Contractor records at any time.

Continuous Mix Plant(s) Recorders: For continuous mixing plants, the recorders shall keep a record of the amount of cement, and aggregates used on both a daily basis and will be used as a check on the soil-cement proportioning. In the event of inconsistencies in the proportioning control of the mixture, the Contractor shall take readings at intervals deemed appropriate by the District.

Measuring Devices: Measuring devices and scales shall be calibrated prior to production of soil-cement, at manufacturer-recommended intervals during production, and as deemed necessary by the District. All measuring device calibration will be approved by the District and performed at the Contractor's expense.

-- End of Section --

# SECTION 31 32 11

# SOIL SURFACE EROSION CONTROL

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The work consists of furnishing and installing temporary and permanent soil surface erosion control materials to prevent the pollution of air, water, and land, including fine grading, vegetative measures, structural measures, and miscellaneous related work, within project limits and in areas outside the project limits where the soil surface is disturbed from work under this Contract at the designated locations. This work includes all necessary materials, labor, supervision, and equipment for installation of a complete system.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D5852 | (2000; R 2007; E 2014) Standard Test Method for Erodibility Determination of Soil in the Field or in the Laboratory by the Jet Index Method |
| ASTM D6629 | (2001; E 2012; R 2012) Selection of Methods for Estimating Soil Loss by Erosion |

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| AMS Seed Act | (1940; R 1988; R 1998) Federal Seed Act |

FLORIDA DEPARTMENT OF TRANSPORTATION AND FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (FDOT/FDEP)

| | |
|---|---|
| FDOT/FDEP | (July 2013) Erosion and Sedimentation Control Designer and Reviewer Manual |

### 1.4 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-01 Preconstruction Submittals

Work Sequence Schedule

Erosion Control Plan

Equipment

SD-02 Shop Drawings

Erosion Control Measures Layout

Silt Fence

Soil Tracking Device

Adjustments for Obstructions

Sediment or Settling Ponds

Maintenance Record

SD-03 Product Data

Wattles

Seed

Wood Hydraulic Mulch

Plastic Sheeting

SD-07 Certificates

Tier II FDEP Qualified Inspector

Mulch

Wood Hydraulic Mulch

Geotextile Fabrics

Installer's Qualification

SD-10 Operation and Maintenance Data

Maintenance Instructions

## 1.5 QUALITY CONTROL

### 1.5.1 Installer's Qualification

The installer must be certified by the manufacturer for training and experience installing the material. Submit the installer's company name and address, and/or certification.

1.5.2 Erosion Potential

Assess potential effects of soil management practices on soil loss in accordance with ASTM D6629. Assess erodibility of soil with dominant soil structure less than 2.8 to 3.1 inches in accordance with ASTM D5852.

1.5.3 Substitutions

Substitutions will not be allowed without written request and approval from the District.

1.5.4 Equipment

Submit a listing of equipment to be used for the application of erosion control materials.

1.5.5 Seed Quality

Inspect seed upon arrival at the jobsite for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, must be rejected.

1.6 DELIVERY, STORAGE, AND HANDLING

Prior to delivery of materials, submit certificates of compliance attesting that materials meet the specified requirements. Store materials in designated areas and as recommended by the manufacturer protected from the elements, direct exposure, and damage. Do not drop containers from trucks. Material must be free of defects that would void required performance or warranty.

a. Furnish erosion control blankets and geotextile fabric in rolls with suitable wrapping to protect against moisture and extended ultraviolet exposure prior to placement. Label erosion control blanket and geotextile fabric rolls to provide identification sufficient for inventory and quality control purposes.

b. Furnish and deliver plastic sheeting in rolls. Store the rolls off the ground and cover the rolls to protect against moisture and extended ultraviolet exposure prior to placement.

c. All synthetic grids, synthetic sheets, and articulating cellular concrete block grids must be sound and free of defects that would interfere with the proper placing of the block or impair the strength or permanence of the construction. Minor cracks in synthetic grids and concrete cellular block, incidental to the usual methods of manufacture, or resulting from standard methods of handling in shipment and delivery, will not be deemed grounds for rejection.

d. Inspect seed upon arrival at the jobsite for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, must be rejected.

1.7 SCHEDULING

Submit a construction work sequence schedule, with the District approved erosion control plan a minimum of 30 days prior to start of construction.

The work schedule must coordinate the timing of land disturbing activities with the provision of erosion control measures to reduce on-site erosion and off-site sedimentation. Coordinate installation of temporary erosion control features with the construction of permanent erosion control features to assure effective and continuous control of erosion, pollution, and sediment deposition. Include a vegetative plan with planting and seeding dates and fertilizer, lime, and mulching rates. Distribute copies of the work schedule and erosion control plan to site subcontractors. Submit an erosion control plan for review and approval by the District. Address the following in the erosion control plan:

a. Statement of erosion control and stormwater control objectives.

b. Description of temporary and permanent erosion control, stormwater control, and air pollution control measures to be implemented on site.

c. Description of the type and frequency of maintenance activities required for the chosen erosion control methods.

d. Comparison of proposed post-development stormwater runoff conditions with predevelopment conditions.

## 1.8 FDEP QUALIFICATION

Contractor shall provide a full time Tier II FDEP Certified Inspector for the life of the construction project. Contractor shall submit FDEP certification for the Tier II FDEP Qualified Inspector. The inspector will be critical to the management, prevention and mitigation of erosion and sediment migration.

## 1.9 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 GENERAL

Provide temporary erosion and sediment control products that either do not contain netting, or that contain netting manufactured from 100 percent biodegradable non-plastic materials such as jute, sisal, or coir fiber. Degradable, photodegradable, UV-degradable, oxo-degradable, or oxo-biodegradable plastic netting (including polypropylene, nylon, polyethylene, and polyester) are not acceptable alternatives. Netting used in these products should have a loose-weave wildlife-safe design with movable joints between the horizontal and vertical twines, allowing the twines to move independently and thus reducing the potential for wildlife entanglement.

Plastic sheeting is an acceptable material for protecting against erosion however it should be limited to small areas and for short durations.

## 2.2 SILT FENCE

Silt fence fabric shall meet the following specifications:

| PROPERTY | UNITS | ACCEPTABLE VALUES | TEST METHOD |
|---|---|---|---|
| Minimum tensile strength | lbs | 120 | ASTM D 4632 |
| Maximum Elongation | lbs | 60 at <15% | ASTM D 4632 |
| Minimum Puncture Strength | lbs | 50 | ASTM D 4833 |
| Minimum Tear Strength | lbs | 40 | ASTM D 4533 |
| Apparent Opening Size | mm | < = 0.84 | ASTM D 4751 |
| Minimum Permittivity | sec. -1 | 1X10-2 | ASTM D 4491 |
| Water Flow Rage | gal/min/sq ft | 15 | |
| UV Exposure Strength Retention | Percent | 70 at 500 hours | ASTM G 4355 |

The Contractor shall submit shop drawings of the silt fence for review and approval. Provide the certifications and test reports for the geotextile fabrics.

Provide type and size of posts, wire reinforcement and post spacing (if required) as indicated. Provide a durable and effective silt fence that controls sediment as indicated in the drawings and comparable to the Erosion and Sediment Control Designer and Reviewer Manual (FDOT/FDEP).

## 2.3 WATTLES

Provide staked straw filled wattles with a minimum diameter of 9 inches.

## 2.4 MULCH

Mulch must be free from weeds, mold, and other deleterious materials. Mulch materials must be native to the region. Submit certification that the mulch meets the specification requirements.

### 2.4.1 Straw

Straw must be stalks from oats, wheat, rye, barley, or rice, furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment.

### 2.4.2 Hay

Hay must be native hay, sudan-grass hay, broomsedge hay, or other herbaceous mowings, furnished in an air-dry condition suitable for placing with commercial mulch-blowing equipment.

### 2.4.3 Coir

Coir must be manufactured from 100 percent coconut fiber cured in fresh water for a minimum of 6 months.

### 2.4.4 Wood Hydraulic Mulch

Wood hydraulic mulch must be made of 100 percent total recovered material. Wood must be naturally air-dried to a moisture content of 10.0 percent, plus or minus 3.0 percent. A minimum of 50 percent of the fibers must be equal to or greater than 0.15 inch in length and a minimum of 75 percent of the

fibers must be retained on a 28 mesh screen. No reprocessed paper fibers must be included in the hydraulic mulch. Submit a certification that the wood hydraulic mulch meets the specification requirements. Hydraulic mulch must have the following mixture characteristics:

| CHARACTERISTIC (typical) | VALUE |
|---|---|
| pH | 5.4 + 0.1 |
| Organic Matter (oven dried basis) | percent 99.3 within + 0.2 |
| Inorganic Ash (oven dried basis) | percent 0.7 within + 0.2 |
| Water Holding Capacity | percent 1,401 |

## 2.5 PLASTIC SHEETING

Plastic sheeting shall be clear polyethylene and have a minimum thickness of 6 mil. Submit product information for the plastic sheeting.

## 2.5 SEED

Submit classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested.

### 2.5.1 Seed Classification

Provide the certification of the State-certified native seed mix of the latest season's crop in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Conform labels to the AMS Seed Act and applicable state seed laws. Submit the calendar time for Seed Establishment Period. When there is more than one seed establishment period, the boundaries of the seeded area covered for each period must be described.

### 2.5.2 Quality

Weed seed must be less than 1 percent by weight of the total mixture.

## 2.6 STAKING

Stakes must be 100 percent biodegradable manufactured from plastic or wood and must be designed to safely and effectively secure erosion control blankets for temporary or permanent applications. The biodegradable stake must be fully degradable by biological activity within a reasonable time frame. The bio-plastic resin used in production of the biodegradable stake must consist of polylactide, a natural, completely biodegradable substance derived from renewable agricultural resources. The biodegradable stake must exhibit ample rigidity to enable being driven into hard ground, with sufficient flexibility to resist shattering. Serrate the biodegradable stake on the leg to increase resistance to pull-out from the soil.

## 2.7 SOIL TRACKING DEVICE

The soil tracking device is a temporary feature used during construction to assist with removal of soil material captured on vehicles tires entering and leaving the site. It is to be constructed at major entrances and exits of

the construction site. Refer to the Drawings for the proposed locations. The course aggregate shall conform to the FDOT No. 1 aggregate. The filter fabric shall be Type R-2 meeting the physical requirements of FDOT Section 985.

## 2.8 FLOATING TURBIDITY BARRIER

Refer to Section 33 03 00 TURBIDITY CONTROL AND MONITORING for the floating turbidity barrier.

# PART 3 EXECUTION

## 3.1 GENERAL

This project is a large earthwork project that will potentially expose many acres and sections along the dam, canals, benches, access roads and other construction components of unprotected bare earth until the final and permanent ground cover has been applied. Several erosion protection measures have been indicated and specified. It is the Contractor's responsibility to provide, install, and maintain these erosion protection measures and others that the Contractor feels are necessary to provide adequate erosion protection through the final inspection and acceptance of the project.

Dam embankment slopes placed at final grade shall receive permanent erosion control measures as soon as practical, but not longer than two weeks. In no case shall more than 5 acres (per working front) be exposed without temporary or final erosion control measures. Contractor shall install temporary erosion control measures on surfaces to receive permanent measures other than grassing.

Prior to any known rainfall events during the progression of the dam embankment construction the contractor shall, and prior to shutting down for the day, construct temporary earth berms, or windrows, at the top of bank on both sides of crest of the dam embankment(s). The intent is to minimize the rills and gullies that are created by surface runoff. The earth berm or windrow shall be a minimum of one (1) foot tall. The earth berm or windrow shall remain until work continues on that section of the embankment. Additionally, prior to any known rainfall event, the Contractor shall place and secure plastic sheeting over dam embankment slopes and canal slopes that do not have an established vegetative cover and are subject to erosion from the surface water runoff.

In the event a section(s) of the dam embankment will lay dormant for two weeks or more the contractor shall construct a temporary earth berm or windrow, as mentioned above, at the top of bank on both sides of crest of the dam embankment(s) and establish a stand of temporary grass on both the landward and waterward sides of the dam embankment. The temporary earth berm or windrow and the temporary grassing shall be maintained until embankment construction resumes.

In the event a section(s) of the perimeter canal or the Townsend Canal will lay dormant for two weeks or more the contractor shall construct a temporary earth berm or windrow, as mentioned above, at the top of bank(s) of the canal and establish a stand of temporary grass on the exposed ground not permanently inundated by water in the canal. The temporary earth berm or windrow and the temporary grassing shall be maintained until construction

resumes on that section(s) or permanent erosion protection can be constructed.

3.2 WEATHER CONDITIONS

Perform erosion control operations under favorable weather conditions; when excessive moisture or other unsatisfactory conditions prevail, the work must be stopped as directed. When special conditions warrant a variance to earthwork operations, submit a revised construction schedule for approval. Do not apply erosion control materials in adverse weather conditions which could affect their performance.

3.3 LAYOUT

Submit scale drawings of an erosion control measures layout that defines areas to receive recommended materials as required by federal, state or local regulations. Erosion control material locations may be adjusted to meet field conditions.

3.4 PROTECTING EXISTING VEGETATION

When there are established lawns in the work area, the turf must be covered and/or protected or replaced after construction operations. Identify existing trees, shrubs, plant beds, and landscape features that are to be preserved on site by appropriate tags and barricade with reusable, high-visibility fencing along the dripline. Mitigate damage to existing trees at no additional cost to the District. Damage must be assessed by a state certified arborist or other approved professional using the National Arborist Association's tree valuation guideline.

3.5 ADJUSTMENTS FOR OBSTRUCTIONS BELOW GROUND

When obstructions below ground affect the work, submit shop drawings showing proposed adjustments to placement of erosion control material for approval.

3.6 INSTALLATION

3.6.1 Silt Fence

1. Install staked silt fence as indicated prior to any backfilling, clearing and grubbing, dredging, or excavation.

2. Remove silt fence system at completion of construction.

3.6.2 Sediment or Settling Ponds

1. Install sediment or settling ponds where necessary to capture runoff or groundwater to allow the suspended particles to settle prior to discharging to the receiving water(s). Submit shop drawings of the proposed sediment or settling ponds including the pond location, the routing of the runoff into and out of the pond and the point(s) of discharge from the ponds.

2. Maintain ponds during construction.

3.6.3 Earth Berms

1. Construct earth berms as discussed earlier as a temporary measure to mitigate runoff that could erode the face of embankment fill slopes. Construct these earth berms in advance of anticipated rainfall events.

### 3.6.4 Wattles

1. Submit product data for the wattles.

2. Install wattles on the embankment slopes as indicated.

3. Maintain and replace damaged or missing wattles until the embankment slope is stabilized and has an established stand of grass.

4. Remove the wattle system at the completion of construction but not before the embankment slope is stabilized and has an established stand of grass.

### 3.6.5 Plastic Sheeting

Secure the plastic sheeting by toeing in and burying the edges in trenches providing a minimum of 1 foot of cover over the edge of the sheeting. Secure the field of the sheeting with pins suitable in length to hold the sheeting in place during a heavy windstorm. Provide an energy dissipation system (i.e. temporary riprap) at the toe of the slopes covered with sheeting to prevent erosion caused by the runoff.

### 3.6.6 Seeding, Fertilizing, Mulching

Install seed, fertilizer and mulch in accordance with Section 32 92 19 SEEDING.

## 3.7 CLEAN-UP

Dispose of excess material, debris, and waste materials offsite at an approved landfill or recycling center. Clear adjacent paved areas. Immediately upon completion of the installation in an area, protect the area against traffic or other use by erecting barricades and providing signage as required, or as directed.

## 3.8 WATERING SEED

Start watering immediately after installing the seed and mulch. Apply water to supplement rainfall at a sufficient rate to ensure moist soil conditions to a minimum 1 inch depth. Prevent run-off and puddling. Do no drive watering trucks over turf areas, unless otherwise directed. Prevent watering of other adjacent areas or plant material.

## 3.9 MAINTENANCE RECORD

Submit a maintenance record describing the maintenance work performed, record of measurements and findings for product failure, recommendations for repair, and products replaced.

### 3.9.1 Maintenance

Maintenance must include but not be limited to eradicating weeds; protecting embankments, canals and ditches from surface erosion; maintaining the

performance of the erosion control materials and mulch; protecting installed areas from traffic.

### 3.9.2 Maintenance Instructions

Furnish written instructions containing drawings and other necessary information, describing the care of the installed material; including, when and where maintenance should occur, and the procedures for material replacement. Submit instruction for year-round care of installed material. Include manufacturer supplied spare parts.

### 3.9.3 Inspection, Repair, and Replacement

The silt fence shall be inspected by the Contractor every work day, after every rainfall event of 0.5 inches or greater in a 24-hour period, and after every extreme weather event that could dislodge or damage the silt fence system.

Remove built up sedimentation.

Damaged or ineffective silt fence that is reported to the Contractor shall be satisfactorily repaired or replaced within 2 days of the notification. At the District's discretion and no cost to the District the Contractor shall add silt fence to areas that demonstrate a need for erosion prevention and control. The additional silt fence shall be installed within 2 days of the notification.

Unless otherwise directed, damaged silt fence material must be replaced, seamed or patched as recommended by the manufacturer. Remove material not meeting the required performance as a result of placement, seaming or patching from the site. Replace the unacceptable material at no additional cost to the District.

It is anticipated that prolonged, unprotected exposure to the elements of embankments that are under construction will result in significant erosion damage. The Contractor shall maintain all slopes to prevent damage from erosion. Correct all damage to the earthworks under construction on a daily basis to prevent excessive erosion. Damage to previously placed embankment, drain or filter materials shall be reworked, corrected, recompacted and tested as specified. When notified by the District the Contractor shall correct all embankments damaged by erosion as directed. **See photo sheet drawing C-02701.**

## 3.10 SATISFACTORY STAND OF GRASS PLANTS

Evaluate the grass plants for species and health when the grass plants are a minimum 1 inch high. No bare areas comprising more than 1 percent of any given 1,000 square foot area. The total bare spots must not exceed 2 percent of the total vegetation area.

-- End of Section --

# SECTION 31 41 16

# SHEET PILING

## PART 1 GENERAL

### 1.1 REFERENCES

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

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A572/A572M | (2015) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| ASTM A6/A6M | (2016) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A328/A328M | (2013a) Standard Specification for Steel Sheet Piling |
| ASTM A690/A690M | (2013a) Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments |
| ASTM A857/A857M | (2007; R 2013) Standard Specification for Steel Sheet Piling, Cold-Formed, Light Gage |
| ASTM B221 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM B221M | (2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) |
| ASTM B308/B308M | (2010) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles |
| ASTM D4216 | (2017) Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) and Related PVC and Chlorinated Poly (Vinyl Chloride) (CPVC) Building Products Compounds |

| | |
|---|---|
| ASTM F964 | (2013) Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Exterior Profiles Used for Fencing and Railing |

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Sheet Piling

Vinyl Sheet Piling

Vinyl Sheet Piles Cross Sectional Data

Pile With Interlocks

SD-03 Product Data

Driving

Pile Driving Equipment

Pulling and Redriving

Vinyl Sheet Piles Cross Sectional Data and Interlocks

SD-06 Test Reports

Materials Tests

Vinyl Sheet Piles Certificate of Analysis

Certificate Of Analysis

SD-11 Closeout Submittals

Pile Driving Record

Vinyl Sheet Pile Warranty

manufacturer/OEM warranty

## 1.3 QUALITY REQUIREMENTS

### 1.3.1 Material Certificates

For each shipment, submit certificates identified with specific lots prior to installing piling. Include in the identification data piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Materials delivered to the site shall be new and undamaged and shall be accompanied by certified test reports. Provide the Manufacturer's logo and mill identification mark on the sheet piling as required by the referenced specifications. Store and handle sheet piling in the manner recommended by the Manufacturer to prevent permanent deflection, distortion or damage to the interlocks; as a minimum, support on level blocks or racks spaced not more than 10 feet apart and not more than 2 feet from the ends. Storage of sheet piling should also facilitate required inspection activities and prevent damage to coatings and corrosion prior to installation.

## 1.5 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 METAL SHEET PILING

Submit detail drawings for sheet piling, including fabricated sections, showing complete piling dimensions and details, driving sequence and location of installed piling.

a. Include in the drawings details of top protection, special reinforcing tips, tip protection, lagging, splices, fabricated additions to plain piles, cut-off method, corrosion protection, and dimensions of templates and other temporary guide structures for installing piling. Provide details of the method for handling piling to prevent permanent deflection, distortion or damage to piling interlocks.

b. Metal sheet piling shall be hot-rolled steel sections conforming to ASTM A572/A572M, Grade 50. Use of cold rolled and/or cold formed sheets for temporary or permanent sheet piles is not permitted.

c. For protection of sheet piling, coat in accordance with Section 09 06 90 PROTECTIVE COATINGS.

### 2.1.1 Interlocks

The interlocks of sheet piling shall be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed.

### 2.1.2 General Requirements

Sheet piling shall be full-length sections of the dimensions shown. Temporary sheet piling shall be provided with standard pulling holes.

## 2.2 APPURTENANT METAL MATERIALS

Provide metal plates, shapes, bolts, nuts, rivets and other appurtenant fabrication and installation materials conforming to Manufacturer's standards and to the requirements specified in the respective sheet piling standards and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

## 2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Requirements for material tests, workmanship and other measures for quality requirements and controls shall be as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS and Section 05 12 00 STRUCTURAL STEEL.

### 2.3.1 Materials Tests

Submit certified materials tests reports showing that sheet piling and appurtenant metal materials meet the specified requirements, for each shipment and identified with specific lots prior to installing materials. Material test reports shall meet the requirements of ASTM A6/A6M. Perform materials tests conforming to the following requirements. Sheet piling and appurtenant materials shall be tested and certified by the Manufacturer to meet the specified chemical, mechanical and section property requirements prior to delivery to the site. Testing of sheet piling for mechanical properties shall be performed after the completion of all rolling and forming operations. Testing of sheet piling shall meet the requirements of ASTM A6/A6M.

## 2.4 POLY VINYL CHLORIDE (PVC) SHEET PILING

### 2.4.1 Materials

PVC sheet piles shall be manufactured by a continuous extrusion process made of post-industrial recycled PVC as the substrate. The exterior portion, or "capstock", shall use UV-protected, virgin PVC for resistance against weather and UV degradation. Materials shall be made to ASTM F964.

### 2.4.2 Material Properties

Sheets shall have the following physical properties;

Width: 30 inches
Thickness: .385 inches
Depth: 10 inches
Moment of Inertia: 122 in4/ft.

All virgin PVC capstock used in sheet pile shall have a minimum cell classification of 1-42443-33 in accordance with ASTM D4216. The full composite product of the substrate and cap shall meet mechanical property requirements 2 through 8 of Table A-1.

Table A-1 PVC Sheet Pile ASTM D4216 Cell Classification Requirements

| Designation | Order # Properties | Cell Classification | Values |
|---|---|---|---|
| 1 | Type of Resin | 1 | PVC vinyl chloride copolymer |
| | Impact resistance | | |
| 2 | (1) Izod Notch Testing | 4 | >5 ft. lb./in |
| 3 | (2) Drop dart ASTM 4226 Procedure A 2 | 2 | >1.5 in. lb./mil |

| Designation | Order # Properties | Cell Classification | Values |
|---|---|---|---|
| 4 | (3) Drop dart ASTM 4226 Procedure B 4 | 4 | >3 in. lb./mil |
| 5 | Tensile strength | 4 | >6,500 psi |
| 6 | Modulus of elasticity | 3 | >377,000 psi |
| 7 | Deflection temperature under (264 psi) | 3 | >158 degrees Fahrenheit |
| 8 | Coefficient of linear expansion | 3 | <4.4 x 10-5 |

Submit the vinyl sheet piles cross sectional data and interlocks properties and vinyl sheet piling shop drawing of the pile with interlocks.

2.4.3 Warranty

Certificate of Analysis and Warranty. All exterior portions of the PVC sheet pile, which could become exposed to the elements, shall be manufactured with a virgin compound. ASTM D4216 shall be used to ensure proper formulation and quality. PVC sheet pile shall submit a certificate of analysis from an ISO 9001:2008 certified compounder indicating the minimum cell classification for the virgin PVC is 1-42443-33. A minimum 50 year manufacturer/OEM warranty for the final product shall be submitted.

PART 3 EXECUTION

3.1 EARTHWORK

Perform in accordance with Section 31 00 00 EARTHWORK. Pre-excavation will not be permitted. Backfill as indicated.

3.2 INSTALLATION

3.2.1 Pile Driving Equipment

Submit complete descriptions of sheet piling driving equipment including hammers, extractors, protection caps and other installation appurtenances, prior to commencement of Work. Descriptive information includes Manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, and templates. Provide pile driving equipment conforming to the following requirements.

3.2.1.1 Driving Hammers

Hammers shall be steam, air, or diesel drop, single-acting, double-acting, differential-acting type.

3.2.1.2 Jetting Equipment

Jetting will not be permitted for metal sheet walls.

### 3.2.2 Placing and Driving

#### 3.2.2.1 Placing

Any excavation required within the area where sheet pilings are to be installed shall be completed prior to placing sheet pilings. Pilings properly placed and driven shall be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

It is recommended that sheet piles along the west bank of the Townsend Canal are driven using the Press-in Method.

a. Pilings to be placed in cofferdam cells and connecting arcs shall be picked up and completely threaded to demonstrate that they slide freely in interlock. Caution shall be taken when using vibratory hammers when hard driving condition is encountered to avoid interlock melt or damages. Discontinue the use of vibratory hammers and instead use impact hammers when the penetration rate due to vibratory loading is one foot or less per minute. Refusal for impact hammers shall be defined as 10 blows per inch.

b. Pilings shall be carefully located as indicated. Pilings shall be placed plumb with out-of-plumbness not exceeding 1/4 inch per foot of length and true to line. Place the pile so the face will not be more than 6 inches from vertical alignment at any point. Top of pile at elevation of cut-off shall be within 1/2 inch horizontally and 2 inches vertically of the location indicated. Manipulation of piles to force them into position will not be permitted. Check all piles for heave. Redrive all heaved piles to the required tip elevation.

c. Provide temporary wales, templates, or guide structures to ensure that the pilings are placed and driven to the correct alignment. Use a system of structural framing sufficiently rigid to resist lateral and driving forces and to adequately support the sheet piling until design tip elevation is achieved. Use two templates, at least, when placing each piling at third points. Templates shall not move when supporting sheet piling. Fit templates with wood blocking to bear against the web of each alternate sheet pile and hold the sheet pile at the design location alignment. Provide outer template straps or other restraints as necessary to prevent the sheets from warping or wandering from the alignment. Mark template for the location of the leading edge of each alternate sheet pile. If in view, also mark the second level to assure that the piles are vertical and in position. If two guide marks cannot be seen, other means shall be used to keep the sheet pile vertical along its leading edge.

#### 3.2.2.2 Driving

Submit records of the completed sheet piling driving operations, including a system of identification which shows the disposition of approved piling in the Work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations of installed piling. Prior to driving pilings in water, paint a horizontal line on both sides of each piling at a fixed distance from the bottom so that it will be visible above the water line after installation. This line shall indicate the profile of the bottom elevation of installed pilings and potential problem areas can be

identified by abrupt changes in its elevation. Drive pilings with the proper size hammer and by approved methods so as not to subject the pilings to damage and to ensure proper interlocking throughout their lengths.

a. Maintain driving hammers in proper alignment during driving operations by use of leads or guides attached to the hammer.

b. Employ a protecting cap in driving when using impact hammers to prevent damage to the tops of pilings. Remove and replace pilings damaged during driving or driven out of interlock at the Contractor's expense.

c. Drive pilings without the aid of a water jet.

d. Take adequate precautions to ensure that pilings are driven plumb. Where possible, drive Z-pile with the ball end leading. If an open socket is leading, a bolt or similar object placed in the bottom of the interlock will minimize packing material into it and ease driving for the next sheet. If at any time the forward or leading edge of the piling wall is found to be out-of-plumb in the plane of the wall the piling being driven shall be driven to the required depth and tapered pilings shall be provided and driven to interlock with the out-of-plumb leading edge or other approved corrective measures shall be taken to insure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling shall be 1/8 inch per foot of length.

e. Pilings in each run or continuous length of piling wall shall be driven alternately in increments of depth to the required depth or elevation. No piling shall be driven to a lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. Incrementally sequence driving of individual piles such that the tip of any sheet pile shall not be more than 4 feet below that of any adjacent sheet pile. When the penetration resistance exceeds five blows per inch, the tip of any sheet pile shall not be more than 2 feet below any adjacent sheet pile. For cofferdam cells the driving increments shall be such that no piling leads the adjacent piling by more than 2 feet and the direction of advancing the driving hammer shall be reversed after each pass around the cell. If the piling next to the one being driven tends to follow below final elevation it may be pinned to the next adjacent piling.

f. If obstructions restrict driving a piling to the specified penetration, the obstructions shall be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical, make changes in the design alignment of the piling structure as directed to ensure the adequacy and stability of the structure. Pilings shall be driven to depths shown and shall extend up to the elevation indicated for the top of pilings. A tolerance of 12 inches above the indicated top elevation will be permitted. Pilings shall not be driven within 100 feet of concrete less than 7 days old.

g. Pre-augering or spudding of piles will not be permitted. However, at locations where 'Press-in Method' is used, press-in with simultaneous augering during sheet pile driving/pushing (which is part of the Press-in Method operation) will be acceptable. Press-in Method shall not be used for PVC Sheet Walls.

### 3.2.3 Cutting-Off and Splicing

Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance shall be cut off to the required elevation. Pilings driven below the required top elevation and pilings damaged by driving and cut off to permit further driving shall be extended as required to reach the top elevation by splicing when directed at no additional cost to the District. If directed, pilings shall be spliced as required to drive them to depths greater than shown and extend them up to the required top elevation.

a. Pilings adjoining spliced pilings shall be full length unless otherwise approved. Splicing of pilings shall be as indicated. Ends of pilings to be spliced shall be squared before splicing to eliminate dips or camber. Pilings shall be spliced together with concentric alignment of the interlocks so that there are no discontinuities, dips or camber at the abutting interlocks. Spliced pilings shall be free sliding and able to obtain the maximum swing with contiguous pilings. Welding of splices shall conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop and field welding, qualification of welding procedures, welders, and welding operators shall be in accordance with AWS D1.1/D1.1M.

b. The tops of pilings excessively battered during driving shall be trimmed when directed, at no cost to the District. Piling cut-offs shall become the property of the Contractor and shall be removed from the site.

c. Cut holes in pilings for bolts, rods, drains or utilities in a neat and workmanlike manner, as shown or as directed. Use a straight edge in cuts made by burning to avoid abrupt nicks. Bolt holes in steel piling shall be drilled or may be burned and reamed by approved methods which will not damage the surrounding metal. Bolt holes in aluminum pilings shall be drilled. Holes other than bolt holes shall be reasonably smooth and the proper size for rods and other items to be inserted. All holes in steel pilings on the wet side of cofferdams shall be made watertight by welding steel plates over the holes after the piling installation is completed. Do not use explosives for cutting.

### 3.2.4 Inspection of Driven Piling

Perform continuous inspection during pile driving. Inspect all piles for compliance with tolerance requirements. Bring any unusual problems which may occur to the attention of the Construction Manager. Inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock shall be removed and replaced at the Contractor's expense. Use divers to inspect underwater interlocked joints of cofferdam sheet piling. District divers may also inspect the interlocked joints. The inspection of cofferdams shall be performed after driving is completed, prior to filling each cell and connecting arc, and within 48 hours after filling each cell and arc.

### 3.2.5 Pulling and Redriving

Submit the proposed method of pulling sheet piling, prior to pulling any piling. Jetting will not be permitted to aid in the pulling or re-driving

sheet piles. Pull, as directed, selected pilings after driving to determine the condition of the underground portions of pilings. Any piling so pulled and found to be damaged, to the extent that its usefulness in the structure is impaired, shall be removed and replaced at the Contractor's expense. If pilings can be reused, the coatings shall be re-applied to the criteria specified. Pilings pulled and found to be in satisfactory condition shall be redriven when directed.

## 3.3 REMOVAL

The removal of sheet pilings shall consist of pulling, sorting, cleaning the interlocks, inventorying and storing previously installed sheet pilings as shown and directed.

### 3.3.1 Pulling

The method of pulling piling shall be approved. Provide pulling holes in pilings, as required. Extractors shall be of suitable type and size. Care shall be exercised during pulling of pilings to avoid damaging piling interlocks and adjacent construction. If the Construction Manager determines that adjacent permanent construction has been damaged during pulling, the Contractor will be required to repair this construction at no cost to the District. Pull pilings one sheet at a time. Pilings fused together shall be separated prior to pulling, unless the Contractor demonstrates, to the satisfaction of the Construction Manager, that the pilings cannot be separated. The Contractor will not be paid for the removal of pilings damaged beyond structural use due to proper care not being exercised during pulling.

### 3.3.2 Sorting, Cleaning, Inventorying and Storing

Pulled pilings shall be sorted, cleaned, inventoried and stored by type into groups as:

a. Piling usable without reconditioning.

b. Piling requiring reconditioning.

c. Piling damaged beyond structural use.

## 3.4 INSTALLATION RECORDS

Maintain a pile driving record for each sheet pile driven. Indicate on the installation record: installation dates and times, type and size of hammer, rate of operation, total driving time, dimensions of driving helmet and cap used, blows required per foot for each foot of penetration, final driving resistance in blows for final 6 inches, pile locations, tip elevations, ground elevations, cut-off elevations, and any reheading or cutting of piles. Record any unusual pile driving problems during driving. Submit complete records to the Construction Manager.

-- End of Section --

# SECTION 31 52 10

# DEWATERING AND COFFERDAM

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work: The Contractor shall furnish all labor, material and equipment necessary for the removal of all surface and subsurface waters from the footprint of the dam, structure excavations and other construction areas. This Section includes the installation of dewatering systems used in conjunction with an open excavation or cofferdam, temporary cofferdams with steel sheet piling and bracing, other systems as proposed by the Contractor, and for unwatering of areas of ponded surface waters. Also, this section includes the requirements for Contractor-designed excavation support systems such as sheeting, shoring, and bracing of open excavations greater than 4 feet deep, and dewatering of excavations. No sheet piling, either temporary or permanent, shall be installed within the central one third of the dam, or in any other area that will conflict with the dam's Soil Bentonite Wall and/or Select Fill seepage barriers. Sheet piling installation elsewhere shall consider the limitations on such as described in this specification.

The subsurface components include a clay stratum which is described as somewhat over-consolidated. Some of the structures that require sheet pile supported cofferdams exist within the footprints of existing and/or former preload fills that were constructed as part of Bid Package 1. The Contractor shall be aware of the presence of the over-consolidated clays and the impacts of these materials in the selection of sheet pile sections and sheet pile driving equipment.

The Work includes the removal of and/or cutting off temporary sheet piling and other temporary features at the completion of the Work. All aspects of the dewatering systems required for the project, including design, installation, operation, maintenance, and removal shall be the sole responsibility of the Contractor. The limits of the dewatering shall be determined by the Contractor for the various structures associated with Bid Package 4 work. All temporary excavation support systems, sheet pile walls, braced cofferdams, and/or earthen cofferdams associated with the work described in the Contract shall be wholly designed by the Contractor. This is a general summary and is not intended to be complete and all-inclusive of the required work items.

Related Section include but are not necessarily limited to:

Section 01 32 16 COST LOADING CONSTRUCTION SCHEDULES

Section 01 33 00 SUBMITTAL PROCEDURES

Section 01 11 00 SUMMARY OF WORK

Section 31 41 16 METAL SHEET PILING

Section 33 03 00 TURBIDITY CONTROL AND MONITORING

Section 31 00 00 EARTHWORK - EARTH DAM

Section 33 11 53 MONITORING WELLS

## 1.2 REFERENCES

Standards or Codes: The edition of the standards of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. See the various paragraphs for the specified standard. In the case of a conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A328 | Standard Specification for Steel Sheet Piling |
| ASTM A36/A36M | (2014) Standard Specification for Carbon Structural Steel |
| ASTM A572/A572M | (2015) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| ASTM D1785 | (2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D2241 | (2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) |
| ASTM D2488 | (2017) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) |

ASTM D2488 Description and Identification of Soils (Visual Manual Procedure)

U. S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-220-05 | Dewatering and Groundwater Control |

INTERNATIONAL CODE COUNCIL (ICC)

ICC FBC Florida Building Code

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

29 CFR 1910 Occupational Safety and Health Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 1110-2-1901 | Seepage Analysis & Control for Dams |
| EM 1110-2-1902 | Slope Stability |
| EM 1110-1-1905 | Bearing Capacity of Soils |

| | |
|---|---|
| EM 1110-2-2504 | Design of Sheet Pile Walls |
| EM 1110-2-2906 | Design of Pile Foundations |
| EM 385-1-1 | (2014) Safety and Health Requirements Manual |
| ER 1110-2-8152 | Planning and Design of Temporary Cofferdams and Braced Excavations |

ADDITIONAL REFERENCE MATERIAL:

a. Geotechnical Site Characterization Report, Bid Package 4.

b. Generalized ~~Suggested~~ Excavation & Dewatering Plan, Bid Package 4 Structures. Note: the term "Generalized" as used in this specification, is intended to demonstrate that the excavation and dewatering plans have been thought through, developed and presented only to demonstrate their viability. The "generalized" plans and sequencing do not relieve the Contractor from developing his/her own plans for District review and approval before implementing them. The sheet pile sections shown in the Generalized Excavation & Dewatering Plan were determined based upon stability analyses. The Contractor shall perform their own stability and drivability analyses to determine the sheet pile sections required for accomplishing the work for each structure location.

## 1.3 DEFINITIONS

### 1.3.1 Cofferdam

Either a steel sheet pile supported excavation, a braced excavation, or an earthen plug placed in a water body, used to facilitate dewatering for the purpose of creating a dry working area.

### 1.3.2 Excavation Support Systems

Sheet piling and/or wood lagging used to create a safe excavation. Typically, such systems are used in concert with sheet pile cofferdams and braced excavations.

### 1.3.3 Dewatering

Groundwater and/or surface water lowering for the purpose of creating a dry working space. Dewatering is a contract requirement for any excavation that bottoms below the phreatic surface, as well as for any construction activity that requires foundation soil preparation, ditch/canal cleaning and remediation, structure excavations and other areas of the project.

### 1.3.4 Unwatering

Removal of ponded and/or existing surface waters within specific areas of the site.

### 1.3.5 Prepared Foundation Grade

Ground surface resulting from stripping to remove vegetation and root systems, excavation for removal of buried conduits, excavation to subgrade

levels upon which dam materials are to be constructed, and excavation (and associated dewatering) to clean existing 10th Row Ditches, canals and other pre-existing excavations in the footprint of the dam and to the lateral extent shown on the Drawings.

## 1.4 SYSTEM DESCRIPTION

Where excavation support systems are shown or become necessary for dewatering of excavations, they shall be furnished, placed, maintained, and except as shown or specified otherwise, removed by the Contractor. Sheet piling within the footprint of the dam plus a horizontal margin of 20 feet beyond the upstream toe of dam and 50 feet beyond the downstream toe of the dam shall be cutoff below the prepared foundation grade and abandoned in place. The Contractor shall be responsible for the design and selection of methods for areas shown on the Drawings and in conformance with OSHA and the design criteria as specified herein.

Contractor-designed cofferdams (steel or earthen) and excavation support systems shall be designed, and shop drawings signed and sealed, by a Professional Engineer licensed to practice in the State of Florida and experienced in the design of cofferdams and excavation support systems. Applicable designs should be in accordance with EM 1110-1-1905, EM 1110-2-1901, EM 1110-2-1902, EM 1110-2-2504, EM 1110-2-2906, ER 1110-2-8152 and EM 385-1-1. Contractor design and construction of all systems for the support of excavation shall be in accordance with the codes and standards referenced herein and other design standards and manufacturers guidelines, as appropriate.

### 1.4.1 Excavation Support Systems

#### 1.4.1.1 Design Requirements

The design, planning, installation, and removal and/or abandoning, if required, of all sheeting, shoring, H piles, walers and supports, lagging and bracing and laying back slopes shall be accomplished in such a manner as to maintain the required excavation for structures and to maintain the undisturbed state of the soils below and adjacent to the excavation.

The use of open cut excavation and/or the method of excavation support shall be selected and designed by the Contractor and reviewed by the District.

## 1.5 SUBMITTALS

The Contractor shall make submittals for the following items in accordance with Section 01 33 00 SUBMITTAL PROCEDURES. Submittals are to be made not less than 60 days prior to anticipated start of work activity covered under each submittal.

SD-01 Preconstruction Submittals

Dewatering Plan

Cofferdam Work Plan

Contingency Plan

Support of Excavation Submittals

Open Cut Excavation Stability Plan

Earthen Cofferdam Plan

Dewatering Schedule

Qualifications of Civil/Geotechnical Engineer

Surface Water Management Plan

SD-02 Shop Drawings

Proposed Modifications to Dewatering Systems During Construction

SD-03 Product Data

Filter Sand

Sheet Pile

Structural Steel

SD-05 Design Data

Design Criteria

1.5.1 Requirements

In general, dewatering system design shall follow guidelines in UFC 3-220-05 or this section, whichever is more stringent. The dewatering system shall be installed and operated to maintain dry excavations and to lower the phreatic and piezometric levels below the bottom of the excavations for the duration of construction activities as required in this Specification until approval by the District to cease dewatering operations. Dewatering effluent may be stored on site provided storage areas are designed and documented in the Contractor's Surface Water Management Plan, as described in Section 31 00 00.

1.5.1.1 Dewatering Plan

A Dewatering Plan detailing how surface and groundwater will be controlled throughout construction shall be submitted for District approval. Each excavation that requires dewatering shall be described in the plan, including typical dewatering efforts for ditches and canals, as well as specific excavations for hydraulic structure foundations and for reclamation of major canals (i.e. Header, Roberts and Banana Branch Canals) where the footprint of the dam crosses these features.

Acquire all permits required to discharge water and protect waterways from turbidity during the dewatering operation. Special permit conditions associated with the dewatering permit for the S-476 Pumping Station (Bid Package 2) stated that the maximum allowable elevation for the dewatering for that project was -30 feet NAVD. Contractors bidding this project should anticipate similar special conditions will apply to the construction dewatering permit for all Bid Package 4 excavations.

The Contractor shall demonstrate a minimum of ten (10) years of experience in the construction of dewatering systems including, but not limited to, sheet pile, pumping, well point installation and extraction, and earthen cofferdams. The dewatering system design engineer shall be a Florida licensed professional engineer with a minimum of ten (10) years of experience in performing similar work. Surface and/or groundwater control will likely require as a minimum the use of a single stage or multistage well point system, the use of temporary diversion ditches, deep wells, containment berms, and dewatering by the use of pumping and sumps may also be required to maintain a dry excavation. The information submitted in the dewatering plan shall be in accordance with all project permit requirements. The following information shall be included in the Dewatering Plan:

a. Qualifications of the design professionals responsible for design and operation of the dewatering system and safety inspection procedures. The dewatering plans and calculations for the dewatering system shall be signed and sealed by a registered professional engineer licensed in the State of Florida.

b. Site plan of the project component with a description of the dewatering system and equipment, well details including installation and removal procedures, layout including the location of sumps, well points, deep wells, backup pumps, temporary containment berms, cofferdams, or diversion ditches as necessary; details of pumped wells, monitoring wells and piezometers (i.e. depths and diameters); installation and removal methods; details for location, installation, construction, and abandonment of all piezometers; description and layout for the onsite water detention system; location of the proposed discharge points, discharge rates, and the associated water quality monitoring location; and re-watering procedures.

c. A detailed description of the sequence of construction and dewatering, including a description of control elevations during cofferdam/stability berm construction, and control elevations during construction. A description of the groundwater level monitoring plan shall also be provided.

d. The location and type of turbidity control devices and methods necessary to ensure State Water Quality will be met.

e. Calculations estimating the area of influence of dewatering, depth of dewatering, pumping rates, duration and volumes, and stability of system, consistent with planned construction activities.

f. A plan for construction of each temporary cofferdam system. The plan shall contain a description of the type of cofferdam, a list of materials to be used, and a detailed installation and removal sequence.

g. An operational plan, which demonstrates that the discharge to the receiving water body meets all applicable State Water Quality standards prior to discharge, and also contains the proposed sampling locations and daily turbidity measurements.

h. A contingency plan, which includes procedures for ceasing dewatering operations and corrective actions (to include a contingency plan in the event proper dewatering as per the Contractor's design is not achieved) until water quality standards are met. The contingency plan shall also

include provisions for maintenance of dewatering systems such as cleaning dewatering components and responding to biofouling.

i. A plan for re-watering the site so that no adverse impacts to the structure and/or surrounding landform occur. At a minimum, include the proposed rate of groundwater level rise.

Earthwork operations shall not commence until the Dewatering Plan is approved. The Contractor shall allow 45 calendar days in the schedule for the District's review. No adjustments for time or money will be made if resubmittal of the Dewatering Plan is required due to deficiencies in the plan.

1.5.1.2 Cofferdam Work Plan

Submit certification from a Professional Engineer registered in the State of Florida that the temporary cofferdam has been designed to meet the criteria specified herein.

Two (2) sets of signed and sealed prints of the temporary cofferdam system shall be submitted to the District including a signed and sealed design report with all back-up information as described below. Cofferdam as described herein may consist of either a steel sheet pile supported excavation, a braced excavation, or an earthen plug.

1.5.1.2.1 Submittal Information

Prior to commencing excavation Work requiring temporary excavation support systems such as sheeting, shoring, and bracing, or the construction of an earthen cofferdam, the Contractor shall submit its plans for excavation support systems and/or earth slopes to the District for review. No excavations or dewatering shall be started until the submittal review of the excavation support system and/or earth slopes is complete. This review by the District of the Contractor's design shall not be construed as a detailed analysis for adequacy of the support system, nor shall any provision of the above requirements be construed as relieving the Contractor of its overall responsibility and liability for the Work. Information to be provided shall be made in accordance with these Contract Documents and shall include the following:

a. A general description of the type of cofferdam to be constructed (i.e. earthen or sheet pile supported).

b. Materials to be utilized for earthen cofferdam construction, embankment typical sections, seepage and stability calculations, etc.

c. Method of installation and removal and/or abandoning of all sheeting, sheet piling, soldier piles, tie backs, soil anchors, shoring, and bracing, as applicable.

d. These are described more fully in the following sections of this specification.

e. Design and details for safe access and protection for all workers and inspection personnel.

1.5.1.3 Support of Excavation Submittals

The following shall be submitted in compliance with the Contract Documents, and in concert with the requirements stated in Section 1.5.1.9.

a. The proposed excavation support system for each construction component where excavation support systems shall be used.

b. Arrangement, size and details for each excavation support system, and construction method to be used for the installation of each system.

c. Certified calculations shall be submitted for Contractor engineered support of excavation systems.

d. The geotechnical information collected and prepared for the project design and made available to the Contractor via the provided reference material shall be used for support of excavation design. In the event additional geotechnical information (including the water table) is required for complete design of Contractor designed systems, the Contractor shall be responsible for collecting this information and additional geotechnical recommendations and design values shall be part of the sealed calculations for support of excavation design at no additional cost to the District.

e. Depths below the main excavation bottom elevation to which the support system shall be installed.

f. Elevations of ground surface, struts, and shores, as applicable. Elevation datum shall be NAVD 1988.

g. Permissible depth to which excavation may be carried before supports must be installed and preloaded.

h. Preloads, as required.

i. Proposed sequence of strut, tie-back, and shore removal as applicable and as related to backfilling operations.

The above submittals shall be coordinated by the Contractor with other submittals for Work specified elsewhere in which support of excavation is required.

Contingency plans for alternative procedures to be implemented if the excavation support system is found to perform unfavorably or if obstructions are encountered during driving.

1.5.1.4 Open Cut Excavation Stability Plan

The Contractor shall submit to the District a site-specific Open Cut Excavation Stability Plan for each and every structure where an open cut in excess of 4 feet deep is planned or proposed. The slope stability plan shall include the requirements for dewatering, slope angle, slope stability factor of safety, equipment and stockpile surcharge load limitations at top of bank and monitoring of the safety of the excavation slopes. The plan shall also include requirements for inspection of slope stability by the Contractor's engineer, and a description of remedial work to be implemented in the event of a slope failure or slide. The plan shall be developed by

the Contractor's geotechnical engineer based upon criteria set forth in EM 1110-2-1902.

1.5.1.5 Earthen Cofferdam Plan

The Contractor shall submit to the District a site-specific Earthen Cofferdam Plan for each and every structure where such work is anticipated. For example, if the Contractor desires to unwater a portion of an existing canal or other water feature, an earthen plug may be utilized, provided it is designed and constructed in accordance with this specification. The earthen plug or cofferdam shall be designed to resist the full hydrostatic pressure acting upon it, and shall be designed to manage seepage through the earthen plug. Seepage and stability of the earthen cofferdams shall be designed, constructed and monitored by the contractor in accordance with criteria established in the USACE EM's listed in Section 1.2 of this specification. The plan shall be developed by the Contractor's geotechnical engineer. Contractor shall coordinate submittals for Earthen Cofferdam Plans with the requirements for such work described in Section 31 00 00.

1.5.1.6 Dewatering Schedule

The design, installation, operation, scheduled maintenance and system(s) decommissioning for all dewatering systems shall be shown on the Construction Schedule in accordance with requirements described in Section 01 32 16 COST LOADING CONSTRUCTION SCHEDULES. The schedule shall include, at minimum, pump testing, system construction, drawdown time anticipated start of excavation, duration of operations, and system performance monitoring.

1.5.1.7 Information on Completed Dewatering Systems during Construction

a. Provide records of all equipment and dewatering system components installed and/or replaced and updated inventories of backup parts on a weekly basis. Provide daily reports to include monitoring records and a description of dewatering system components in operation. Pumping systems shall be calibrated to determine actual discharge volumes.

b. Provide the weekly summaries of the daily readings associated with monitoring of the dewatering system. For pumping wells and/or systems, provide daily volumetric flow rates and changes in flow rates over the subject week, and documentation for maintenance activities during that week. For each observation well and piezometer, the measured data shall be presented in tabular and graphical real time data plots, so that the District can evaluate the dewatering progress by comparing the initial, current and required groundwater elevations. In the event that monitoring suggests the system is not in compliance with these Specifications and Drawings or the submitted dewatering system design, the Contractor shall immediately notify the District.

c. Within 5 working days of installation, the Contractor shall provide "as- built" records and diagrams for all drill holes, wells and/or other applicable installations. The records shall be prepared by a Florida licensed well driller, registered professional civil engineer licensed in the State of Florida, or registered professional geologist licensed in the State of Florida. All subsurface materials encountered during drilling of dewatering and piezometers shall be logged and sampled in accordance with ASTM D2488 by a licensed Geologist, Engineer, Engineering Geologist or dewatering specialist provided by

the Contractor. The Work is to provide additional subsurface information and documentation of the geologic conditions. Logging shall include drilling method, depth, elevation, description of subsurface materials, changes in subsurface materials, drill action, and driller's notes, and other relevant information noted during drilling and installation, all in accordance with Specification Section 33 11 53 MONITORING WELLS. Field logs shall be submitted to the District upon completion of each well.

1.5.1.8 Proposed Modifications to Dewatering Systems During Construction

As necessary to achieve required dewatering levels, for the convenience of the Contractor, or as required by the District, additional dewatering and/or unwatering systems of sheet pile supported excavations, open cut excavations and/or ditches may be designed, constructed, and operated by the Contractor. The Contractor shall submit the Proposed Modifications to Dewatering Systems During Construction for review and approval by the District. At a minimum the following shall be submitted for review and approval:

a. A description of the supplemental or modified dewatering or unwatering system including the reason for the system. Information should include the general geology, soil and groundwater conditions, and characteristics at the location to be dewatered.

b. Design of all supplemental or modified dewatering system components including methods of analysis, assumptions, standards, reference materials, and detailed calculations.

c. Final design Drawings and Specifications that show and describe the dewatering or unwatering system(s), including a plan, appropriate sections and details, and as applicable pump and pipe capacity and size, power systems and associated demands, filter gradation, surface water control, valves, spare parts list and disposal of water.

d. A list of required equipment and labor, water discharge points, erosion and sediment control measures or precautions, equipment operation and maintenance schedules, and decommissioning plans.

e. Other information as needed for a complete plan submittal or as requested by the District.

1.5.1.9 Design Criteria

Shop drawings for the various excavation support systems shall be prepared in accordance with the following criteria, as well as the requirement of Section 1.5.1.3.

a. Design the excavation support systems and all components to support the earth pressures, unrelieved hydrostatic pressures, utility loads, equipment, traffic, and construction loads including impact, and other surcharge loads in such manner as will allow the safe and expeditious construction of the permanent structures to minimize ground movement or settlement, and to prevent damage to or movement of adjacent structures, access drives, and utilities. Design for loads appropriate for conditions present at the site or anticipated to be present at the time of construction.

b. Design support members to resist the maximum loads expected to occur during the excavation and support removal stages.

Vertical support capacity shall be provided for wall systems and internal bracing elements, for loads due to vertical force components of tieback anchors, the weight of the structural systems themselves, and live load on any portion of the system. No tie-backs shall be allowed within the footprint of the dam. All sheeting within the footprint of the dam shall be cutoff below grade and abandoned in place.

## 1.6 QUALIFICATIONS

### 1.6.1 Contractor Qualifications

The Contractor shall demonstrate a minimum of ten (10) years experience in the construction of dewatering systems including, but not necessarily limited to, sheet pile, pumping and cofferdams.

### 1.6.2 Qualifications of Civil/Geotechnical Engineer

This individual shall be a State of Florida registered professional engineer, specializing in geotechnical engineering, and having not less than 10 years of design and construction experience related to earth dams, levees and cofferdams. They shall be responsible for designing sheeted excavations, open cut excavations, braced cofferdams, earthen cofferdams and related dewatering systems necessary to accomplish the work. Designs shall be in accordance with the Engineering Manuals (EM's) cited in this specification. Design submittals shall be signed and sealed by this individual.

## 1.7 GENERAL PROVISIONS

### 1.7.1 Groundwater Elevations

Groundwater shall be maintained within the limits of the dewatered excavation (including sheeted cofferdams, earthen cofferdams, remedial work for ditches and canals, open cut excavations and/or braced excavations) a minimum of three feet below the bottom of the required excavation for each structure or to the level determined by the Contractor's Engineer to limit the potential for instability in the excavation bottom. Groundwater levels outside of the cofferdam shall be maintained at or below the level determined by the Contractor's Engineer to limit the potential for instability of the excavation bracing system and/or the stability of excavation slopes. Monitoring of groundwater monitoring wells shall continue during construction both inside and outside the cofferdam until backfilling is complete.

### 1.7.2 Surface Water

Excavations shall be maintained free of surface water and precipitation in order to maintain stable slopes, maintain excavation bottom stability, and prevent deposition of sediment in the excavation, and to allow foundation preparation, approval, and backfill according to Section 31 00 00 EARTHWORK.

### 1.7.3 Damage Due to Dewatering System Failure

The Contractor shall maintain backup power and supplies of critical dewatering equipment and shall maintain labor at the site necessary to

assure the continued safe and effective operation of the dewatering systems until the District approves cessation of dewatering activities.

Should dewatering and surface water drainage systems fail during construction as a result of the Contractor's negligence, inadequate or improper design and operation of the dewatering system, bio-fouling, or any mechanical or electrical failure of the dewatering system resulting in damage to excavations, previously placed backfill materials, or the Contractor's equipment, the Contractor shall remove and replace all damaged work (completed and in progress) and associated materials to the satisfaction of the District at no cost to the District.

### 1.7.4 Contingency Plan

The Contractor shall provide a Contingency Plan for alternative procedures to be implemented if unfavorable performance of the dewatering system, excavation slope, or excavation bracing system is evidenced. The Contractor shall keep on hand materials, equipment (such as backup generator) and labor necessary to implement the contingency plan. Such materials shall consist of (but not necessarily be limited to) geotextile fabric, filter sand and gravel, steel beams and sheet piles, etc. The Contingency Plan shall be submitted for review and approval by the District.

Potential flood related impacts to below ground excavations and temporary excavation support systems shall be considered by the Contractor's design, as appropriate. The Contingency Plan shall account for the potential of very heavy rainfall events typical for the South Florida climate.

### 1.7.5 Surveying

The Contractor shall provide a Professional Survey Mapper to determine the elevation of the top of all foundations to monitor the potential for foundation movement during construction.

## 1.8 RESPONSIBILITIES

This is a performance specification. Except as otherwise specified or indicated, selection of equipment, materials, and methods shall be Contractor's responsibility. The dewatering of any excavation areas and disposal of all water handled shall be in strict accordance with all applicable local and state government rules and regulations.

The Contractor shall be responsible for the design of the dewatering system including, but not necessarily limited to, the temporary cofferdam, required pump equipment, temporary shoring, as well as any miscellaneous temporary structures required.

Unless otherwise specified, the dewatering systems shall lower the groundwater level to a minimum of three feet below the excavation bottom. The dewatering plan shall include installation of a sufficient number of groundwater level monitoring wells, with half of the monitoring wells adjacent to the cofferdam and/or cofferdam limits. Monitoring wells shall be situated both inside and outside of the cofferdam. Distance between adjacent monitoring wells shall not exceed 100 feet, measured at the perimeter of the cofferdam and/or open cut top of bank.

Volume of water discharged must be reported at each Site. The Contractor shall submit, calibration data, operating ranges of the pumping equipment, and instrumentation to be used to determine flows and daily volumes pumped.

If it is anticipated that offsite discharges will occur due to construction dewatering activities, the Contractor must also include documentation that the dewatering activities will meet the criteria contained in the Basis of Review for Water Use Permit Applications within the South Florida Water Management District - latest edition.

## 1.9 CERTIFICATIONS AND TESTING

A Professional Engineer registered in the State of Florida hired by the Contractor shall inspect, accept, and certify the temporary sheet piling for temporary cofferdam(s) used for dewatering purposes.

## 1.10 INSPECTION COORDINATION

The Contractor shall provide safe access to the Work for the District as requested for inspection. The Contractor shall provide at least 48 hours advance notice of its intention to begin new Work activities.

## 1.11 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 PRODUCT REQUIREMENTS

All materials used in the construction of the dewatering facilities shall be selected, furnished, and installed by the Contractor in accordance with the Contractor's design as submitted to the District.

## 2.2 FILTER SAND

Filter sand for wellpoints, deep wells, monitoring wells and piezometers shall consist of aggregate materials whose gradation is determined by the Contractor. The Contractor shall submit the gradation of the Filter Sand materials to the District for review.

## 2.3 PUMPING EQUIPMENT

The Contractor shall maintain an adequate back-up supply of piping, equipment, repair parts, and system components to maintain the system products required to construct, maintain, modify or supplement the dewatering system. Products shall comply with ASTM D1785 and ASTM D2241.

## 2.4 SHEET PILE

The Contractor shall provide new or used sheet piling, for use in the temporary cofferdam, conforming to the requirements of ASTM A328. The Contractor shall submit product data sheets with verification that the provided Sheet Pile materials meet the requirements of ASTM A328.

## 2.5 STRUCTURAL STEEL

The Contractor shall provide structural steel, for use in the cofferdam, conforming to the requirements of ASTM A572/A572M. The Contractor shall submit product data sheets with verification that the provided Structural Steel meets the requirements of ASTM A572/A572M.

## 2.6 OTHER MATERIALS

Fabricated connections, walers, and accessories, steel H-piles, W shapes, and other structural steel shall conform to the requirements of ASTM A36/A36M or ASTM A572/A572M as noted.

Wood lagging: Untreated hardwood of sufficient thickness as required by design.

Pile Driving Hammer: Vibratory and/or impact type hammer of sufficient size for installations capable of consistently delivering driving energy to the sheet pile.

Other engineered system may be used with materials as required by the engineered design that are consistent with all other contract requirements.

# PART 3 EXECUTION

## 3.1 DEWATERING

### 3.1.1 Performance

The Contractor shall furnish and install sheet pile cofferdams, earthen cofferdams and/or combinations thereof and dewatering systems in accordance with the following. Alternative means and methods may be considered provided they are presented in the Dewatering Plan and/or Cofferdam Work Plan.

#### 3.1.1.1 General

The Contractor shall dewater the subsurface sufficiently to lower the phreatic and piezometric levels in the existing ditches, canals and foundation excavation areas to levels at or below those determined by the Contractor as part of the dewatering plan submittal, and as approved by the District, and maintain the dewatered condition for the duration of the applicable Work. The Contractor shall coordinate the dewatering work with the LaBelle Private Drainage District (LPDD)and other land owners, and shall ensure no adverse impact on canals or adjacent property owners. Adverse impacts on adjacent lands may consist of (but not necessarily limited to) groundwater and/or surface water lowering, depletion of water supply, or new canal bank slope failure not considered to be a pre-existing condition. Groundwater levels are to be monitored along the southern project boundary and maintained as described in Specification 31 00 00.

#### 3.1.1.2 Dewatering

a. Excavations may not extend below the existing phreatic surface or local groundwater table until an approved dewatering system has effectively lowered the water level as required herein. Prior to commencement of the Work for each excavation, the dewatering system will be required to

lower the water levels in accordance with the dewatering plan submittal, and as approved by the District over the entire excavation area, including the portion of the Intake Canal adjacent to the pump station. Dewatering measure shall be designed, implemented, and modified during construction, as necessary and as approved by the District, to effectively dry work areas.

b. The dewatering system shall be used to maintain dry excavations and for maintaining required phreatic and piezometric levels on a continuous basis, 7 days a week and 24 hours a day. The system shall be operational and satisfy the requirement of these Specifications and Drawings prior to starting excavation and until such time as construction activities for each excavation is complete according to the Project Specification or as approved by the District. The Contractor shall inspect the dewatering system prior to start of work each morning. The dewatering system shall provide required dewatering during all conditions, including but not limited to, normal and elevated groundwater levels and corresponding seepage conditions, and for runoff during storm events. Exceptions may include an event such as a hurricane during which evacuation of the site for safety reasons is mandated. The District shall stipulate such exceptions on a case by case basis.

c. Materials and components used in the system shall meet criteria described in other sections of these specifications, and must meet filter criteria for internal stability and permeability in accordance with design criteria for filters as described in EM 1110-2-1901 (Seepage Analysis & Control for Dams).

d. The rate of discharge shall be measured and quality monitored and logged every 24 hours or as required by the District.

e. The Contractor shall maintain a 100 percent backup power source in the event of a loss of primary power supply. Sufficient fuel shall be stored on site to enable the backup power supply to function continuously for seven days.

f. The monitoring system shall include an automatic alarm system to provide immediate notification in the event of power loss and/or failure of any system or component determined by the Contractor and agreed to by the District to be critical to system operations and dewatering objectives.

g. In the case that the cessation of dewatering of an excavation has a negative impact on the dewatering of any adjacent work to the levels specified in this Section and the Drawings, the Contractor shall make provisions to dewater the adjacent work.

h. Dewatering associated with other aspects of the work such as unwatering of areas of ponded surface water, excavation of rim ditches and pumping from same, and the placement of earthen and/or steel cofferdams shall follow the requirements of this specification.

i. Monitoring wells and piezometers shall be established both inside and outside of the areas to be dewatered. Monitoring shall be accomplished in accordance with the Contractor's Dewatering Plan. A piezometer shall be installed and monitored in the center of each structure dewatered

area. The piezometer shall be abandoned by grouting when no longer needed.

3.1.1.3 Excavation Safety Provisions

a. During excavation, the Contractor shall observe water levels and other instrument readings, and seepage conditions along the exposed cut slopes and bottom for evidence of discrete seepage points, local areas of slope instability, seepage that is removing material, and/or unacceptable conditions. Any rise in the phreatic or piezometric readings to above the levels required under these Specifications, or other conditions described above, will be considered unacceptable and will require modification of the dewatering system. The Contractor shall assign qualified employees to continuously monitor dewatering system performance. These persons shall be responsible for obtaining an understanding of events and conditions that may result in unsatisfactory dewatering conditions and shall submit instrument readings to the District. The District reserves the right to disqualify individuals that, in the District's judgement, do not appear to have the ability to properly assess these conditions and to require the Contractor to assign more qualified personnel. A logbook used to record discharge reading and other observations shall be maintained by the Contractor at the site and shall be available at all times for review by the District.

b. The final decision regarding the acceptability of the dewatering system and the need to modify or improve dewatering control measures shall be at the discretion of the District. The Contractor shall be prepared to increase dewatering efforts using measures indicated in the dewatering plan. If the Contractor does not have the necessary equipment available to complete the Work, the District may stop the Work until conditions are sufficiently remedied to address the foundation excavation concerns. Schedule delays associated the stoppage of Work due to unsatisfactory performance of the dewatering system are the sole responsibility of the Contractor and delays may result in penalties.

c. The Contractor shall be prepared to mobilize personnel and equipment to specific excavation sites within 8 hours, during normal hours of operation to respond to directives issued by the District. The Contractor shall have a readily available supply of geotextile fabric, filter sand and gravel, and associated equipment and personnel needed for implementation of emergency measures should conditions warrant. During off hours, the Contractor shall be prepared to respond with personnel and equipment within 24 hours of directives issued by the District.

3.1.1.4 Disposal of Water

a. The Contractor shall dispose of water pumped, drained, or otherwise collected from the construction site in a suitable manner to avoid public nuisance, sedimentation of existing rivers, streams, or ponds, injury to public health, damage to public and private property, and damage to the finished Work or work-in progress, and in accordance with all applicable local, state and federal regulation and/or guidelines.

b. The Contractor shall properly locate sedimentation traps or basins to meet sedimentation control requirements as specified elsewhere in the

project Drawings and Specifications and as specified by local, state, or Federal regulation and/or guidelines.

3.1.1.5 Verification and Documentation

The Contractor's dewatering system is expected to incorporate an appropriate number of piezometers and observation wells in order to evaluate and monitor the performance and effectiveness of the dewatering system.

a. If, in the judgement of the District, monitoring data does not confirm that the dewatering system is performing as required in order to achieve the target water levels below the excavation bottom, the District may direct additional dewatering work by the Contractor at the sole expense of the Contractor.

b. The Contractor shall be responsible for the accuracy of all Drawings, design data, and operational records required under this specification section.

3.2 DESCRIPTION OF WORK

3.2.1 General

The dewatering system shall control, by acceptable means, all water regardless of the source whether known or unknown. The dewatering system shall be of a sufficient size and capacity to lower ground-water levels at least 3 feet below the required elevation along the full length and width of the excavation to permit excavation, placement, and compaction of backfill and structure in a dry condition. The system for each location shall remain in continuous operation, as specified, until the structure and/or excavation backfill have been constructed to the specified parameters and approved by the District.

This Work generally includes the following:

a. Design and submit a detailed design in the dewatering plan for maintaining dry excavations in accordance with this Specification.

b. The dewatering system used to maintain the required phreatic and piezometric surfaces may consist of one or a combination of the following elements:

1) Wellpoints.

2) Eductors.

3) Deep wells.

4) Shallow wells.

5) Capture and pump systems, such as ditches, sumps or sand backfilled trenches. Design of system components that will remain shall be approved by the District prior to installation, and shall be decommissioned as directed by the District. Any ditches shall be located outside the footprint of the dam and/or structure foundation footprints, as shown on the Drawings.

c. The Contractor's dewatering system is expected to incorporate an appropriate number of piezometers and observation wells in order to evaluate, and monitor the performance and effectiveness of the dewatering system. Baseline elements for development of a monitoring plan shall include (but not be limited to) a pump well and monitoring well location plan, pump well and monitoring well depths, elevations and screened intervals, frequency of groundwater level measurements, groundwater elevation data plots as a function of time, and frequency of data submittals for review by the District. However, the District may direct the Contractor to install additional instruments, including, but not limited to, observation wells and piezometers to provide suitable information to monitor ground water levels. The Contractor shall design and operate the dewatering system in a manner that allows the District access to both the dewatering system and instrumentation.

d. If unscheduled downtime of the dewatering system exceeds the criteria included in this Specification, the District may direct the design, construction and operation of additional measures to achieve the required dewatering. In addition, the District may elect to withhold monthly payments for dewatering, until the Contractor demonstrates to the District's satisfaction. The Contractor shall make sufficient design contingency allowances to ensure the dewatering systems remain effective in maintaining the depressed phreatic surface during periods of routine system and/or component maintenance.

e. The Contractor shall decommission and remove all temporary dewatering systems in accordance with criteria described in these Specifications or as submitted by the Contractor and approved by the District. All groundwater monitoring wells and piezometers that are not needed for long term monitoring shall be grouted from bottom to top and cutoff at least two feet below the surrounding finished grade. Shutdown and decommissioning of the dewatering system will only be allowed after backfilling to the level accepted by the District.

For areas where free-standing water is encountered or at the discrete seepage points, temporary dewatering or unwatering systems may be used to dewater, unwater, and/or control surface water. This may be required for general site drainage control, or drainage control and dewatering system(s) along work areas that include existing canals and drainage ditches, excavations and trenches not described above, to maintain unsaturated conditions or to collect point source seepage for subgrades along the excavation slopes, and for drainage control along haul roads and in borrow areas. Excavation below the ground water level will not be permitted without dewatering operations functioning.

The Contractor shall be responsible for interpreting surface and subsurface conditions and for the design of all dewatering and/or unwatering systems required to perform the Work in accordance with criteria described in these Specifications. Dewatering does not include the removal of water from fill materials (moisture conditioning) used during construction as described in Section 31 00 00 EARTHWORK of these Specifications.

If, in the judgment of the District, observed seepage, or excavation moisture conditions pose a potential risk to excavation stability, acceptable backfill placement, or structure construction, the District shall have the right to require the Contractor to increase dewatering efforts. Additionally, the District shall have the right to require the Contractor to

stop any and all Work until, in the judgment of the District, the seepage and moisture condition has been mitigated.

3.2.2 Turbidity Barrier

The Contractor shall install and maintain suitable turbidity barriers as described in SECTION 33 03 00.

3.3 DECOMMISSIONING AND REMOVAL OF TEMPORARY WORKS

a. Decommissioning of elements included as part of the dewatering system proposed at the site shall be performed in accordance with criteria described in these Specifications and in the District approved dewatering plan submitted by the Contractor. In general, the subsurface elements of the dewatering systems shall be completely filled with a cement/bentonite grout mixture in accordance with SFWMD Rules and Regulation. Surface elements of the dewatering system shall be removed and properly disposed of or reused.

b. After other temporary works have served their purposes, the Contractor shall remove, level, and grade temporary dewatering system(s) and areas to the extent required to present a neat appearance and to prevent any obstruction of the flow of water or any other interference with the operation of or vehicular access to the permanent works.

c. Decommissioning is subject to the approval of the District prior to the final increment of payment for dewatering, or work requiring dewatering.

3.4 COFFERDAM

3.4.1 General

a. The construction excavation support system such as sheeting, shoring, tiebacks, soldier piles and bracing shall not disturb the state of soil adjacent to the excavation and below the excavation bottom. No sheet piling, either temporary or permanent, shall be installed within the central one third of the dam, or in any other area that will conflict with the dam's Soil Bentonite Wall and/or Select Fill seepage barriers. Temporary sheet piling located within the footprint of the dam plus a horizontal margin of 20 feet upstream of the inside toe of dam and 50 feet downstream of outside toe of dam shall be cut off below prepared foundation grade and abandoned in place.

b. Damage to existing utilities or structures during installation of excavation support system shall be avoided. If damage occurs, it shall be repaired at no cost to the District and to the satisfaction of the utility owner and District.

c. Water control measures shall be provided in accordance with this specification and the Contractor's design.

d. Shoring shall extend below the planned bottom of excavation or measures shall be implemented to provide support and retention of the excavation below the shoring.

e. Temporary support of excavation facilities may remain abandoned in place unless otherwise required for removal by other elements of the Work. The work shall be sequenced such that the sheet piling within the zone described in item (a) above may be cutoff as described and abandoned in place.

f. If sheet pile wing walls are to be associated with the permanent structure, and are supported by anchor rods connected to anchor walls, concrete deadmen, pilings, etc., installation of a cofferdam shall be phased to avoid interfering with these elements or otherwise reducing their load-carrying capacity.

g. Approximate locations of cofferdam, structural characteristics and embedment depths shall be determined by the Engineer designing the cofferdam. It should be noted that steel sheet pile wing walls are a part of the permanent features to be constructed both within and outside the dewatered areas for some of the structure locations. If a sheet pile cofferdam is proposed, the Contractor shall provide a sequence of construction that does not affect the integrity of the permanent components.

3.4.2 Soldier Piles

Soldier piles shall be installed by necessary methods to tip elevation shown on approved submittal drawings.

3.4.3 Steel Sheet Piling

a. Steel sheet piling shall not impact adjacent utilities or structures. Installation methods shall be adapted to existing subsurface conditions and for installation of sheet piling to the full depth of penetration required, and to proper alignment and plumbness, specified herein, without damage to the sheet piling or rupture of its interlocks.

b. Steel sheet piling shall be installed in plumb position with each pile interlocked with adjoining piles for its entire length so as to form a continuous diaphragm throughout the length of each run of wall, bearing tightly against original ground. Install sheeting to depth required by design, but not less than tip elevations shown on the Cofferdam Work Plan. Exercise care during installation so that interlocking members can be extracted without injury to adjacent ground. The installation equipment shall be suitable to the type and nature of the subsurface materials anticipated to be encountered. The equipment, the methods of installation, cutting, and splicing shall conform to the approved shop drawings.

3.4.4 Obstructions During Driving

If driving obstructions are encountered it is the Contractor's obligation to prevent pile damage and achieve the Contractor's design tip elevations. Obstructions may consist of a sudden increase in penetration resistance and lateral deviation in the horizontal position of the sheet pile resulting from hitting an obstruction such as a boulder.

3.4.5 Internal Bracing Support System

a. All bracing or wale support members shall be installed and maintained in tight continuous contact with each other and with the surface being supported.

b. Bracing members shall be preloaded if required by the Contractor's design.

c. Walers and struts shall be provided with intermediate bracing as needed to enable them to carry their maximum design load without distortion or buckling. Provide diagonal bracing as necessary to maintain the stability of the system. Web stiffeners, plates, or angles shall be provided as needed to prevent rotation, crippling, or buckling of connectors at points of bearing between structural steel members. Allow for eccentricities resulting from field fabrication and assembly.

3.4.6 Instrumentation And Monitoring

Shoring Wall Monitoring:

a. The Contractor shall inspect the cofferdam components prior to start of work each day.

b. The Contractor shall establish horizontal control survey points (movement measurement points) on the tops of temporary walls at a spacing not greater than 20 feet horizontal spacing on all sides of the excavation shoring system.

c. Perform at least two initial baseline surveys on different days of horizontal position of the shoring to an accuracy of 0.01 foot.

d. On a weekly basis until backfilling is complete perform survey measurements and submit to the District.

3.4.7 Removal of Support Systems

a. All sheet piling located within the footprint of the dam, plus a horizontal margin of 20 feet upstream of the inside toe of dam and 50 feet downstream of the outside to of dam shall be cutoff below grade and abandoned in place. The cutoff elevation shall be 3 feet below the prepared foundation grade for the dam, as defined in Specification 31 23 13. In other locations outside of the dam footprint, where removal is required, wholly or in part, such removal shall be performed in a manner that will not disturb or damage adjacent new or existing construction or utilities.

b. Support systems for excavations that will have structures or pipes installed in future work shall remain in place. No tie-backs shall be allowed within the footprint of the dam plus the horizontal margins described in this specification. All sheet piling within the footprint of the dam shall be cutoff below grade and abandoned in place.

c. All damage to property resulting from removal shall be promptly repaired at no cost to the District. The District shall be the sole judge as to the extent and determination of the materials and methods for repair.

## 3.5 OPEN CUT EXCAVATIONS

The excavation for structures to depths determined by the Contractor to be more efficiently achieved using open cut methods. This work shall include the determination of safe excavation slope angles, dewatering, and monitoring of same, all in accordance with the Contractor's Open Cut Excavation Stability Plan.

Earthwork associated with this work shall follow the specifications described in Section 31 00 00 EARTHWORK - EARTH DAM.

-- End of Section --

# SECTION 31 56 13.13

# SOIL BENTONITE SLURRY WALL

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work: The Contractor shall furnish all labor, materials, and equipment for construction of Soil-Bentonite Wall (SB Wall) as shown on the Drawings or as specified herein. The SB Wall shall be constructed in two phases, with the Phase I work accomplished through a Select Fill Work Pad at or slightly above the Prepared Foundation Grade, and with the Phase II work accomplished at elevation 47 feet NAVD. The Phase I SB Wall shall key 5 feet into the top of a clay layer, and the Phase II SB Wall shall key 3 feet into the Phase I SB Wall. Soil boring profiles are provided on the Drawings, as well as in the Geotechnical Site Characterization Report. Additional borings are to be drilled by the Contractor along the alignment of the SB Wall to provide supplemental information related to the top of the clay layer. The design of the project has identified the SB Wall as the primary seepage barrier for the dam. For this reason, the integrity of and continuity of the SB Wall cannot be overemphasized from the standpoint of dam safety.

Dam construction (including the Phase I Soil-Bentonite Wall) within the limits of stations 2020+00 (south baseline) clockwise to 1090+00 (north baseline), a distance of 11,000 feet shall be carefully sequenced in light of the S-476 Temporary Irrigation By-Pass and the use of the existing LPDD PS-1 as a temporary drainage outfall for the project. No Gap Closures and/or Work Arounds shall be allowed in this reach of the dam.

### 1.2 APPLICABLE PUBLICATIONS

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C143/C143M-00 | Standard Test Method for Slump of Hydraulic Cement Concrete |
| ASTM D1557-00a | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,400 ft-lb//ft$^3$) |
| ASTM D1140-00 | Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75- um) Sieve |
| ASTM D1586-99 | Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils |
| ASTM D1587-00 | Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes |
| ASTM D2217-85(1998) | Standard Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants |

| | |
|---|---|
| ASTM D422 | Standard Test Method for Particle Size Analysis of Soils |
| ASTM D2216-98 | Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass |
| ASTM D2974-00 | Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils |
| ASTM D4318-00 | Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D4380-84(2006) | Standard Test Method for Density of Bentonitic Slurries |
| ASTM D4381-06 | Standard Test Method for Sand Content by Volume of Bentonitic Slurries |
| ASTM D5084-03 | Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter |
| ASTM D2487 | Unified Classification System |
| ASTM D2488 | Standard Practice for Description and Identification of Soils (Visual-Manual Procedures) |
| ASTM D6938 | Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |
| ASTM D698 | (2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.)) |
| ASTM D2937 | Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method |
| ASTM D1556/D1556M | (2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| ER 1110-1-1807 | (2014) Drilling in Earth Embankment Dams and Levees |

AMERICAN PETROLEUM INSTITUTE (API)

| | |
|---|---|
| API RP 13B-1 | Standard Procedure for Testing Water-Based Drilling Fluids |
| API Spec 13A | Drilling Fluid Materials |

ADDITIONAL REFERENCE MATERIAL

Existing geotechnical information can be found in the Geotechnical Site Characterization Report, which is part of the bid documents.

## 1.3 DEFINITIONS

### 1.3.1 Soil Bentonite Wall (SB Wall)

The use of a vertical trench filled with a viscous fluid as shown on the plans. The SB Wall consists of a minimum three-foot thick curtain of impermeable material. The trench is excavated through the existing ground or prepared working surface using the slurry method of excavation and backfill. A specified mixture of soil and bentonite slurry, hereinafter referred to as the soil bentonite (SB) backfill material, is used in the backfilling process to form an impervious barrier in the desired location.

### 1.3.2 Slurry Method of Excavation

Excavating a vertical-walled trench while at the same time keeping the trench filled with a bentonite slurry mixture. The purpose of the slurry is to support the trench walls during excavation. The method maintains the sides of the narrow excavation without shoring or other bracing to provide construction of an impervious vertical barrier.

### 1.3.3 Bentonite

An ultra-fine natural clay whose principal mineral constituent is sodium cation montmorillonite.

### 1.3.4 Slurry

A colloidal mixture of bentonite and water.

### 1.3.5 Design Mix

The mix design shall be prepared by the Contractor and shall include laboratory testing of the soils, water, bentonite, and any additives to obtain 1) a suitable bentonite slurry and 2) acceptable SB backfill.

### 1.3.6 Working Pad

The surface from which the slurry trench is constructed. The elevation of the Phase 1 Working Pad shall be at or above the prepared foundation grade. The Working Pad for Phase II SB Wall construction shall be EL 47 on the embankment fill.

### 1.3.7 Select Fill Plug

A portion of the Phase I Work Pad shall be a plug at least 3 feet thick and shall be constructed of Select Fill, as indicated on the Drawings. The location of, thickness of, and permeability characteristics of the Select Fill Plug are critical design features, since the Plug may be the tie-in between Phase I and Phase II SB Walls. Select Fill shall meet the requirements for such materials as described in this specification and in Section 31 00 00 EARTHWORK - EARTH DAM.

1.3.8 SB Wall Key

The Phase I SB Wall key is a 5-foot penetration into a clay strata, but not less than 15 feet below the prevailing stripped grade at any given location. The estimated SB Wall key is indicated on the drawings as the bottom of the SB Wall. The actual elevations shall be determined by the Contractor (and approved by the District), based upon supplemental core borings, and visual inspection of the materials excavated from the SB Wall Key and laboratory test results (for verification purposes). The bottom elevation of the key shall be agreed upon by Contractor's field personnel and by District staff for every 10 feet of SB Wall construction (measured along the plan alignment of the SB Wall). Digging below the agreed 5-foot key elevation will not be counted in the quantities to be paid for. If no clay stratum is found in the Phase I SB Wall excavation, the excavation shall terminate at 70 feet below the top of the Select Fill Plug. The Phase II SB Wall key depth shall be 3 feet into the top of the Phase I SB Wall or Select Fill Plug.

The target soil for the key material shall be classified as CL, CH, CL-CH and/or MH in accordance with Group Symbols described in the Unified Soil Classification System (ASTM D2487). The classification shall be confirmed with laboratory testing on samples obtained from the bottom of the key. Testing requirements are described in paragraph CERTIFICATIONS AND QUALITY CONTROL TESTING of this specification.

1.3.9 SB Wall Specialist and SB Wall QC Geotechnical Engineer

The Contractor shall provide a SB Wall Specialist who has special knowledge in all aspects and experience in the construction of SB Walls. The individual shall have a minimum of ten years of experience in the construction of SB Walls and shall possess a thorough knowledge of construction equipment, material testing, and Quality Control Testing implementation of SB Walls. The SB Wall Specialist shall be located on the project site full time during slurry wall operations. The SB Wall Specialist shall be responsible for the following (as a minimum) activities:

- Arranging for a safe work environment for the Contractor’s crew and equipment, the Contractor’s QC inspection staff, the District’s QA inspection staff, and any other personnel authorized to be within the work zone,
- Scheduling Phase I and Phase II SB Wall construction activities,
- Providing continuity of supply of bentonite slurry and SB Wall backfill,
- Coordination of the work with the earthwork contractor to verify continuity of the seepage barrier, especially at Gap Closure and Work Around locations
- Other aspects of the work as described in this specification.

The Contractor shall provide a SB Wall QC Geotechnical Engineer specific to the construction of the SB Wall. This individual shall be a Florida registered professional engineer, specializing in geotechnical engineering, and having not less than 10 years of design and construction experience related to earth dams, levees, and SB Walls. The SB Wall QC Geotechnical Engineer shall be responsible for the following (as a minimum) activities:

- Scheduling and completing the additional exploratory borings,
- Determination of the target bottom elevations for the SB Wall for both Phase I and Phase II portions of the work,

- Arranging for QA and QC inspections of the work,
- Laboratory testing for bentonite slurry properties,
- Determination of actual SB Wall bottom elevations,
- Laboratory testing of the material properties of the clay stratum into which the SB Wall is keyed,
- Laboratory testing of SB Wall backfill material properties,
- SB Wall backfill profiles,
- Documentation of the work,
- Identification of portions of the work that do not meet the specification requirements,
- Development of remedial action plans to bring those portions of the work that are identified as not consistent with the specification requirements into compliance with the contract documents~~,~~
- Coordination of the work with the SB Wall Specialist and the District QA staff to assure that all quality aspects of the work are consistent with the plan and specification requirements.

1.3.10 Soil-Bentonite (SB) Backfill:

A homogeneous mixture of soils, slurry, bentonite, additives, and water. The terms soil-bentonite backfill, "SB", "SB backfill", and "backfill" may be used interchangeably in these specifications.

1.3.11 Select Fill

A homogeneous mixture of soils, additives, and water used to construct the Select Fill Plug as well as the SB Wall cap, as shown on the Drawings. Powdered or granulated bentonite may be utilized as an additive at Contractor's option. The mixing of these materials shall not generate significant dust.

1.3.12 Heading

A separate section of the slurry wall excavated and backfilled separately from other sections. Each excavating machine digging the slurry wall typically represents one heading.

1.3.13 Proof of Concept

Demonstration by Contractor that means and methods utilized will accomplish the intended goals of the project, meet the quality control aspects of the project, and establish protocols for survey controls, communication of schedule, inspections, and documentation of the work. Proof of Concept for the SB Wall shall successfully demonstrate all aspects of the SB Wall construction, including the Working Pad, Phase I and Phase II SB Walls and the SB Wall Cap. Although the Separator Dam does not include an SB Wall, a portion of the Separator Dam may be utilized for Proof of Concept.

1.3.14 SB Wall Cap

This will be constructed at the top of the Phase II SB Wall, as shown on the Drawings. It is a transition between the SB Wall backfill material and conventional earthwork construction. It shall be constructed after

completion of the Phase II SB Wall by excavating to the lines and grades shown on the Drawings, and backfilling the excavation with Select Fill.

1.3.15 Gap Closures and Work Arounds

Gap Closures are discontinuities in the embankment construction that are caused by the location of new conduits through the dam. Work Arounds are discontinuities in the embankment construction that are caused by existing water features that remain in service for a portion of the duration of construction. Details related to Gap Closures and Work Arounds are provided on the Drawings, as well as within Specification Section 31 00 00 EARTHWORK - EARTH DAMS. The Contractor shall not create Gap Closures or Work Arounds except at locations as shown on the Drawings.

1.3.16 Waiting Periods

A duration of time required at specific elevations when no additional fill shall be placed within the limits of the dam that are governed by the waiting periods. There are two waiting periods, one at Elevation +47 feet and one at Elevation +54 feet. The limits of each section and the corresponding waiting periods are shown on the Drawings. The Contractor shall build the Phase II SB Wall Cap up to Elevation +47 feet at the conclusion of the Waiting Period at Elevation +47 feet. Likewise, the Contractor shall build the Chimney Drain up to Elevation +43 feet to account for settlement that may occur during the waiting period.

1.3.17 Emergency Backfill

A stockpile of materials to be placed in the trench in a rapid manner with the understanding that such materials will need to be removed when the trench excavation resumes.

1.4 SUBMITTALS

The Contractor shall make submittals for the following in accordance with the requirements of Section 01 33 00 SUBMITTAL PROCEDURES. The elements of each submittal are described elsewhere in this specification.

SD-01 Preconstruction Submittals

Qualifications

Proof of Concept Plan

Exploration Plan

SB Backfill Design

Select Fill Design

Proof of Concept Summary Report

SB Wall Construction Plan

Quality Implementation Plan

Emergency Backfill Plan

Protection Plan for SB Wall and Chimney Drain

SD-03 Product Data

Bentonite Certificate of Compliance

SD-06 Test Reports

Field Test Results

Field Soundings and Measurements

Laboratory Test Results

1.5 RESPONSIBILITIES

The Contractor shall be responsible for maintaining and delivering to the District project quality control records. The Contractor shall appoint a QC Geotechnical Engineer responsible for all inspections, testing and reporting. The Contractor shall also provide a staff of field inspectors, working under the QC Geotechnical Engineer, who are qualified to determine that the excavation has keyed into the clay layer, identify the clay layer, to observe and record the soundings of excavation depths and bottom elevations, and to perform or oversee all other QC testing and inspections related to the SB Wall as required of the Contractor. Each member of this staff shall have a minimum of three years of field experience related to slurry wall construction. At least one QC staff inspector shall be available on a full time basis for each heading and be present for depth soundings of the top of the clay layer and the final depth soundings for each cut. All quality control records and test reports shall be made available for inspection and review by the District at any time. The Contractor shall submit appropriate work plans and shop drawings as follows:

A. Qualifications: The Contractor shall have a minimum of ten years of experience in the construction of SB Walls and shall have successfully completed not less than ten SB Wall projects using the slurry method of excavation. These projects shall have been completed with depths and geologic conditions generally similar to that of the C-43 Reservoir project. The Contractor shall assign an SB Wall Specialist to oversee, supervise, and direct the construction of all SB Walls included in the Work. The SB Wall Specialist must be resident on site for the full duration of the SB Wall construction activities.

B. Exploration Plan: Borings have been drilled at the locations indicated on the drawings as well as in the Geotechnical Site Characterization Report. The Contractor shall submit a plan indicating the location of supplemental core borings located along the alignment of the SB Wall for review and approval by the District. The borings shall be spaced such that the combination of existing borings provided by the District and additional borings supplied by the Contractor shall result in a spacing between borings not greater than 500 feet, measured along the centerline of the dam. Of the borings provided by the District, only those existing within 200 feet of the centerline of the dam shall be considered as part of the development of the Exploration Plan. Additional borings shall be drilled in accordance with criteria set forth in ER 1110-1-1807.

C. Proof of Concept Plan: A written narrative with associated graphics as needed to summarize the means and methods utilized by the Contractor for each aspect of the work, to achieve the quality objectives of the contract, and to document the work. The objectives of the plan shall provide the information necessary for the Contractor to complete the Proof of Concept Summary Report, which is described in the following section of this specification.

D. Proof of Concept Summary Report: A written summary of the work developed during the Proof of Concept efforts with associated graphics as necessary to describe the means and methods used to accomplish the work, the safety and quality objectives of the work, summaries of quality control data, and forecasted production rates. At a minimum, this report shall include the following aspects of the work:

1. A description of the construction methods used to mix, place and compact the Working Pad, supporting documentation for field and laboratory test results, and survey control data for location, elevation and thickness.

2. A discussion related to the equipment used for installation of the Phase I SB Wall, survey controls for alignment, SB Wall backfill mix design, production QC field and laboratory test results, SB Wall bottom soundings and elevations, and the elevation profile of the top of the clay layer at sounding locations.

3. The methods used for installation of the Phase II SB Wall, survey controls for alignment of the wall, production QC field and laboratory test results, and SB Wall bottom soundings and elevations.

4. Waiting Period - a description of methods used to protect the Phase II SB WALL during the Waiting Period, and prior to construction of the SB WALL Cap.

5. SB Wall Cap - This section will provide a discussion of the equipment used to construct the SB Wall Cap, materials used to construct the cap, lift thicknesses, and QC field and laboratory test results.

6. Safety Protocol - A description of procedures for personnel and equipment to assure that safety takes priority over production, especially given the hazards associated with working adjacent to a slurry filled trench, and given the proximity of large equipment.

7. Lessons Learned - A summary of the critical intelligence gained during construction of the Proof of Concept.

The District shall review the Proof of Concept Summary Report and provide comments to the Contractor. The report shall be considered accepted provided the District's comments are resolved by the Contractor prior to commencement of the work. Approval by the District of the Proof of Concept shall not be construed by the Contractor as authorization of specific equipment and/or production rates, which are entirely the responsibility of the Contractor.

E. SB Backfill Design: Submit a laboratory design mix for the SB backfill to be used in the Work, including Proof of Concept. The Contractor shall be responsible for the development of a design mix and for testing and demonstrating the mix's adequacy for incorporation in the Work. The

laboratory design mix shall consist of mixture of soil, bentonite and water, consistent with the materials to be utilized for construction of the SB Wall. The design mix shall consider the natural geology of the location where the SB Wall is to be constructed and shall ensure that the backfill is non-reactive with local surface water and groundwater (i.e. that the permeability of the backfill does not increase with time). The design mix shall demonstrate that the backfill shall have a hydraulic conductivity of not more than $1x10^{-7}$ cm/sec at a confining stress of 10 psi when tested in accordance with ASTM D5084-03. Other criteria related to the requirements of the SB Backfill materials are provided in paragraph MATERIALS (and elsewhere) within this specification.

F. Select Fill Design: Submit a design for the Select Fill to be used in the Work, including Proof of Concept. The Contractor shall be responsible for the development of a design mix and for testing and demonstrating the mix's adequacy for incorporation in the Work. The mix design shall demonstrate that the Select Fill shall have an in-situ hydraulic conductivity of not greater than $1x10^{-6}$ cm/sec when compacted to 98 percent of its maximum dry density, as determined by ASTM D698, and at a confining stress of 10 psi. It shall be tested in accordance with ASTM D5084-03.

G. SB Wall Construction Plan: Submit for the approval of the District a construction work plan that includes the following. This plan shall incorporate the findings of the Proof of Concept Summary Report:

1. A detailed description of the methods of construction including vertical trench excavation construction methods, material handling, slurry mixing and handling, and backfill mixing and handling.

2. A plan indicating approximate locations anticipated for mixing and hydrating the slurry.

3. A plan addressing traffic crossing the SB Wall.

4. A plan addressing procedure for connecting to previously constructed sections of SB Wall.

5. A list of major equipment by type and capacity that shall include excavators, slurry mixer, slurry pumps, material handler, and support and transport equipment.

6. Source and properties of all materials used in the slurry wall including mix water, bentonite, native soils, borrow soils, additives, etc.

7. Quality Implementation Plan: Contractor shall submit a Quality Implementation Plan for District review and approval. The plan shall include the standards with which to gauge the quality of the Work during construction including (but not limited to) descriptions of sampling instruments and methods, testing instruments, testing methods, and measurement of slurry viscosity, SB backfill material characteristics, control of SB Wall depth, and SB Wall plumbness, Select Fill material characteristics and all other criteria described in this specification. The plan shall include corrective procedures to be employed by the Contractor in the case of deviation from the stated requirements. Provide a table listing test standards, frequencies of testing, methods, acceptable values, and responsible entities. Submit

QC forms, including computer spreadsheets and charts from soundings. Contractor shall provide QC reports as required in Sections 01 45 00.00 10 QUALITY CONTROL, 01 45 04 CONTRACTOR QUALITY MANAGEMENT SYSTEM and 01 45 08 GEOGRAPHIC INFORMATION SYSTEM DATA REQUIREMENTS - QUALITY CONTROL AND QUALITY ASSURANCE DATA.

8. Survey Control: A description of the methodology to be utilized by the Contractor to assure that the SB Wall alignment is consistent with the location shown on the Drawings, and that the Phase II portion of the SB Wall aligns with the previously placed Phase I portion of the SB Wall. The Survey control is to be provided by the Contractor's Professional Survey Mapper (PSM).

Approval by the District of the SB Wall Construction Plan shall not be construed by the Contractor as authorization of specific equipment and/or production rates, which are entirely the responsibility of the Contractor.

H. Emergency Backfill Plan: The Contractor shall submit this plan detailing the steps to be taken in the event of either a tropical storm (or hurricane), or a sudden drop in slurry level within the trench. The Contractor shall have materials available to backfill the trench in a rapid manner with the understanding that such materials will need to be removed when the trench excavation resumes.

I. Protection Plan for SB Wall and Chimney Drain: The Contractor shall submit a plan indicating the means and methods to be utilized to protect the integrity of the SB Wall Backfill materials and the Chimney Drain materials during construction activities and during full duration of the Waiting Periods.

J. Bentonite Certificate of Compliance: For each shipment and each lot of bentonite delivered to the site, submit a certificate of compliance and a copy of test reports from the manufacturer stating that the material complies with these specifications.

## 1.6 CERTIFICATIONS AND QUALITY CONTROL TESTING

A. Bentonite: Each truckload or railcar of bentonite delivered to the site shall be sampled and tested in accordance with API Spec 13B. The Contractor shall provide manufacturer's certificates for each load of bentonite shipped and used for the project. Additional samples may be taken and sampled by the District at their discretion. Bentonite material will meet the requirements of Paragraph MATERIALS in this Section.

B. Water: Laboratory testing during an early design phase (i.e. C-43 Test Cell Project) indicated that the backfill is non-reactive with local surface and groundwater, as summarized in the Geotechnical Site Characterization Report. Water to be mixed with the bentonite shall be tested for pH hardness and conductivity to confirm conformance with mix design water. Tests shall be repeated monthly or if there is an apparent change in water quality. With approval from the District, the Contractor shall be allowed to amend water quality if and as needed to conform with the SB Wall backfill mix design.

C. Fresh Bentonite Slurry: Fresh bentonite slurry shall be sampled and tested from each pond, pit or tank prepared for use in the trench. Prior to use in the trench and at least twice per shift the slurry shall be tested

for viscosity and density, and at least once per shift for pH and filtrate. Slurry shall be tested in accordance with the publications listed in paragraph APPLICABLE PUBLICATIONS.

D. Trench Bentonite Slurry: Trench bentonite slurry shall be sampled within five feet of the top of the trench and within five feet of the bottom of the trench from a zone within 20 feet of the toe of the soil- bentonite backfill slope at least twice per shift for each heading. The slurry shall be tested for viscosity, filtration, density and sand content. Slurry shall be tested in accordance with the publications listed in paragraph APPLICABLE PUBLICATIONS.

E. The sampling methods and devices shall be defined in the Quality Implementation Plan, which is to be submitted as part of the SB Wall Construction Plan. Testing of fresh bentonite slurry and trench bentonite slurry shall be in accordance with API RP 13B-1.

F. Excavation and soil-bentonite backfill soundings shall be made every 10 feet along the centerline of the excavation. The method of sounding and equipment used shall be defined in the Quality Implementation Plan. The following information shall be recorded as applicable for each sounding:

1. Elevation of top of clay layer.

2. Elevation of and thickness of rock layers found in the excavation

3. Depth of and thickness of the aquifer (zone above clay layer)

4. Elevation of bottom of excavation at the time of excavation

5. Elevation of bottom of excavation prior to backfilling

6. Profile of backfill slope. Soundings shall be performed during backfilling to monitor progress of filling operations and monitor the backfill slope profile. Soundings of the SB backfill slope shall be performed at 10 foot horizontal intervals at the beginning and end of each shift for each heading. Soundings of the SB backfill slope shall be recorded and submitted daily on computer generated spreadsheets (e.g. Excel) that will produce a graphic representation suitable for evaluating the slope to determine potential cave-ins, sloughing, and excessive sedimentation. Corrective measures shall be implemented as necessary. SB Wall profile soundings shall be determined using survey controls, with coordinates and elevations accurate to the nearest one foot horizontally and to the nearest half-foot vertically.

G. The excavation bottom key material shall be sampled on a horizontal spacing of not more than 100 feet on center. The samples may be obtained using the excavator, provided the sample is discrete and not mixed with other soils or backfills. Each sample shall be visually classified in accordance with the Standard Practice for Description and Identification of Soils (ASTM D2488) and the Unified Soil Classification System (ASTM D2487) and tested for gradation in accordance with ASTM D1140-00. Field testing for fines contents shall be accomplished using scales, burners and pans in order to provide rapid test results. This testing shall be followed with laboratory testing to confirm the results of the field testing. On 500-foot centers, the excavation bottom key material shall be tested for gradation in accordance with ASTM D1140 and Atterberg Limits (ASTM D4318), and classified

in accordance with the Unified Soil Classification System (ASTM D2487) as described in paragraph SB WALL KEY of this specification.

H. SB Wall backfill shall be sampled and tested by the Contractor in accordance with APPLICABLE PUBLICATIONS and the following.

1. Sampling equipment and methods shall be defined in the plan.

2. Slump of the SB backfill shall be tested at least twice per shift per heading.

3. Density of the SB backfill shall be tested at least twice per shift per heading using containers of measured weights and volumes.

4. Characteristics of the SB backfill shall be tested at least once per shift at each heading. Field testing for fines contents may be accomplished using scales, burners and pans in order to provide rapid test results. This testing shall be followed with laboratory testing to confirm the results of the field testing.

5. Backfill shall be tested for gradation in accordance with ASTM D1140-00 and ASTM D2217-85, Atterberg Limits per ASTM D4318 and organic content in accordance with ASTM D2974.

I. Quality Control Test Reports to be submitted by Contractor:

1. Field Test Results.

2. Field Soundings and Measurements.

3. Laboratory Test Results

J. Backfill hydraulic conductivity testing by the District: For the first 200 feet of excavation of each heading, one sample will be taken for each 50 feet of SB Wall constructed. Thereafter, one sample will be taken for each 200 feet of SB Wall constructed. Backfill samples are to be obtained from the trench using equipment capable of sampling high moisture content materials from various depths within the backfilled trench. The Contractor shall assist the District in obtaining samples for testing, including arranging for the safety of the sampling personnel.

Hydraulic conductivity tests will be performed in accordance with ASTM D5084-03.

## 1.7 REINSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide 48 hours notice of its intention to begin new Work activities.

## 1.8 WARRANTY

Not Used

# PART 2 PRODUCTS

## 2.1 MATERIALS

The Contractor shall furnish materials for use in the construction of the SB Wall conforming to the following.

Bentonite: The bentonite shall be a sodium cation base montmorillonite powder (Premium Grade Wyoming-type) conforming to API Spec 13A, Section 9.

Water: On-site water sources may be utilized provided the SB Wall backfill design is based on the on-site water.

The bentonite slurry shall consist of a stable colloidal suspension of powdered Bentonite and Water. The properties of the slurry used in all construction sequences shall be in accordance with the following.

1. Initial Bentonite Slurry Mixture: The Contractor shall allow for the minimum hydration time to be in accordance with the bentonite supplier's recommendation for the specific application. When introducing the Slurry into the trench, the slurry shall have a minimum viscosity of 36 seconds and a maximum viscosity of 40 seconds as measured by the Marsh funnel. The minimum Slurry density shall be 64-lb./cu. ft. The maximum water loss shall be 20 cubic centimeters (20cc) in 30 minutes as measured by a filter press at 100 psi in accordance with test procedures described in API RP 13B-1. The Contractor shall measure the thickness of the filter cake during the filter press test, and shall monitor trends in the measurements of filter cake thickness. The Contractor shall evaluate the whole slurry wall process should the measurements trend (or be trending) outside the bounds considered to be normal and acceptable for trench slurry. Mixing bentonite slurry in the trench will not be permitted.

2. Trench Slurry: The bentonite slurry in the trench shall have a minimum viscosity of 40 seconds and a maximum viscosity of 65 seconds as measured by Marsh funnel. The maximum density of the slurry shall be 85 pcf. At all times, the slurry in the trench shall be have a density that is at least 15 pcf less than the density of the SB backfill. Results of the following tests on in-trench slurry do not have specified criteria and are for information only: filtrate, filter press cake thickness, and sand content.

3. SB Backfill: All SB backfill including the laboratory mixture selected in the laboratory design mix program and all field samples shall meet the minimum requirements listed in this section. SB backfill that does not meet these requirements shall be removed and replaced. SB backfill shall consist of a mixture of the bentonite slurry, soil and dry bentonite. SB backfill shall be free of roots, organic matter and deleterious materials. The backfill shall not contain particles greater than 4 inches in any dimension or contain fines with an organic content greater than 2 percent. Suitable borrow material shall be used to supplement the excavated soils to provide the required backfill volume. Prior to utilizing borrow, representative samples of the material shall be submitted for approval of the District. The materials shall be thoroughly mixed into a homogeneous mass at the time of placement. SB backfill shall conform to the following criteria:

a. Slump ranging from 4 to 6 inches.

b. Total fines (Amount Passing U.S. Standard No. 200 Sieve) ranging from 15 percent to 50 percent.

c. Organic content of 2 percent or less.

d. Density at least 15 pcf in excess of the density of the trench slurry.

e. Hydraulic conductivity of 1 x $10^{-7}$ cm/sec or lower when tested at a 10 psi confining stress, as measured in laboratory tests in accordance with ASTM D5084-03.

4. Select Fill: All Select Fill including the laboratory mixture selected in the laboratory design mix program and all field samples shall meet the minimum requirements listed in this section, as well as in Section 31 00 00. Select Fill that does not meet these requirements shall be removed and replaced. Select Fill shall consist of a mixture of soil, water and, at Contractor's option, dry powdered or granulated bentonite. Prior to utilizing borrow, representative samples of the material shall be submitted for approval of the District. The materials shall be thoroughly mixed into a homogeneous mass at the time of placement. Select Fill shall conform to the following criteria:

a. Select Fill shall consist of SANDS containing not less than 25 percent passing the U.S. Standard No. 200 Sieve and/or CLAYS. It shall consist of sand-silt-clay material that has not more than 2 percent organic material and no rock pieces greater than 1.5 inches in maximum dimension. Select Fill shall have not more than 10 percent retained on the U.S. Standard 3/4-inch Sieve. Select Fill shall have a Liquid Limit not less than 25, and a Plasticity Index not less than 10. Select Fill shall have a Unified Soil Classification System (ASTM D2487) Group Symbol of SC, CL or SC-CL.

b. It shall have a permeability of not more than 1 x 10-6 cm/sec when tested in accordance with ASTM D5084 at a confining pressure of 10 psi.

c. Select Fill shall be placed at minimum dry density of 98 percent of the Standard Proctor Compaction Tests (ASTM D698) maximum dry density, and at a moisture content from -1 to +2 percent of the Standard Proctor Compaction Test optimum moisture content. Exceptions to this density requirement are described in paragraph TRENCH BACKFILLING of this specification for the SB Wall Cap. Verification of the density of Select Fill shall be in accordance with Section 31 00 00 EARTHWORK - EARTH DAM, which includes references to Standard Proctor (ASTM D698), In-Place Density by Nuclear Gauge (ASTM D6938), In-Place Density by Drive Cylinder (ASTM D2937) and In-Place Density by Sand Cone (ATMD D1556).

See paragraph TESTING for table of testing requirements and frequencies.

## 2.2 EQUIPMENT

The Contractor shall furnish equipment suitable for the work intended meeting the following guidance.

Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated that the trench excavation bottom elevation can be controlled and that uniform trench widths and vertical sidewalls are obtained from the top of the trench to the bottom of the trench. The equipment used shall not impose excessive live-loads that will produce an adverse contribution to the instability of the trench.

The excavator shall have the capability to excavate at least five feet deeper than the maximum depth shown on the plans. Special chopping, chiseling or other suitable equipment may be used as necessary to satisfactorily accomplish the required excavation. The width of the excavating tool shall be equal to or greater than the specified minimum width (36 inches) of the slurry trench.

Slurry mixing plant shall be equipped with a high-speed/high-shear colloidal mixer or a high-velocity/high-pressure venturi jet mixer used in conjunction with a high-speed/high shear centrifugal pump. The plant shall be capable of delivering a continuous supply of slurry from the hydration pond to the slurry trench. The Contractor shall have sufficient mechanically or hydraulically agitated ponds or pits for storage of hydrated bentonite.

## PART 3 EXECUTION

### 3.1 GENERAL

The Contractor shall construct the SB Wall to the elevations, lines, and grades as shown on the Drawings and in accordance with the specifications. Adjustments to the SB Wall construction may be made with the approval of the District to accommodate field conditions. The Contractor shall construct the SB WALL in two stages, except at the locations of Work Arounds, as shown on the Drawings. The Phase II portion of the soil bentonite Wall may be constructed during the waiting period associated with elevation +47 feet. The SB Wall Cap shall be constructed to Elevation +47 feet after accounting for settlement during the Waiting Period at Elevation +47 feet. All work shall be performed in accordance with the Contractor's approved work plan.

The Contractor shall provide Proof of Concept that the means and methods, safety protocols, communication and quality controls proposed for the work will yield a work product that meets the project specification requirements. Completion of Proof of Concept, submittal of Proof of Concept Summary Report, and acceptance of same by the District shall be considered a necessary precedent prior to notice to proceed for the work.

### 3.2 SUPPLEMENTAL CORE BORINGS

The Contractor shall drill supplemental core borings along the alignment of the SB Wall consistent with the Exploration Plan. The supplemental core borings shall be completed prior to the placement of the Phase I Work Pad. The supplemental core borings shall be drilled to 75 feet below the existing ground surface, and shall be completed in accordance with Section 02 33 00 STANDARD PENETRATION TEST. The borings shall be logged by a geologist, geotechnical engineer, and/or engineering technician, all under direct supervision of the QC Geotechnical Engineer. The Contractor shall submit certified logs of the borings to the District in accordance with the requirements of Section 02 33 00, and shall clearly indicate the depth to

the top of the clay layer. At the conclusion of each boring, the borehole shall be grouted as described in Section 02 33 00 STANDARD PENETRATION TEST.

3.3 EXCAVATION

The Contractor shall perform excavation in accordance with the approved Plan. The following provisions shall apply and be incorporated into the Plan.

A. The Contractor shall construct the SB Wall so that the finished top is level with the working surface. The trench shall be excavated from top of working surface and measure at least 36 inches in width. The trench shall be excavated from top of the working surface to the bottom as shown on the plans or as determined in the field by the District. Construction of the SB WALL shall be continuous, without interruption, until complete, except at designated locations. Where the SB Wall is constructed in sections, re-excavation of a portion of previously constructed section will be required at points of connection, in accordance with the approved work plan. Whenever a portion of the slurry wall is re- excavated after a period of inactivity or in the case of repair (due to rework, cave-in, extension, etc.), the overlap excavated into acceptable SB backfill shall be a minimum of 10 linear feet. The subsurface profiles indicate the presence of moderately well cemented limestone within the vertical interval of the SB Wall. Equipment selected for excavation of the SB Wall shall be capable of excavation of such materials. Blasting will not be permitted.

B. The Contractor shall introduce slurry into the excavation upon commencement of excavation. The slurry level shall be maintained a minimum of two feet above the level of the groundwater and not more than a foot below the top of the working surface until placement of backfill material is complete. The quality of the slurry shall be maintained at all times, dilution of slurry by surface waters shall be prevented. Trench slurry liquid levels shall be monitored continuously during operations to verify that significant slurry losses are not occurring. The Contractor shall establish means and methods to monitor slurry levels during non-production hours.

C. In the event the surface water rises, or is expected to rise, the Contractor shall take appropriate steps to protect the Work. The Contractor shall take measures to raise the slurry to at least one foot above the top of the expected water level by either constructing a dike around the open trench area or otherwise taking measures to protect the work. With the onset of a tropical storm or hurricane event, the Contractor shall protect the work in accordance with the Emergency Backfill Plan.

D. The Contractor shall maintain the excavation stability and maintain the slurry density at all times. The Contractor shall monitor imposed loads on the excavation walls and limit them as necessary to maintain the stability of the excavation.

E. The Contractor shall clean the excavation bottom of sand, gravel, sedimentation and other materials left by the excavator that may have fallen or settled through the slurry. The Contractor shall sample the excavation bottom to verify completion to clay stratum in accordance with the methods and frequency described in paragraph CERTIFICATIONS AND QUALITY CONTROL TESTING of this specification. If impervious stratum cannot be verified, additional excavation shall be performed to a depth not exceeding 70 feet

below the prevailing ground surface existing at the time of Phase I installation (i.e. pre-construction landform). All additional excavation shall be completed in concert with the knowledge of and agreement by the District.

## 3.4 TRENCH BACKFILLING

The Contractor shall perform trench backfilling in accordance with the approved work plan. The following provisions shall apply and be incorporated into the work plan.

A. The Contractor shall mix stockpiled or imported material with slurry and dry bentonite in accordance with the approved SB Backfill Design. Backfill may be created by mixing new slurry or slurry displaced from the trench by backfilling with stockpiled or imported material. Backfill shall be thoroughly mixed and uniform prior to placement. The method of mixing shall be determined by the Contractor, but may include mechanical agitation using earth moving equipment. The consistency of the backfill characteristics shall be determined by field and laboratory test results. Clay lumps up to 2 inches in maximum dimension shall be considered acceptable, provided these lumps are not concentrated to the point where they restrict the flow of the SB Wall backfill.

B. The Contractor shall use care in placing the backfill so as not to cause sloughing or other damage to the excavation walls. Damaged excavation walls shall be repaired or restored by the Contractor prior to placing additional backfill. No backfill shall be pushed over the side of the trench wall for placement. Backfill shall be lifted from the mixing location past the edge and placed directly on the top of the backfill using an excavator or similar equipment. If backfill is mixed remotely, it may be trucked or otherwise transported to the placement location and placed directly into the trench at the location of the top of the backfill slope. Excess material shall not be pushed into the trench.

C. The Contractor shall place backfill in the excavation in such a manner to prevent the development of slurry pockets. An example of such is the use of a lead-in trench or starter ramp. The lead-in trench shall have a maximum slope of 1H:1V.

D. Backfill shall be placed continuously from the beginning of the excavation in the direction of excavation to the end of the excavation.

E. Free dropping of the backfill through the slurry shall not be permitted.

F. The initial backfill shall be lowered to the bottom of the excavation in a bucket or clam shell and placed on the bottom of the excavation. Subsequent backfill shall be placed in such a manner that it enters the trench and slides down the forward face of the previously placed backfill displacing slurry and preventing slurry pockets from forming. An acceptable alternative is the use of a lead-in trench or starter ramp. A lead-in trench is an excavated slope that extends from the surface to the bottom of the trench and is used to convey SB backfill into the trench without separating or segregating.

G. Within two days of the completion of any segment of the Phase I SB Wall, the soil-bentonite backfill shall be covered with a mound of temporary fill with a thickness of not less than 2 feet to protect the SB Wall material

from drying. Temporary fill used for this purpose shall consist of Embankment fill or excess SB Wall backfill material, placed without compaction. Temporary fill for this purpose shall not be more than 3 feet thick, and shall extend laterally to cover the SB Wall material, plus a horizontal margin of 2 feet on each side of the SB backfill. Temporary fill shall be placed in a similar manner over the top of the Phase II portion of the SB Wall and over the SB Wall Cap. The Contractor shall protect the temporary fill mound from erosion.

H. Upon completion of the Phase II SB Wall the Contractor shall remove the temporary cover and cap the top of the completed SB Wall with Select Fill Material a minimum of 3 feet thick and as indicated on the Drawings. The placement and in-place density requirements of the SB Wall Cap shall be as follows:

1. Excavate to the bottom of the SB Wall Cap to expose the SB Wall backfill. Place the initial 8 inches (thick) lift of the SB Wall Cap Select Fill and compact to create a reasonably firm and stable surface at the top of the lift. No specific density shall be required for the initial lift.

2. Place and compact the second lift of the SB Wall Cap Select Fill to a dry density of at least 90 percent of the maximum dry density determined in accordance with ASTM D698. Density testing in the second lift shall be completed at a frequency of one test per 500 feet of SB Wall alignment.

3. Place and compact subsequent lifts to at least 95 percent of maximum density (ASTM D698). Density testing in subsequent lifts shall be completed at a frequency of one test per 500 feet of SB Wall alignment.

I. The Contractor shall clean the area of construction upon completion of the Work. Excess material shall be removed from the working platform and embankment slopes, and disposed. Mixing areas shall be restored and graded to the pre-existing ground levels.

J. Prepare an as-built survey (Field Soundings and Measurements) of the constructed SB Wall representing the bottom profile, top profile, side slopes, and description of materials into which the SB Wall is keyed during construction, together with associated documentation of field measurements and laboratory test results.

## 3.5 TESTING

During production of the SB Wall installation, the Contractor shall provide QC testing of slurry, SB Wall backfill and Select Fill materials as described in this specification, and as summarized in the following table.

| **Material Type** | **Location of Material** | **Test Type** | **Frequency** |
|---|---|---|---|
| Bentonite Slurry | Initial | Viscosity, Density, Filter Press | Daily per Front |
| | In Trench | Viscosity, Density, Filter Press, Sand | Daily per Front |

| | | | |
|---|---|---|---|
| | | Content | |
| Clay Key | SB Wall Key | Fines | 100 feet on center |
| | | Fines, Atterberg Limits, Unified Soil Classification | 500 feet on center |
| SB Wall Backfill | SB Wall Trench | Slump, Density | Twice Daily per Front |
| | | Gradation, Atterberg Limits, Organic Content | Daily per Front |
| | | Permeability | District |
| Select Fill | Phase I Work Pad, SB Wall Cap | Gradation, Organic, Atterberg Limits, Moisture, Proctor, Permeability | 1 Set per 10,000 cubic yards |
| | Phase I Work Pad | In-Place Density | 1 Test per 1,000 Cubic Yards |
| | SB Wall Cap | | 1 Test per Lift per 500 feet |

-- End of Section --

# SECTION 31 62 13.20

# PRECAST/PRESTRESSED CONCRETE PILES

## PART 1 GENERAL

### 1.1 REFERENCES

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

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 211.1 | (1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete |
| ACI 301 | (2016) Specifications for Structural Concrete |
| ACI SP-66 | (2004) ACI Detailing Manual |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.4/D1.4M | (2011) Structural Welding Code - Reinforcing Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1064/A1064M | (2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| ASTM A27/A27M | (2013) Standard Specification for Steel Castings, Carbon, for General Application |
| ASTM A36/A36M | (2014) Standard Specification for Carbon Structural Steel |
| ASTM A416/A416M | (2017) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete |
| ASTM A572/A572M | (2015) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| ASTM A615/A615M | (2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A706/A706M | (2016) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement |

| | |
|---|---|
| ASTM A996/A996M | (2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement |
| ASTM C1202 | (2012) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration |
| ASTM C1218/C1218M | (1999; R 2008) Standard Specification for Water-Soluble Chloride in Mortar and Concrete |
| ASTM C1240 | (2014) Standard Specification for Silica Fume Used in Cementitious Mixtures |
| ASTM C1260 | (2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) |
| ASTM C136/C136M | (2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C143/C143M | (2015) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C150/C150M | (2017) Standard Specification for Portland Cement |
| ASTM C1567 | (2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method) |
| ASTM C172/C172M | (2014a) Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C260/C260M | (2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete |
| ASTM C31/C31M | (2015a; E 2016) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C33/C33M | (2016) Standard Specification for Concrete Aggregates |
| ASTM C39/C39M | (2017) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C494/C494M | (2016) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C595/C595M | (2017) Standard Specification for Blended Hydraulic Cements |
| ASTM C618 | (2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |

| | |
|---|---|
| ASTM C666/C666M | (2015) Resistance of Concrete to Rapid Freezing and Thawing |
| ASTM C989/C989M | (2017) Standard Specification for Slag Cement for Use in Concrete and Mortars |
| ASTM D1143/D1143M | (2007; R 2013) Piles Under Static Axial Compressive Load |
| ASTM D3689 | (2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load |
| ASTM D3966/D3966M | (2007) Standard Test Methods for Deep Foundations Under Lateral Load |
| ASTM D4945 | (2012) High-Strain Dynamic Testing of Piles |

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

| | |
|---|---|
| PCI BDM | (2011) Precast Prestressed Concrete Bridge Design Manual |
| PCI JR-382 | (1993) PCI Journal: Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling |
| PCI MNL-116 | (1999) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 4th Edition |

## 1.2 PILE REQUIREMENTS

Provide precast prestressed concrete piles per PCI Journal Volume 38, Number 2) (PCI JR-382). Production of piles shall be in accordance with PCI MNL-116.

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures

Geotechnical Consultant Documentation

Wave Equation Analysis

Order List

Precasting Manufacturer's quality requirement procedures

Pile Testing Procedures

Provide instructions and procedures on how the Contractor will assist the Construction Manager in the processes of Dynamic Pile Testing, Inspection and Monitoring of piles during installation and testing.

SD-02 Shop Drawings

Piles

SD-03 Product Data

Pile Driving Equipment

Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, cap blocks, pile cushions, leads, extractors, and preboring/preforming equipment at least 30 days prior to commencement of Work.
~~Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, cap blocks, pile cushions, leads, extractors, jetting equipment, and preboring equipment at least 30 days prior to commencement of Work.~~

SD-05 Design Data

Concrete mix design

Submit a concrete mix design before concrete is placed, for each type of concrete used for the piles.

SD-06 Test Reports

Aggregates

Concrete Compressive Strength

Submit concrete cylinder compressive strength test results.

SD-07 Certificates

Aggregates

Admixtures

Silica fume Manufacturer's representative

Prestressing steel

Cement

Fly ash and pozzolan

Ground Slag

SD-11 Closeout Submittals

Pile records

Submit pile records. Submit load test data and results.

## 1.4 QUALITY REQUIREMENTS

### 1.4.1 Piles

Prepare in accordance with ACI SP-66. Indicate placement of reinforcement including tendons. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up. Provide certification of a Professional Engineer registered in Florida, that layout and details of reinforcement and tendons conform with that shown on the structural design drawings.

### 1.4.2 Quality Requirement Procedures

Submit the precasting Manufacturer's quality requirement procedures and inspection records established in accordance with PCI MNL-116.

### 1.4.3 Installation Procedures

a. Submit information on the type of equipment proposed to be used, proposed methods of operation, pile driving plan including proposed sequence of driving, and details of all pile driving equipment and accessories.

b. Provide details of pile driving equipment and a Wave Equation Analysis of pile drivability for selection of the hammer along with a statement of driving procedures. The Wave Equation Analysis is to be completed by the Contractor's Geotechnical Consultant to obtain the production pile blow count criteria and to provide reasonable assurance that the piles can be driven to their target tip elevation without being damaged. The Wave Equation Analysis is to include the following information pertaining to the proposed pile driving equipment:

   (1) Complete Pile and Driving Equipment Data Form, (which can be downloaded at: http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf) for each proposed pile hammer and pile type combination.

   (2) Copies of computer input and output sheets and graphs showing soil resistance versus blow count as well as maximum tension and compression stresses versus blow count. Analysis shall be run at the estimated tip elevation as well as other required elevations to define maximum stress levels in the pile during driving.

### 1.4.4 Geotechnical Consultant Documentation

The services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and Pile Dynamic Analysis, shall be hired by the Contractor to observe test pile installation and job pile installation as specified herein. The Geotechnical Consultant shall be independent of the Contractor and shall have no employee of employer relationship which could constitute a conflict of interest.

### 1.4.5 Concrete Mix Design

Certify, using a Construction Manager-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI

211.1 for specified strength and is based on aggregate data which has been determined by laboratory tests during last twelve months. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolan, ground slag, and admixtures; and applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted.

1.4.6 Silica Fume Manufacturer's Representative

Provide statement that the Manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

1.5 DELIVERY, STORAGE, AND HANDLING

Piles shall be stored, handled, and transported in accordance with PCI MNL-116 except as follows. Methods used for handling and storage of piles shall be such that the piles are not subjected to excessive bending stress, cracking, spalling, or other damage.

1.5.1 Damaged Piles

The Contractor shall inspect each pile for sweep and structural damage such as cracking and spalling before transporting them to the project site and immediately prior to placement in the driving leads. Any unusual cracks (cracks other than crazing, surface drying, shrinkage cracks and end cracks) shall be brought to the attention of the Construction Manager. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the Work, in the opinion of the Construction Manager, shall be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Construction Manager.

1.5.1.1 Repairable Cracks

Piles with cracks equal to or greater than 0.006 inches but less than 0.06 inches shall be rejected or repaired. As an alternate to pile rejection, the Contractor may submit a proposal to repair deficient piles, which shall be restored prior to driving to provide its required design capacity, perform its intended function in the structure, and take into consideration long term durability in corrosive environment.

1.5.1.2 Non-Repairable Cracks

Piles with cracks equal to or greater than 0.06 inches shall be rejected.

1.5.2 Pile Sweep

Sweep shall be limited to 1/8 inch per 10 feet over the length of the pile. Piles having excessive sweep shall be rejected.

# PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Cementitious Materials

Cementitious materials shall be portland cement, or portland cement in combination with natural pozzolan or fly ash or ground granulated blast furnace slag and conforms to appropriate specifications listed below.

#### 2.1.1.1 Cement

ASTM C150/C150M, Type I, II, or III with a maximum alkali content of 0.60 percent. Type III cement shall not be used in conjunction with silica fume.

#### 2.1.1.2 Fly Ash and Pozzolan

ASTM C618, Class N, or F except that the maximum total alkalies shall be 3.0 percent, and the maximum allowable loss on ignition shall be 3 percent. If the aggregates are reactive, the maximum calcium oxide content shall be 13.0 percent. Class C shall not be used.

#### 2.1.1.3 Ground Iron Blast-Furnace Slag

ASTM C989/C989M, Grade 120.

#### 2.1.1.4 Supplemental Cementitious Materials (SCM) Content

The concrete mix shall contain one of the SCMs listed below, or a linear combination thereof.

| SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT | | |
|---|---|---|
| SCM | Minimum Content | Maximum Content |
| Class N Pozzolan or Class F Fly Ash with $SiO_2$ plus $Al_2O_3$ plus $Fe_2O_3$ greater than 70 percent | 25 percent | 35 percent |
| Class N Pozzolan or Class F Fly Ash with with $SiO_2$ plus $Al_2O_3$ plus $Fe_2O_3$ greater than 80 percent | 20 percent | 35 percent |
| Class N Pozzolan or Class F Fly Ash with with $SiO_2$ plus $Al_2O_3$ plus $Fe_2O_3$ greater than 90 percent | 15 percent | 35 percent |
| GGBF Slag | 30 percent | 50 percent |

### 2.1.2 Water

Water shall be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete or steel.

### 2.1.3 Aggregates

ASTM C33/C33M, except as modified herein. Provide aggregate free from any substance which may be deleteriously reactive with alkalies in cement in an amount sufficient to cause excessive expansion of concrete. Do not mix, store in same stockpile, or use fine aggregates from different sources of supply in same concrete mix or same structure without approval. The fineness modulus of fine aggregate shall be not less than 2.40 or greater than 3.0. For piles that will be exposed to freezing and thawing, fine and coarse aggregate subjected to five cycles of the sodium sulfate soundness test shall show a loss not greater than 10 percent. If the selected aggregates fail the soundness test, the Contractor may use the aggregate source, provided concrete specimens made with the aggregates to be used for the piles shall have a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666/C666M. Prior to pile fabrication, submit certified test reports for the following tests specified in ASTM C33/C33M:

a. Grading

b. Amount of material finer than No. 200 sieve

c. Organic impurities

d. Soundness

e. Clay lumps and friable particles

f. Coal and lignite

g. Weight of slag

h. Abrasion of coarse aggregate

i. Fineness modulus

j. Reactive aggregates

k. Freezing and thawing

#### 2.1.3.1 Alkali-Silica Reactivity (ASR)

Fine and coarse aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate activity.

The fine and coarse aggregates shall be evaluated separately, using ASTM C1260. Test results of the individual aggregates shall have a measured expansion equal to or less than 0.08 percent at 16 days after casting. Should the test data indicate an expansion of greater than 0.08 percent, the aggregates(s) shall be rejected or additional testing, using ASTM C1567, shall be performed as follows: utilize the Contractor's proposed low alkali portland cement and SCM in combination with the proposed aggregate for the test portioning. The SCM quantity shall be determined that will meet all the requirements of these specifications and that will lower the ASTM C1567 expansion to equal or less than 0.08 percent at 16 days after casting.

If the above option does not lower the expansion to less than 0.08 percent at 16 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Construction Manager for evaluation and acceptance.

### 2.1.4 Admixtures

Chemical admixtures shall conform to ASTM C494/C494M, Type A. Air-entraining admixture shall conform to ASTM C260/C260M. Do not use admixtures containing chlorides.

All concrete piles shall have Crystalline Capillary Waterproofing (CCW) admixture in accordance with SECTION 03 31 27 CONCRETE ADMIXTURE WATERPROOFING. Otherwise, it shall be coated in accordance with SECTION 09 06 90 PROTECTIVE COATINGS, System C-3.

### 2.1.5 Prestressing Steel

Use seven-wire stress-relieved or low-relaxation strand conforming to ASTM A416/A416M, Grade 270. Use prestressing steel free of grease, oil, wax, paint, soil, dirt, and loose rust. Do not use prestressing strands or wire having kinks, bends, or other defects.

### 2.1.6 Reinforcing Steel

ASTM A615/A615M, Grade 60.

### 2.1.7 Ties and Spirals

Steel, ASTM A1064/A1064M for spirals and ASTM A615/A615M for ties.

### 2.1.8 Anchorages and End Fittings

Provide Manufacturer's standard anchorages.

### 2.1.9 Grout

Provide cement grout for prestressed piles using materials conforming to requirements stipulated herein for concrete mixes. Use admixtures, if required, known to have no injurious effects on steel or concrete. Do not use calcium chloride.

## 2.2 CONCRETE MIX DESIGN

ACI 211.1 or ACI 301, Chapter 4. Concrete shall have a minimum compressive strength of 6000 psi at 28 days and a maximum size aggregate of 1.5 inches. Concrete shall be air entrained with a minimum of 4.5 percent and a maximum of 7.5 percent. Mix shall contain fly ash or ground iron blast furnace slag to meet the requirements specified herein to mitigate Alkali-Silica Reactivity (ASR). For marine exposure, ensure a dense concrete free of shrinkage cracks, with a minimum degree of permeability. The maximum water cement ratio shall be 0.40. All precast concrete shall have Crystalline Capillary Waterproofing (CCW) admixture in accordance with SECTION 03 31 27.

## 2.3 FABRICATION

### 2.3.1 Formwork

Formwork and dimensional tolerances shall be in accordance with PCI MNL-116, and as specified herein. Provide forms of metal, braced and stiffened against deformation, accurately constructed, watertight, and supported on unyielding casting beds. Forms shall permit movement of pile without damage during release of prestressing force. Form precast dowel holes with galvanized flexible metal conduit. Inside forms or void tubes not to be grouted may be treated cardboard, plywood, or other material.

### 2.3.2 Pretensioning

Pretensioning shall be performed in accordance with PCI MNL-116, and as specified herein. Use gage calibrated within last 6 months by a laboratory approved by Construction Manager. Provide means for measuring elongation of steel to nearest 1/8 inch. Give tensioning steel a uniform prestress prior to being brought to design prestress. Induce same initial prestress in each unit when several units of prestressing steel in a pile are stretched simultaneously.

### 2.3.3 Casting

#### 2.3.3.1 Conveying

Convey concrete to formwork in accordance with PCI MNL-116, and as specified herein. Clean conveying equipment thoroughly before each run. During placing, make any free vertical drop of the concrete less than 3 feet. Remove concrete which has segregated in conveying or placing.

#### 2.3.3.2 Placing and Casting

Perform concrete casting within 3 days after pretensioning steel; however, do not deposit concrete in forms until placement of reinforcement and anchorages has been inspected and approved by pile Manufacturer's quality control representative. Produce each pile of dense concrete straight with smooth surfaces with reinforcement retained in its proper position during fabrication. Use vibrator with heads smaller than the minimum distance between steel for pretensioning. Make surface of pile ends perpendicular to axis of pile. Chamfer, a minimum of 3/4 inch, ends of piles and corners of square piles.

### 2.3.4 Curing of Piles

Cure piles using moist or accelerated curing. Curing of piles shall be in accordance with the PCI MNL-116 except as follows.

#### 2.3.4.1 Moist Curing

Moist cure using moist burlap coverings, plastic sheeting, or membrane curing compound until minimum strength to detension is achieved.

#### 2.3.4.2 Accelerated Curing

After placement of concrete, moist cure for a period of 4 hours. Follow by accelerated curing until concrete has reached specified release strength. Enclose casting bed for accelerated curing with a suitable enclosure. During application of steam or heat, increase the air temperature at a rate not to exceed 40 degrees F per hour. Cure at a maximum temperature of 150 degrees F until concrete has reached specified release strength. Reduce temperature at a rate not to exceed 20 degrees F per hour until a temperature of 20 degrees F above ambient air temperature is reached. After accelerated curing, moist cure using either water or membrane curing until a total accelerated and moist curing time of 72 hours is achieved.

### 2.3.5 Detensioning

Detensioning shall be performed in accordance with PCI MNL-116, and as specified herein. Gradually release tension in strands from anchorage. Detension after approval by pile Manufacturer's quality control representative. Perform transfer of prestressing force when concrete has reached a minimum compressive strength of 3000 psi.

## 2.4 PRODUCT QUALITY CONTROL

Where piling is manufactured in a plant with an established quality control program as attested to by a current certification in the PCI "Certification Program for Quality Control" perform product quality control in accordance with PCI MNL-116. Where piling is manufactured by specialists or in plants not currently enrolled in the PCI "Certification Program for Quality Control," set-up a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an independent commercial testing laboratory approved by the Construction Manager in accordance with the following.

### 2.4.1 Aggregate Tests

Take samples of fine and coarse aggregate at concrete batch plant and test. Perform mechanical analysis (one test for each aggregate size) in accordance with ASTM C136/C136M. Tabulate results of tests in accordance with ASTM C33/C33M.

### 2.4.2 Slump and Strength Tests

Sample concrete in accordance with ASTM C172/C172M at time concrete is deposited for each production line. Perform slump tests in accordance with ASTM C143/C143M. Mold cylinders in accordance with ASTM C31/C31M. Mold at least six cylinders per day. Cure cylinders in same manner as piles and for accelerated curing, place at coolest point in casting bed. Perform strength tests in accordance with ASTM C39/C39M. Test two cylinders of each set at 7 days or 14 days, or at a time for establishing transfer of prestressing force (release strength) and removal of pile from forms. Test remaining cylinders of each set 28 days after molding.

2.4.3 Changes in Proportions

If, after evaluation of strength test results, compressive strength is less than specified compressive strength, make adjustments in proportions and water content and changes in temperature, moisture, and curing procedures as necessary to secure specified strength. Submit changes in mix design to Construction Manager in writing.

2.4.4 Compressive Strength Test Results

Evaluate compressive strength test results at 28 days in accordance with ACI 301 using a coefficient of variation of 10 percent. Evaluate strength of concrete by averaging test results of each set of standard cylinders tested at 28 days. Not more than 10 percent of individual cylinders tested shall have a compressive strength less than specified design strength.

2.4.5 Chloride Ion Concentration

Sampling and determination of water soluble chloride ion content in accordance with ASTM C1218/C1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed 0.06 percent by weight of cement.

2.4.6 Chloride Ion Penetration

To ensure the durability of concrete in marine environment, concrete shall be proportioned to have the chloride ion penetration test in accordance with ASTM C1202, and be below 3000 coulombs for concrete specimens tested at 56 days.

PART 3 EXECUTION

3.1 PILE DRIVING EQUIPMENT

3.1.1 Pile Hammers

Furnish a hammer capable of developing the indicated ultimate pile capacity considering hammer impact velocity; ram weight; stiffness of hammer and pile cushions; cross section, length, and total weight of pile; and character of subsurface material to be encountered. Obtain required driving energy of hammer, except for diesel hammers, by use of a heavy ram and a short stroke with low impact velocity. At final driving, operate pile hammer in accordance with Manufacturer's recommendation for driving either end bearing piles or friction piles. At final driving, operate diesel powered hammers at rate recommended by Manufacturer for hard driving. Maintain pressure at steam or air hammer so that: (1) for double-acting hammer, the number of blows per minute during and at completion of driving of a pile is equal approximately to that at which hammer is rated; (2) for single-acting hammer, there is a full upward stroke of the ram; and (3) for differential type hammer, there is a slight rise of hammer base during each upward stroke.

### 3.1.2 Driving Helmets and Cushion Blocks

#### 3.1.2.1 Driving Helmets or Caps and Pile Cushions

Use a steel driving helmet or cap including a pile cushion between top of pile and driving helmet or cap to prevent impact damage to pile. Use a driving helmet or cap and pile cushion combination capable of protecting pile head, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over top of pile. Provide driving helmet or cap that fits sufficiently loose around top of pile so that pile may be free to rotate without binding within driving helmet. During test pile installation, demonstrate to satisfaction of Construction Manager that equipment to be used on project performs specified function. Use pile cushion of solid wood or of laminated construction using plywood, softwood or hardwood boards with grain parallel to end of pile. Provide pile cushion with thickness of 4 inches minimum and the thickness shall be increased so as to be suitable for the size and length of pile, character of the sub-surface material to be encountered, hammer characteristics, and the required driving resistance. Replace pile cushion at the start of driving of each pile and when it becomes highly compressed, charred or burned, or has become spongy or deteriorated in any manner. Show details of driving helmets, capblocks, and pile cushions. Submit 2 weeks prior to pile installation.

#### 3.1.2.2 Hammer Cushion or Capblock

Use a hammer cushion or capblock between driving helmet or cap and hammer ram consisting of a solid hardwood block with grain parallel to the pile axis and enclosed in a close-fitting steel housing. Use steel plates at top and bottom of capblock. Replace wood capblock when it becomes highly compressed, charred or burned or becomes spongy or deteriorated in any manner. Replace aluminum, micarta or polymer discs that have become damaged, split or deteriorated in any manner. Do not use small wood blocks, wood chips, rope or other materials that permit excessive loss of hammer energy.

## 3.2 PRELIMINARY WORK

### 3.2.1 Wave Equation Analysis of Pile Drivability

a. Prior to driving any pile, the Contractor shall submit a pile Wave Equation Analysis, performed by his Geotechnical Consultant, for each size pile and distinct subsurface profile condition. These analyses shall take into account the proposed hammer assembly, pile cap block and cushion characteristics, the pile properties and estimated lengths and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity.

b. The Wave Equation Analysis shall demonstrate that the piles will not be damaged during driving, shall indicate that the driving stresses will be maintained within the limits below and indicate the blow count necessary to achieve the required ultimate static pile capacities.

**Allowable Driving Stresses**

Steel Piles

Compression - 0.9 fy
Tension - 0.9 fy

Where fy is yield strength of steel

Concrete

Compression - 0.85f'c minus UPL
Tension - (3 times (the square root of f'c)) plus UPL

f'c is compressive strength of concrete
UPL = Unit Prestress after Losses
(Obtain values from pile Manufacturer)

c. Production pile driving criteria shall be developed based on the results of the Wave Equation Analysis. The concrete piles used to support the Stilling Well Platform shall have a safe design capacity of 5 tons and a moment capacity of 30 ft kips at the soil interface.

d. All pile driving equipment furnished by the Contractor shall be subject to the approval of the Contractor's Geotechnical Consultant. Complete the attached pile and driving equipment data form, including hammer information, in full as part of the submittal of the results of the Wave Equation Analyses.

e. The cost of performing the Wave Equation Analyses shall be paid for by the Contractor and included in the base bid.

f. Pile testing procedures shall be submitted to the District and approved by the District prior to testing piles.

3.2.2 Order List

The Contractor shall submit to the Construction Manager for approval, an itemized list for piles prior to placing the order with the supplier. The list shall indicate the pile lengths required at each location as shown on the plans and the corresponding ordered length of each pile. Load testing and refined wave equation analysis shall be completed prior to submission of an order list.

3.2.3 Pile Length Markings

The Contractor shall mark each pile prior to driving with horizontal lines at one foot intervals, and the number of feet from pile tip at 5 foot intervals.

3.3 PILE DRIVING

3.3.1 Driving Piles

Notify Construction Manager 10 days prior to driving of piles . Piles may be driven when the specified 28-day concrete strength has been achieved but not less than 7 days after casting. The minimum tip elevation for concrete

piles used to support the Stilling Well Platform shall be -30 feet NAVD. Drive piles to or below indicate minimum tip elevation to reach a driving resistance established by the wave equation analyses (WEAP). During initial driving and until pile tip has penetrated beyond layers of very soft soil, use a reduced driving energy of the hammer as required to prevent pile damage. If a pile fails to reach indicated minimum tip elevation, or if a pile reaches minimum tip elevation without reaching required driving resistance, notify Construction Manager and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB. Piles or pile sections shall not be handled or moved in any manner that would result in cracking or permanent damage to the concrete or to the grout surrounding the prestressing cables. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

### 3.3.2 Protection of Piles

Take care to avoid damage to piles during handling, placing pile in leads, and during pile driving operations. Support piles laterally during driving, but allow rotation in leads. Where pile or projecting reinforcement orientation is essential, take precautionary measures to maintain the orientation during driving. Square top of pile to longitudinal axis of pile. Maintain axial alignment of pile hammer with that of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through the reinforcement, by using a special driving head.

### 3.3.3 Tolerances in Driving

Drive piles with a variation of not more than 2 percent from vertical for plumb piles or more than 4 percent from required angle for batter piles. Maintain and check axial alignment of pile and leads at all times. Twist in the pile shall be limited to no more than 1 percent. If subsurface conditions cause pile drifting beyond allowable axial alignment tolerance, notify Construction Manager and perform corrective measures as directed. Place butts within 4 inches of location indicated. Manipulation of piles within specified tolerances will not be permitted.In addition to specified tolerances, maintain a location to provide a clear distance of at least 5 inches from butt to edge of pile cap. If clear distance cannot be maintained, then notify Construction Manager. Check each pile for heave. Redrive heaved piles to required point elevation.

### 3.3.4 Rejected Piles

Piles damaged or impaired for use during handling or driving, mislocated, or driven out of alignment beyond the maximum tolerance shall be withdrawn and replaced by new piles or shall be cut-off and abandoned and new piles driven as directed. Excess cut-off from piles and unacceptable piles shall be removed from the work site. All Work in connection with withdrawing and removing rejected piles from the site shall be done at no additional cost to the Construction Manager.

### 3.3.5 Jetting / Preforming of Piles~~Jetting of Piles~~

Jetting of piles will not be permitted. If preforming of piles are required in order penetrate the upper limestone layer, the cost of such preforming (if required) will be included in the cost of pile driving.

~~Jetting of piles will not be permitted.~~

3.3.6 Splices

Make splices as needed. Splices shall be capable of developing the full strength of the member in compression, tension, shear, and bending. Detail drawings of splices and design calculations demonstrating the strength of the splice shall be submitted for approval.

3.3.7 Build-Ups

Where required, pile section may be extended to cut-off elevation by means of a cast-in-place reinforced concrete build-up. Make build-up in accordance with PCI BDM. Construct build-ups made after completion of driving in accordance with detail, "Build-Up Without Driving." Make build-ups to be driven in accordance with detail "Build-Up With Driving." Have details of means for protecting joints by a suitable mortar or epoxy approved by Construction Manager. Where build-ups are exposed to water, protect cast-in-place section from water during curing period. Concrete in build-up shall have a minimum compressive strength of 4500 psi. Build-ups will not be permitted on more than 25 percent of total number of piles. If this percent figure is exceeded, or if in the judgment of the Construction Manager, the clustered location of build-ups is undesirable, withdraw piles of insufficient length and replace with longer piles. Payment for such withdrawal and replacement will be made as an adjustment to the contract price.

3.3.8 Pile Cut-Off

Cut-off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods approved by Construction Manager. Use of explosives for cutting is not permitted. Cut-off sections of piles shall be removed from the site upon completion of the Work.

3.4 FIELD QUALITY CONTROL

3.4.1 Pile Records

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations, number of blows required for each foot of penetration and number of blows for the last 6 inches penetration or fraction thereof as required to meet the blow count criteria. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, obstructions, jetting, and any driving interruptions. A preprinted pile driving log for recording pile driving data and pile driving equipment data form can be downloaded at: http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf.

-- End of Section --

# SECTION 31 62 19

# TIMBER PILES

## PART 1 GENERAL

### 1.1 SUMMARY

SUMMARY OF WORK: The Contractor shall furnish all labor, materials, and equipment, and perform all operations in connection with the installation of round treated timber piles in accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the contract.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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 WOOD PROTECTION ASSOCIATION (AWPA)

| | |
|---|---|
| AWPA M1 | (2015) Standard for the Purchase of Treated Wood Products |
| AWPA M2 | (2016) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use |
| AWPA M3 | (2016) Standard for the Quality Control of Preservative Treated Products for Industrial Use |
| AWPA M4 | (2015) Standard for the Care of Preservative-Treated Wood Products |
| AWPA M6 | (2013) Brands Used on Preservative Treated Materials |
| AWPA T1 | (2017) Use Category System: Processing and Treatment Standard |
| AWPA U1 | (2017) Use Category System: User Specification for Treated Wood |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1011/A1011M | (2017) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, |

| | |
|---|---|
| | High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| ASTM D25 | (2012) Round Timber Piles |

FEDERAL SPECIFICATION (Fed. Spec.)

| | |
|---|---|
| TT-W-572B | (1969) Wood Preservative: Water-Repellent |

1.4 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-01 Preconstruction Submittals

Safety Plan

SD-03 Product Data

Timber pile

Driving equipment

Cap or cushion block

Pile shoes

SD-06 Test Reports

Inspection report

SD-11 Closeout Submittals

Pile driving records

1.5 SUBMITTAL REQUIREMENTS

The Contractor shall submit a safety plan for the District's approval prior to beginning any pile driving work. Contractor shall submit product data for the timber pile materials, and driving equipment, the cap or cushion block and the pile shoes.

Submit complete and accurate pile driving records of installed piles to the District within 15 calendar days after completion of pile driving. Make pile driving records available to the District at the job site, within 24 hours after each day of pile driving. Provide pile driving records as specified in Part 3. Preparation of the record must be by, or under the direct supervision of a registered professional engineer.

1.6 QUALITY ASSURANCE

The producer must brand each treated pile, in accordance with AWPA M1, AWPA M2, AWPA M6, AWPA T1 and AWPA U1. Submit the inspection report of an independent inspection agency, approved by the District, stating that

offered products comply with applicable AWPA Standards, and that the plant conforms to AWPA M3.

## 1.7 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide at least 48-hour notice of its intention to begin new work activities.

The District, at its discretion, reserves the right to inspect the treating process. Notify the District at least 3 weeks prior to beginning the treatment, stating where preservative treatment will be done. Allow District inspector access to all parts of the plant. Allow inspection of all facets of the treating process.

## 1.8 SUBSURFACE DATA

Subsurface soil data logs and subsurface investigation information can be found in the Geotechnical Site Characterization Report, which is included as part of the bid documents. The pile locations, top and tip elevations are indicated on the drawings. The final record drawings must include the surveyed location of the installed piles.

## 1.9 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Piles

Provide pressure treated Douglas fir or southern pine clean-peeled piles conforming to ASTM D25. Minimum butt diameters measured at 3 feet from the butt must be indicated.

### 2.1.2 Preservative Treatment

The following pressure treated wood formulations are acceptable:

a. Alkaline Copper Quaternary Type C (ACQ-C) and Type D (ACQ-D with carbonate)

b. Copper Azole Type B (CA-B)

The method of treatment for all timber materials shall be in accordance with Fed. Spec. TT-W-572B. Use of Chromated Copper Arsenate (CCA) treated timber shall only be permitted for marine (salt water) applications assigned in the Use Category 5 (UC5), as specified under Sub-Section 6 of the AWPA Standard U1.

Pressure treatment shall be in accordance with the requirements of American Wood Preserves Association (AWPA) Standard U1 and T1. Each piece of pressure preservative treated lumber shall bear the AWPA stamp, indicating point of

treatment, preservative symbol, symbol of standard, date of treatment, and moisture content after treatment.

The minimum requirements for preservative retention shall be calculated as pounds of any preservative system per cubic feet (lbs/ft3) of wood as indicated in the AWPA Commodity Specifications in Standard T1.

The minimum requirements for preservative penetration shall not be less than the predetermined values in AWPA Standard U1.

### 2.1.3 Capblocks

Provide capblocks used between the cap and the hammer ram made of solid hardwood with grain parallel to the pile axis and enclosed in a close-fitting housing of steel, or aluminum and approved industrial type plastic laminate disks stacked alternately in a steel housing. Use steel plates at the top and bottom of the capblock.

If the capblock is other than that specified above, submit to the District at least two weeks prior to the commencement of test pile driving, detailed drawings and records of previous successful use.

Replacement of a wood capblock during the final driving of any pile is not allowed. The use of small wood blocks, wood chips, rope, or any other material permitting excessive loss of hammer energy is not permitted.

### 2.1.4 Pile Shoes

Boot type or point type specially fabricated for the purpose and the product of a manufacturer regularly engaged in the manufacture of pile fittings. Provide size to fit tip indicated. Fabricate boot-type of 3/16 inch carbon steel conforming to ASTM A1011/A1011M, fully welded, with minimum three straps, each with 3/16 inch nail hole. Fabricate point type of four 3/16 inch steel plates, fully welded and sized to adequately cover full pointed area of pile; provide each plate with 3/16 or 1/4 inch nail hole.

## PART 3 EXECUTION

### 3.1 EXAMINATION

Examine piles when delivered and when in the leads immediately before driving. The District will inspect the piles at the Site of the work. Facilities shall be made available to the District for proper inspection of each pile throughout its length. Piles damaged after inspection may be subsequently rejected if damage is deemed sufficient for rejection by the District. All rejected piles shall be removed as directed. Treatment of piles will be inspected in accordance with AWPA Standard M2.

The Contractor shall provide piles of sufficient length to allow for "Heading" and cutting off square after driving. The Contractor shall furnish piles in lengths at least one foot greater than the lengths specified to be below the cut-off elevations.

### 3.2 PREPARATION

Where the protective shell of treated wood is impaired at a point which after installation will be not less than 10 feet below the ground, make

repairs in accordance with AWPA M4 unless the pile is damaged to such extent that it is rejected.

## 3.3 INSTALLATION

Cut piles at cut-off grade with pneumatic tools, sawing, or other approved method. Size bolt holes to ensure a driving fit.

Holes bored into piles shall be treated as specified in paragraph 2.1.2 and, when not used for bolts, shall be tightly closed by a treated plug. Holes shall not be bored or spikes driven into piles to support scaffolding.

The Contractor shall cap the tops of all piles as shown on the Drawings with stainless steel sheet metal formed in the field to the shape of pile head with no sharp or protruding edges. Fasten caps to timber pile with stainless steel 6D nails around perimeter of pile head at two (2) inches centers.

### 3.3.1 Driving Piles

General:

a. No piles shall be driven until the excavation or fill in the area, which they are to occupy, has been completed to elevation of grade indicated on the Drawings, nor within 100 feet of concrete less than seven (7) days old, unless authorized by the District.

b. The Contractor shall carefully locate all piles to the lines and spacing shown on the Drawings and shall drive piles either to the vertical or batter lines indicated on the Drawings.

c. The Contractor, when working in difficult alignment areas such as sloped surfaces, shall use appropriate means that may consist of templates or pilot holes to properly align piles.

d. Drive continuously and without interruption to the indicated tip elevation. If a pile fails to reach the indicated pile tip elevation, notify the District who will determine the procedure to be followed.

### 3.3.2 Driving Equipment

Select and use a pile hammer of sufficient weight and energy to suitably install the specified pile without damage into the soils expected to be encountered. Place driving helmet or a cap or cushion block combination capable of protecting the head of the pile between the top of the pile and the ram to prevent impact damage to the pile. If block is damaged, split, highly compressed, charred or burned or has become spongy or deteriorated in any manner, replace with a new block. The helmet or block must uniformly transmit energy to the pile and minimum loss of energy.

Vibratory hammers shall not be used.

## 3.4 JETTING OF PILES

Jetting of piles is not allowed.

## 3.5 PRE-AUGERING OR SPUDDING OF PILES

Pre-augering or spudding of piles will not be permitted.

## 3.6 BLASTING

Blasting of holes for the piles will not be permitted.

## 3.7 TREATMENT

Treat cut, bored, dappled, and damaged surfaces as specified in AWPA M4.

## 3.8 TOLERANCES IN DRIVING

A variation of not more than 0.25 inch per foot of pile length from the vertical for plumb piles or more than 0.50 inch per foot of pile length from the required angle for batter piles is permitted. The center of butts must be within 4 inches of the location indicated. Manipulation of piles is not permitted. Re-drive heaved piles to the required tip elevation. Remove and replace with new piles those damaged, mislocated, or driven out of alignment or provide additional piles, driven as directed.

## 3.9 PILE DRIVING RECORDS

Keep a complete and accurate record of each pile driven. Indicate the pile location, butt diameter, original length, ground elevation, tip elevation, cutoff elevation, penetration in blows per foot for the entire length of penetration for test piles, penetration in blows per foot for the last 10 feet for job piles, hammer data including make and size, and any unusual pile behavior or circumstances experienced during driving such as redriving, heaving, weaving, obstructions, jetting, spudding, and unanticipated interruptions which may occur. The following log is a preprinted form for recording pile driving data.

PILE DRIVING LOG

CONTRACT NO._____ CONTRACT NAME_____
CONTRACTOR_____ TYPE OF PILE_____
PILE LOCATION_____ PILE SIZE: BUTT/TIP: _____ LENGTH_____
GROUND ELEVATION_____ CUT OFF ELEVATION_____
PILE TIP ELEVATION_____ VERTICAL (_____) BATTER 1 ON (_____)
SPLICES ELEVATION_____ COMPANY_____

HAMMER: MAKE & MODEL_____ WT. RAM_____
STROKE_____ RAM RATED ENERGY_____
DESCRIPTION & DIMENSIONS OF DRIVING CAP_____
CUSHION MATERIALS & THICKNESS_____

INSPECTOR_____

"DEPTH" COLUMN OF PILE DRIVING RECORD REFERENCED TO:
_____ CUT-OFF ELEVATION
_____ FINISH FLOOR ELEVATION

TIME: START DRIVING_____ FINISH DRIVING_____ DRIVING TIME_____
INTERRUPTIONS (TIME, TIP ELEV. & REASON)_____
JET PRESSURE & ELEVATIONS_____

_____

DRIVING RESISTANCE

| DEPTH FT. | NO. OF BLOWS | DEPTH FT. | NO. OF BLOWS | DEPTH FT. | NO. OF BLOWS |
|---|---|---|---|---|---|
| 0 | _____ | 18 | _____ | 36 | _____ |
| 1 | _____ | 19 | _____ | 37 | _____ |
| 2 | _____ | 20 | _____ | 38 | _____ |
| 3 | _____ | 21 | _____ | 39 | _____ |
| 4 | _____ | 22 | _____ | 40 | _____ |
| 5 | _____ | 23 | _____ | 41 | _____ |
| 6 | _____ | 24 | _____ | 42 | _____ |
| 7 | _____ | 25 | _____ | 43 | _____ |
| 8 | _____ | 26 | _____ | 44 | _____ |
| 9 | _____ | 27 | _____ | 45 | _____ |
| 10 | _____ | 28 | _____ | 46 | _____ |
| 11 | _____ | 29 | _____ | 47 | _____ |
| 12 | _____ | 30 | _____ | 48 | _____ |
| 13 | _____ | 31 | _____ | 49 | _____ |
| 14 | _____ | 32 | _____ | 50 | _____ |
| 15 | _____ | 33 | _____ | 51 | _____ |
| 16 | _____ | 34 | _____ | 52 | _____ |
| 17 | _____ | 35 | _____ | 53 | _____ |

SHEET 1 OF 2

| | | | | | |
|---|---|---|---|---|---|
| 54 | _____ | 77 | _____ | 99 | _____ |
| 55 | _____ | 78 | _____ | 100 | _____ |
| 56 | _____ | 79 | _____ | 101 | _____ |
| 57 | _____ | 80 | _____ | 102 | _____ |
| 58 | _____ | 81 | _____ | 103 | _____ |
| 59 | _____ | 82 | _____ | 104 | _____ |
| 60 | _____ | 83 | _____ | 105 | _____ |
| 61 | _____ | 84 | _____ | 106 | _____ |
| 62 | _____ | 85 | _____ | 107 | _____ |
| 63 | _____ | 86 | _____ | 108 | _____ |
| 64 | _____ | 87 | _____ | 109 | _____ |
| 65 | _____ | 88 | _____ | 110 | _____ |
| 66 | _____ | 89 | _____ | 111 | _____ |
| 67 | _____ | 90 | _____ | 112 | _____ |
| 68 | _____ | 91 | _____ | 113 | _____ |
| 69 | _____ | 92 | _____ | 114 | _____ |
| 70 | _____ | 93 | _____ | 115 | _____ |
| 71 | _____ | 94 | _____ | 116 | _____ |
| 72 | _____ | 95 | _____ | 117 | _____ |
| 73 | _____ | 96 | _____ | 118 | _____ |
| 74 | _____ | 97 | _____ | 119 | _____ |
| 75 | _____ | 98 | _____ | 120 | _____ |
| 76 | _____ | | | | |

---

DRIVING RESISTANCE IN BLOWS PER INCH FOR LAST FOOT OF PENETRATION:

DEPTH_____ DEPTH_____

1"___2"___3"___4"___5"___6"___7"___8"___9"___10"___11"___12"___

ELEV._____ ELEV._____

REMARKS_____

_____

CUT OFF ELEVATION: FROM DRAWING _____

TIP ELEVATION = GROUND ELEVATION - DRIVEN DEPTH = _____

DRIVEN LENGTH = CUT OFF ELEVATION - TIP ELEVATION = _____

CUT OFF LENGTH = PILE LENGTH - DRIVEN LENGTH = _____

SHEET 2 OF 2

-- End of Section --

# SECTION 32 11 23.10

# LIMEROCK BASE

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all labor, equipment and materials to construct the rock base required for the different pavement sections as required by the plans or as specified herein.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.3 REFERENCES

The following standard specifications shall apply to the work of this section as indicated:

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Constructions |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D1557 | (2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D2922 | Standard Test Methods for Density of Soil and Soil-Aggregate in Place by the Nuclear Methods (Shallow Depth) |

### 1.4 DEFINITIONS

Not Used

### 1.5 SUBMITTALS

SD-06 Test Reports

Density Test Reports

SD-07 Certificates

Limerock Material

### 1.6 QUALIFICATIONS

Not Used

## 1.7 RESPONSIBILITIES

Not Used

## 1.8 CERTIFICATIONS AND TESTING

### 1.8.1 Tests

If the District deems necessary, field density tests in accordance with ASTM D2922, Test for Density of Soil and Soil-Aggregate in Place by the Nuclear Method will be performed. The areas to be tested shall be determined by the District. Laboratory compaction tests in accordance with ASTM D1557 Standard Test Methods for Laboratory compaction Characteristics of Soil Using the Modified Effort (56,000 ft-lbf/cu. ft.) will also be performed. The Contractor shall make the site available for testing and cooperate fully to allow tests to be taken. Failure to meet the specified density will require the Contractor to recompact and retest those areas directed by the District. Contractor shall submit density test reports within 3 working days of the tests. Submit certification that the limerock material meets the specification requirements.

## 1.9 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide 48 hours advance notice of its intention to begin new Work activities.

## 1.10 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

LIMEROCK BASE

## 2.1 LIMEROCK BASE

The Contractor shall provide new limerock conforming to FDOT Standard Specifications for Road and Bridge Construction Section 911. The density of limerock shall be 129 lbs./cu. ft. Acceptance of the material will be in accordance with FDOT Standard Specifications for Road and Bridge Construction SECTION 200-7.

## 2.2 EQUIPMENT

The Contractor shall furnish equipment as needed to transport, deliver, place, spread, incorporate, moisten and compact the limerock base material as specified and required by the Drawings.

# PART 3 EXECUTION

## 3.1 GENERAL

The Contractor shall place limerock aggregate in conformance with Section 200 "Base Rock" of the FDOT Standard Specifications for Road and Bridge Construction and as follows:

Preparation of Subgrade: The Contractor shall prepare the subgrade In accordance with the requirements of Section 200 and as follows:

1. Clean off all foreign substances.

2. Correct any ruts or soft yielding spots or any areas with inadequate compaction.

## 3.2 COMPACTING AND FINISHING BASE

The Contractor shall compact by rolling with either the grid-type roller or the sheepsfoot roller, properly weighted, after the spreading and mixing operations are complete. The material being compacted shall be maintained within plus or minus 2 percent of its optimum moisture content during compaction. Final rolling shall be accomplished with traffic rollers. The base shall be compacted to not less than 95 percent of the maximum density as determined by ASTM D1557, and in accordance with FDOT Standard Specifications for Road and Bridge Construction Section 204-6.

## 3.3 PRIMING AND MAINTAINING

The Contractor shall apply prime coat only when the base meets the specified density requirements and the moisture content in the top half of the base does not exceed 90 percent of the optimum moisture of the base material. At the time of priming, the base shall be firm, unyielding and in such condition that no undue distortion will occur. The Contractor shall be responsible for assuring that the true crown and template are maintained, with no rutting or other distortion, and that the base meets all the requirements at the time the surface course is applied.

## 3.4 FIELD QUALITY CONTROL

### 3.4.1 Smoothness Test

Perform smoothness test with a 10-foot straightedge applied parallel with and at right angles to the center line of the finished surface. Correct surface deviations more than 1/4 inch by loosening, adding or removing material, reshaping, watering, and compacting. When base course is constructed in more than one layer, smoothness requirements apply only to the top layer.

### 3.4.2 Thickness Tests

Take at least one depth measurement for each 500 square yards of completed base course. Make depth measurements by test holes, at least 3 inches in diameter, through the course. Where thickness deficiency exceeds 1/2 inch, correct by scarifying, adding mixture of proper gradation, reblading, and recompacting. Where measured thickness exceeds 1/2 inch thicker than shown, it shall be considered as the indicated or specified thickness plus 1/2 inch for determining the average. Average thickness shall be the average of the depth measurements and shall not underrun the thickness shown by more than 1/4 inch.

-- End of Section --

# SECTION 32 11 39

# SHELL BASE COURSE

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all labor, equipment, and materials to stabilize the access roads indicated with shell rock base material.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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.

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Construction |

ASTM International (ASTM)

| | |
|---|---|
| ASTM D1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using the Modified Effort (56,000 ft-lb/ft3 (2,700 kN-m/m3)) |
| ASTM D2922 | Standard Test Methods for Density of Soil and Soil-Aggregate in Place by the Nuclear Methods (Shallow Depth) |

### 1.4 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Density test reports

SD-07 Certificates

Shell Rock

## 1.5 SUBMITTAL REQUIREMENTS

The Contractor shall submit certification stating that the shell rock subgrade stabilizing material meets the requirements stated in section 911 of the FDOT specifications.

The Contractor shall submit density test reports for all access roads that receive the shell rock stabilization.

## 1.6 QUALITY CONTROL

If the District deems necessary, field density tests in accordance with ASTM D2922, Test for Density of Soil and Soil-Aggregate in Place by the Nuclear Method will be performed. The areas to be tested shall be determined by the District. Laboratory compaction tests in accordance with D1557 Standard Test Methods for Laboratory compaction Characteristics of Soil Using the Modified Effort (56,000 ft-lbf/cu.ft.) will also be performed. The Contractor shall make the site available for testing and cooperate fully to allow tests to be taken. Failure to meet the specified density will require the Contractor to recompact and retest those areas directed by the District.

## 1.7 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide 48 hours advance notice of its intention to begin new Work activities.

## 1.8 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 SHELL ROCK

The Contractor shall provide shell rock subgrade stabilization material in accordance with FDOT Standard Specifications for Road and Bridge Construction Section 914. The District shall review and approve the material.

# PART 3 EXECUTION

## 3.1 PREPARATION

The Contractor shall complete the area to be stabilized to the lines and to a grade parallel to the finished elevation of the stabilized base before the stabilizing material is added. For access roads without proposed grades or alignments prepare the area to be stabilized by meeting/matching the existing alignments and widths unless otherwise directed by the District.

## 3.2 SPREADING AND MIXING

The Contractor shall place shell rock on the areas to be stabilized and spread it uniformly to the loose depth of 6 inches or as directed by the District. The Contractor shall then thoroughly mix the shell-rock with the soil. The mixing operation shall be accomplished by use of a rotary tiller

or other approved equipment and shall be repeated as may be necessary to distribute the shell rock uniformly throughout the soil for the depth indicated. The material shall be further manipulated until uniform distribution of the shell rock throughout the width and the depth is achieved.

## 3.3 MIXING DEPTH

The Contractor shall mix the shell rock and soil to a depth as indicated and in accordance with FDOT Standard Specifications for Road and Bridge Construction Section 230-5.5.

## 3.4 SURFACE

After mixing is complete the Contractor shall shape the surface so that, after being compacted, it will conform to the lines and grades as indicated or as directed in the field.

## 3.5 COMPACTING AND FINISHING BASE

After the spreading and mixing operations are complete, the Contractor shall compact the mixed soil/shell rock base by rolling with either the grid-type roller or the sheepsfoot roller. The material being compacted shall be maintained within plus or minus 2 percent of its optimum moisture content during compaction. Final rolling shall be accomplished with traffic rollers. The base shall be compacted to the density of not less than 90 percent of the maximum density as determined by ASTM D1557. Density tests shall be performed at 1,000 foot (maximum) intervals.

-- End of Section --

# SECTION 32 12 13

# BITUMINOUS TACK AND PRIME COATS

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all labor, equipment and materials to apply tack and/or prime coats as indicated or specified.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.3 REFERENCES

The following standard specifications shall apply to the work of this section as indicated:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO T 102 | (2009; R 2013) Standard Method of Test for Spot Test of Asphaltic Materials |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D140/D140M | (2016) Standard Practice for Sampling Asphalt Materials |
| ASTM D2028/D2028M | (2015) Cutback Asphalt (Rapid-Curing Type) |
| ASTM D2995 | (1999; R 2009) Determining Application Rate of Bituminous Distributors |
| ASTM D946/D946M | (2015) Penetration-Graded Asphalt Cement for Use in Pavement Construction |
| ASTM D977 | (2013; E 2014) Emulsified Asphalt |

### 1.4 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Sampling and Testing

SD-07 Certificates

Asphalt materials

## 1.5 QUALITY ASSURANCE

Contractor shall submit certificates of compliance for asphalt materials that will be reviewed for compliance with the specification requirements. Quantities of applied material will be determined. Tack coat materials will not be diluted. Prime coat materials when emulsions are used can be diluted on site with potable water up to 1 part emulsion to 1 part water.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with a minimum of handling.

## 1.7 EQUIPMENT, TOOLS AND MACHINES

### 1.7.1 General Requirements

Equipment, tools and machines used in the work are subject to approval. Maintain in a satisfactory working condition at all times. Calibrate equipment such as asphalt distributors, scales, batching equipment, spreaders and similar equipment within 12 months of their use. If the calibration expires during project, recalibrate the equipment before work can continue.

### 1.7.2 Bituminous Distributor

Provide a self-propelled distributor with pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the surface being sprayed. Calibrate the distributer in accordance with ASTM D2995. Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled total liquid rates from 0.03 to 1.0 gallons per square yard, with a pressure range of 25 to 75 psi and with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor will be capable of circulating and agitating the bituminous material during the heating process.

### 1.7.3 Heating Equipment for Storage Tanks

Use steam, electric, or hot oil heaters for heating the bituminous material. Provide steam heaters consisting of steam coils and equipment for producing steam, so designed that the steam cannot come in contact with the bituminous material. Fix an armored thermometer to the tank with a temperature range from 40 to 400 degrees F so that the temperature of the bituminous material may be determined at all times.

### 1.7.4 Power Brooms and Power Blowers

Use power brooms and power blowers suitable for cleaning the surfaces to which the bituminous coat is to be applied.

## 1.8 ENVIRONMENTAL REQUIREMENTS

Apply bituminous coat only when the surface to receive the bituminous coat is dry. A limited amount of moisture (approximately 0.03 gallon/square yard) can be sprayed on the surface of unbound material when prime coat is used to improve coverage and penetration of asphalt material. Apply bituminous coat only when the atmospheric temperature in the shade is 50 degrees F or above and when the temperature has not been below 35 degrees F for the 12 hours prior to application, unless otherwise directed.

# PART 2 PRODUCTS

## 2.1 PRIME COAT

Provide asphalt conforming to one of the following grades:

### 2.1.1 Cutback Asphalt

Provide cutback asphalt conforming to ASTM D2028/D2028M, Grade RC-70.

### 2.1.2 Emulsified Asphalt

Provide emulsified asphalt conforming to ASTM D977, Type SS-1. Asphalt emulsion can be diluted up to 1 part water to 1 part emulsion for prime coat use. Do not dilute asphalt emulsion for tack coat use.

## 2.2 TACK COAT

### 2.2.1 Asphalt Cement

Provide asphalt cement conforming to ASTM D946/D946M.

### 2.2.2 Cutback Asphalt

Provide cutback asphalt conforming to ASTM D2028/D2028M, Grade RC-70.

### 2.2.3 Emulsified Asphalt

Provide emulsified asphalt conforming to ASTM D977, Type SS-1. For prime coats the emulsified asphalt can be diluted with up to 1 part emulsion to 1 part water. No dilution is allowed for tack coat applications. The base asphalt used to manufacture the emulsion is required to show a negative spot when tested in accordance with AASHTO T 102 using standard naphtha.

# PART 3 EXECUTION

## 3.1 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated by means of a power broom or blower supplemented with hand brooms. Apply treatment only when the surface is dry and clean.

## 3.2 APPLICATION RATE

The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the District.

3.2.1 Tack Coat

Apply bituminous material for the tack coat in quantities of not less than 0.05 gallons nor more than 0.15 gallons per square yard of residual asphalt onto the pavement surface.

3.2.2 Prime Coat

Apply bituminous material for the prime coat in quantities of not less than 0.18 gallons nor more than 0.35 gallons per square yard of residual asphalt for asphalt emulsion up to a 1 to 1 dilution rate or for residual asphalt for cutback asphalt.

3.3 APPLICATION TEMPERATURE

3.3.1 Viscosity Relationship

Apply asphalt at a temperature that will provide a viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 centistokes, kinematic. Furnish the temperature viscosity relation to the District.

3.3.2 Temperature Ranges

The viscosity requirements determine the application temperature to be used. The following is a normal range of application temperatures:

| **Cutback Asphalts** | |
|---|---|
| MC-30 | 85-190 degrees F |
| SC-70, MC-70, RC-70 | 120-225 degrees F |
| SC-250, MC-250, RC-250 | 165-270 degrees F |
| **Asphalt Emulsion** | |
| All Grades | 70-160 degrees F |
| **Asphalt Cement** | |
| All Grades | 275-350 degrees F |

Some of these temperatures for rapid cure cutbacks are above the flash point of the material and care should be taken in their heating.

3.4 APPLICATION

3.4.1 General

Following preparation and subsequent inspection of the surface, apply the bituminous prime or tack coat with the bituminous distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots, not capable of being sprayed with the distributor, with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost to the District. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment are permitted within 25 feet of heating,

distributing, and transferring operations of cutback materials. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat requirements are described herein.

### 3.4.2 Prime Coat

The prime coat is required if it will be at least 7 days before the asphalt mixture is constructed on the underlying (base course, etc.) compacted material. The type of liquid asphalt and application rate will be as specified herein. Protect the underlying layer from any damage (water, traffic, etc.) until the surfacing is placed. If the Contractor places the surfacing within seven days, the choice of protection measures or actions to be taken is at the Contractor's option. Repair (recompact or replace) damage to the underlying material caused by lack of, or inadequate, protection by approved methods at no additional cost to the District. If the Contractor opts to use the prime coat, apply as soon as possible after consolidation of the underlying material. Apply the bituminous material uniformly over the surface to be treated at a pressure range of 25 to 75 psi; the rate will be as specified above in paragraph APPLICATION RATE. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper and to ensure that all sprayers will operate at full force on the surface to be treated. Immediately after application remove and destroy the building paper.

### 3.4.3 Tack Coat

Apply the tack coat when the surface to be treated is clean and dry. Immediately following the preparation of the surface for treatment, apply the bituminous material by means of the bituminous distributor, within the limits of temperature specified herein and at a rate as specified above in paragraph APPLICATION RATE. Apply the bituminous material so that uniform distribution is obtained over the entire surface to be treated. Treat lightly coated areas and spots missed by the distributor by spraying with a hand wand or using other approved method. Following the application of bituminous material, allow the surface to cure without being disturbed for period of time necessary to permit setting of the tack coat. Apply the bituminous tack coat only as far in advance of the placing of the overlying layer as required for that day's operation. Maintain and protect the treated surface from damage until the succeeding course of pavement is placed.

## 3.5 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of asphalt mixture allow the bituminous coat to cure and water or volatiles to evaporate prior to overlaying. Maintain the tacked surface in good condition until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread enough sand to effectively blot up excess bituminous material.

## 3.6 FIELD QUALITY CONTROL

Samples of the bituminous material shall be tested for compliance with the applicable specified requirements. A sample shall be obtained and tested by the Contractor for every 500 gallons of bituminous material used. The sample may be retained and tested by the District at no cost to the Contractor.

## 3.7 SAMPLING AND TESTING

Submit copies of all test results for emulsified asphalt, and bituminous materials, within 24 hours of completion of tests. Furnish certified copies of the manufacturer's test reports indicating temperature viscosity relationship for cutback asphalt, compliance with applicable specified requirements, not less than 30 days before the material is required in the work. Perform sampling and testing by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

### 3.7.1 Sampling

Unless otherwise specified, sample bituminous material in accordance with ASTM D140/D140M. Sources from which bituminous materials are to be obtained shall be selected and notification furnished the District within 15 days after the award of the contract.

### 3.7.2 Calibration Test

Furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibrate using the approved job material and prior to applying the bituminous coat material to the prepared surface. Calibrate the bituminous distributor in accordance with ASTM D2995.

### 3.7.3 Trial Applications

Before providing the complete bituminous coat, apply three lengths of at least 100 feet for the full width of the distributor bar to evaluate the amount of bituminous material that can be satisfactorily applied.

#### 3.7.3.1 Tack Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous tack coat materials in the amount of 0.05 gallons per square yard. Make other trial applications using various amounts of material as may be deemed necessary.

#### 3.7.3.2 Prime Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous materials in the amount of 0.25 gallon per square yard. Make other trial applications using various amounts of material as may be deemed necessary.

### 3.7.4 Sampling and Testing During Construction

Perform quality control sampling and testing as required in paragraph FIELD QUALITY CONTROL.

## 3.8 TRAFFIC CONTROLS

Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

-- End of Section --

# SECTION 32 12 16

# HOT-MIX ASPHALT (HMA) FOR ROADS

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all labor, equipment and materials to pave the areas indicated with asphalt pavement.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 156 | (2013) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures |

ASPHALT INSTITUTE (AI)

| | |
|---|---|
| AI MS-2 | (2015) Asphalt Mix Design Methods |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C136/C136M | (2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C566 | (2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying |
| ASTM D1461 | (2011) Moisture or Volatile Distillates in Bituminous Paving Mixtures |
| ASTM D2172/D2172M | (2017) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures |
| ASTM D242/D242M | (2009; R 2014) Mineral Filler for Bituminous Paving Mixtures |

| | |
|---|---|
| ASTM D2950/D2950M | (2014) Density of Bituminous Concrete in Place by Nuclear Methods |
| ASTM D3665 | (2012) Random Sampling of Construction Materials |
| ASTM D3666 | (2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials |
| ASTM D4125/D4125M | (2010) Asphalt Content of Bituminous Mixtures by the Nuclear Method |
| ASTM D5444 | (2015) Mechanical Size Analysis of Extracted Aggregate |
| ASTM D6307 | (2016) Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method |
| ASTM D6925 | (2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor |
| ASTM D6926 | (2016) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Constructions, latest edition |

## 1.4 SUBMITTALS

Testing Laboratory Compliance

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan

SD-03 Product Data

Job Mix Formula

SD-06 Test Reports

Aggregate

QC Test Results

SD-07 Certificates

Asphalt Cement Binder

Testing Laboratory

1.5 ENVIRONMENTAL REQUIREMENTS

Do not place the hot-mix asphalt upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 1. The temperature requirements may be waived by the District, if requested; however, meet all other requirements, including compaction.

| **Table 1. Surface Temperature Limitations of Underlying Course** | |
|---|---|
| **Mat Thickness, inches** | **Degrees F** |
| 3 or greater | 40 |
| Less than 3 | 45 |

1.6 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide 48 hours advance notice of its intention to begin new Work activities.

1.7 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Perform the work consisting of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. HMA designed and constructed in accordance with this section shall conform to the lines, grades, thicknesses, and typical cross sections indicated. Construct each course to the depth, section, or elevation required by the drawings and roll, finish, and approve it before the placement of the next course.

2.1.1 Asphalt Mixing Plant

Plants used for the preparation of hot-mix asphalt shall conform to the requirements of AASHTO M 156 with the following changes:

2.1.1.1 Truck Scales

Weigh the asphalt mixture on approved, certified scales at the Contractor's expense. Inspect and seal scales at least annually by an approved calibration laboratory.

2.1.1.2 Testing Facilities

Provide laboratory facilities at the plant for the use of the District acceptance testing and the Contractor's quality control testing.

2.1.1.3 Inspection of Plant

Provide the District with access at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance as requested, for the District to procure any desired samples.

2.1.1.4 Storage bins

Use of storage bins for temporary storage of hot-mix asphalt will be permitted as follows:

a. The asphalt mixture may be stored in non-insulated storage bins for a period of time not exceeding 3 hours.

b. The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 8 hours. The mix drawn from bins shall meet the same requirements as mix loaded directly into trucks.

2.1.2 Hauling Equipment

Provide trucks for hauling hot-mix asphalt having tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Petroleum based products shall not be used as a release agent. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers (tarps) shall be securely fastened.

2.1.3 Asphalt Pavers

Provide asphalt pavers which are self-propelled, with an activated screed, heated as necessary, and capable of spreading and finishing courses of hot-mix asphalt which will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

2.1.3.1 Receiving Hopper

Provide paver with a receiving hopper of sufficient capacity to permit a uniform spreading operation and equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

2.1.3.2 Automatic Grade Controls

Equip the paver with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically

actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. A transverse slope controller shall not be used to control grade. Provide controls capable of working in conjunction with any of the following attachments:

a. Ski-type device of not less than 30 feet in length.

b. Taut stringline set to grade.

c. Short ski or shoe for joint matching.

d. Laser control.

### 2.1.4 Rollers

Rollers shall be in good condition and shall be operated at slow speeds to avoid displacement of the asphalt mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate.

## 2.2 AGGREGATES

Provide aggregates in compliance with FDOT Standard Specification Section 334-2.1 and associated sub references. Submit all aggregate test reports and samples to the District at least 14 days prior to start of construction. Aggregate shall be supplied from FDOT approved suppliers/sources in accordance with FDOT Standard Specification Section 6-1.3.

### 2.2.1 Coarse Aggregate

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. All individual coarse aggregate shall comply with FDOT Standard Specification Section 901.

### 2.2.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, tough, durable particles free from coatings of clay, silt, or any objectionable material and containing no clay balls. Fine aggregate shall comply with FDOT Standard Specification Section 902.

### 2.2.3 Mineral Filler

Mineral filler shall be nonplastic material meeting the requirements of ASTM D242/D242M.

### 2.2.4 Aggregate Gradation

The combined aggregate gradation shall conform to gradations specified in FDOT Standard Specification Section 334-3.2.2.

## 2.3 MIX DESIGN

Asphalt Concrete: The Contractor shall furnish superpave asphalt concrete conforming to the applicable FDOT Specification Section 334 for traffic level A and the type asphalt as specified on the Drawings. A mix design with sufficient materials to produce 200 pound of blended mixture shall be provided to the District for verification of mix design at least 14 days prior to construction of test section.

### 2.3.1 JMF Requirements

Submit in writing the job mix formula for approval at least 14 days prior to the start of the test section including as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt cement.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt viscosity grade, penetration grade, or performance grade.

e. Number of gyrations of Superpave gyratory compactor.

f. Laboratory mixing temperature.

g. Lab compaction temperature.

h. Temperature-viscosity relationship of the asphalt cement.

i. Plot of the combined gradation on the 0.45 gradation chart, stating the nominal maximum size.

j. Air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2.

k. Specific gravity and absorption of each aggregate.

l. Percent natural sand.

m. Percent particles with 2 or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

o. Percent flat or elongated particles (in coarse aggregate).

p. Tensile Strength Ratio (TSR).

q. Antistrip agent (if required) and amount.

r. List of all modifiers and amount.

s. Percentage and properties (asphalt content, binder properties, and aggregate properties) of reclaimed asphalt pavement (RAP) per FDOT subsection 334-2.3.

t. Submit asphalt cement binder certification.

2.3.2 Adjustments to Field JMF

Keep the Laboratory JMF for each mixture in effect until a new formula is approved in writing by the District. Should a change in sources of any materials be made, perform a new laboratory JMF design and a new JMF approved before the new material is used.

2.4 RECYCLED HOT MIX ASPHALT

Recycled HMA shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement to produce a consistent gradation and asphalt content and properties. RAP material shall conform to requirements noted in FDOT Standard Specification Section 334-2.3.

PART 3 EXECUTION

3.1 PREPARATION OF ASPHALT BINDER MATERIAL

Prepare the asphalt cement in accordance with FDOT Standard Specification Section 330-4.

3.2 PREPARATION OF MINERAL AGGREGATE

Prepare aggregates in conformance with FDOT Standard Specification Section 330-5.

3.3 PREPARATION OF HOT-MIX ASPHALT MIXTURE

Prepare HMA Mixture in accordance with FDOT Standard Specification Section 330-6.

3.4 PREPARATION OF THE UNDERLYING SURFACE

Immediately before placing the hot mix asphalt, clean the underlying course of dust and debris. Apply a prime coat and/or tack coat in accordance with the contract specifications.

3.4.1 Prime Coat

Application of the prime coat shall conform to Specification Section 32 12 13. The surface to be primed shall be clean, and moisture content of the base shall not exceed 90 percent of the optimum. The temperature of the prime material shall be between 100 degrees and 150 degrees Fahrenheit. The material shall be applied by means of a pressure distributor.

3.4.2 Tack Coat

Application of the tack coat shall conform to Specification Section 32 12 13. The tack coat shall be applied with a pressure distributor. The material shall be heated to a suitable temperature for proper application. The time of application shall be sufficiently in advance of laying of the bituminous surface course to permit drying, but shall not be applied so far

in advance so as to lose adhesiveness. The surface shall be kept free from traffic until the subsequent layer of bituminous hot mix has been laid.

## 3.5 TESTING LABORATORY

Submit certification of compliance and Plant Scale Calibration Certification for the testing laboratory. Use a laboratory to develop the JMF that meets the requirements of ASTM D3666. The District will inspect the laboratory equipment and test procedures prior to the start of hot mix operations for conformance to ASTM D3666. The laboratory shall maintain the Corps certification for the duration of the project. A statement signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the District prior to the start of construction. The statement shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

## 3.6 TRANSPORTING AND PLACING

### 3.6.1 Transporting

The mixture shall be transported as specified in FDOT Specification Section 330-7.

### 3.6.2 Placing

Placing the mixture shall conform to FDOT Specification Section 330-9. Total thickness shall be as shown on the Drawings.

## 3.7 COMPACTION OF MIXTURE

Compaction of the asphaltic concrete shall be in accordance with FDOT Specification Section 330-10.

## 3.8 JOINTS

The formation of joints shall be performed ensuring a continuous bond between the courses and to obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

### 3.8.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing material at the joint. Remove the cutback material from the project. In

both methods, all contact surfaces shall be given a light tack coat of asphalt material before placing any fresh mixture against the joint.

### 3.8.2 Longitudinal Joints

Longitudinal joints which are irregular, damaged, uncompacted, cold (less than 175 degrees F at the time of placing adjacent lanes), or otherwise defective, shall be cut back a maximum of 3 inches from the top of the course with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. All cutback material shall be removed from the project. All contact surfaces shall be given a light tack coat of asphalt material prior to placing any fresh mixture against the joint. The Contractor will be allowed to use an alternate method if it can be demonstrated that density, smoothness, and texture can be met.

## 3.9 QUALITY CONTROL

### 3.9.1 General Quality Control Requirements

Develop and submit an approved Quality Control Plan. Submit aggregate and QC test results. Do not produce hot-mix asphalt for payment until the quality control plan has been approved addressing all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management

e. Proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction

l. Surface Smoothness

### 3.9.2 Testing Laboratory

Provide a fully equipped asphalt laboratory located at the plant or job site and meeting the pertinent requirements in ASTM D3666. Contractor to submit a certification that the testing laboratory meets the referenced requirements. Laboratory facilities shall be kept clean and all equipment maintained in proper working condition. The District shall be permitted unrestricted access to inspect the Contractor's laboratory facility, to witness quality control activities, and to perform any check testing

desired. The District will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are corrected.

### 3.9.3 Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, in-place density, grade and smoothness. Develop a Quality Control Testing Plan as part of the Quality Control Program.

#### 3.9.3.1 Asphalt Content

A minimum of two tests to determine asphalt content by one of the following methods: the extraction method in accordance with ASTM D2172/D2172M, Method A or B, the ignition method in accordance with ASTM D6307, or the nuclear method in accordance with ASTM D4125/D4125M. Calibrate the ignition oven or the nuclear gauge for the specific mix being used. For the extraction method, determine the weight of ash, as described in ASTM D2172/D2172M, as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture.

#### 3.9.3.2 Gradation

Determine aggregate gradations from mechanical analysis of recovered aggregate in accordance with ASTM D5444. When asphalt content is determined by the ignition oven or nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix plants. For batch plants, test aggregates in accordance with ASTM C136/C136M using actual batch weights to determine the combined aggregate gradation of the mixture.

#### 3.9.3.3 Temperatures

Check temperatures at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

#### 3.9.3.4 Aggregate Moisture

Determine the moisture content of aggregate used for production in accordance with ASTM C566.

#### 3.9.3.5 Moisture Content of Mixture

Determine the moisture content of the mixture in accordance with ASTM D1461 or an approved alternate procedure.

3.9.3.6 Laboratory Air Voids, Marshall Stability and Flow

Take a minimum of two mixture samples. When the Superpave gyratory compactor is used, mixes will be compacted to 75 gyrations in accordance with ASTM D6925. Hot-mix provided under the FDOT Superpave option shall be compacted in accordance with the DOT requirements. After compaction, determine the laboratory air voids of each specimen in accordance with FDOT Specification Section 334.

3.9.3.7 In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge may be used to monitor pavement density in accordance with ASTM D2950/D2950M.

3.9.3.8 Grade and Smoothness

Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraphs FDOT Specification Section 330.

3.9.3.9 Additional Testing

Any additional testing, which the Contractor deems necessary to control the process, may be performed at the Contractor's option.

3.9.3.10 QC Monitoring

Submit all QC test results to the District on a daily basis as the tests are performed. The District reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.9.4 Sampling

When directed by the District, sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

3.9.5 Control Charts

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 2, as a minimum. These control charts shall be posted as directed by the District and kept current at all times. The control charts shall identify the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 8 applicable to the test parameter being plotted, and the Contractor's test results. Target values from the JMF shall also be shown on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make

decisions concerning mix modifications based on analysis of the results provided in the control charts. The Quality Control Plan shall indicate the appropriate action to be taken to bring the process into control when certain parameters exceed their Action Limits.

**Table 8. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts**

| | Individual Samples | | Running Average of Last Four Samples | |
|---|---|---|---|---|
| **Parameter to be Plotted** | **Action Limit** | **Suspension Limit** | **Action Limit** | **Suspension Limit** |
| No. 4 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values | 6 | 8 | 4 | 5 |
| No. 30 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values | 4 | 6 | 3 | 4 |
| No. 200 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values | 1.4 | 2.0 | 1.1 | 1.5 |
| Asphalt content, percent deviation from JMF target; plus or minus value | 0.4 | 0.5 | 0.2 | 0.3 |
| Laboratory Air Voids, percent deviation from JMF target value | No specific action and suspension limits set since this parameter is used to determine percent payment | | | |
| In-place Mat Density, percent of TMD | No specific action and suspension limits set since this parameter is used to determine percent payment | | | |
| In-place Joint Density, percent of TMD | No specific action and suspension limits set since this parameter is used to determine percent payment | | | |

## 3.10 MATERIAL ACCEPTANCE

Testing for acceptability of work will be performed by an independent laboratory hired by the Contractor. Forward material acceptance test results daily to the District.

### 3.10.1 Sampling

One random mixture sample for determining laboratory air voids, theoretical maximum density, and for any additional testing the District desires, will be taken from a loaded truck delivering mixture. Samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs. Laboratory air voids will be determined from the compacted specimens in accordance with ASTM D6926. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

3.10.2 Additional Sampling and Testing

The District reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the District.

3.10.3 Grade

The final wearing surface of pavement shall conform to the elevations and cross sections shown and shall vary not more than 0.05 foot from the plan grade established and approved at site of work. Finished surfaces at juncture with other pavements shall coincide with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. The grade will be determined by running lines of levels at intervals of 25 feet, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Within 5 working days, test the final wearing surface of the pavement for conformance with the specified plan grade. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

3.10.4 Surface Smoothness

Use the following method to test and evaluate surface smoothness of the pavement. Perform all testing in the presence of the District. Keep detailed notes of the results of the testing and furnish a copy to the District immediately after each day's testing. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the District.

3.10.4.1 Smoothness Requirements

3.10.4.1.1 Straightedge Testing

The finished surfaces of the pavements shall have no abrupt change of 1/4 inch or more, and all pavements shall be within the tolerances of 1/4 inch in both the longitudinal and transverse directions, when tested with an approved 12 feet straightedge.

3.10.4.2 Testing Method

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. If any pavement areas are ground, these areas shall be retested immediately after grinding. Test the pavement in both a longitudinal and a transverse direction on parallel lines. Set the transverse lines 15 feet or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lanes less than 20 feet wide and at the third points for lanes 20 feet or wider. Also, test other areas having obvious deviations. Longitudinal testing lines shall be continuous across all joints.

3.10.4.2.1 Straightedge Testing

Hold the straightedge in contact with the surface and move it ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

-- End of Section --

# SECTION 32 16 23

# CONCRETE SIDEWALKS, CURBS AND GUTTERS, RAMPS, MISCELLANEOUS SLABS AND WHEEL STOPS

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of work: The Contractor shall furnish all labor, materials and equipment necessary for the construction for concrete walkways, curbs and gutters, ramps, miscellaneous concrete slabs and wheel stops, as shown on the Drawings.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.3 REFERENCES

The following standard specifications shall apply to the work of this section as indicated:

Florida Department of Transportation (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Construction, latest edition |

### 1.4 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Slump tests

SD-07 Certificates

Concrete mix designs

### 1.5 CERTIFICATIONS AND TESTING

Perform sampling and testing in accordance with the FDOT Specifications Section 346 and with the standards hereinafter specified.

Submit concrete mix designs for Type I concrete as specified in the FDOT Specifications Section 346.

Provide copies of the slump tests.

### 1.6 CERTIFICATIONS AND TESTING

Perform tests in accordance with standards hereinafter specified.

## 1.7 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide at least 48 hours advance notice of its intention to begin new Work activities.

## 1.8 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 CONCRETE

The Contractor shall provide concrete for sidewalks, curbs and gutters, ramps and miscellaneous concrete slabs as specified in FDOT Specifications Section 346. For miscellaneous concrete slabs Class I concrete shall have a minimum strength of 3000 psi.

## 2.2 METAL ACCESSORY MATERIALS

The Contractor shall provide metal accessory materials for miscellaneous concrete slabs as indicated on the Drawings and as specified in FDOT Specification Section 931.

## 2.3 PRE-CAST CONCRETE WHEEL STOPS

The Contractor shall furnish pre-cast concrete wheel stops that are nominally six (6) inches high by six (6) inches wide by six (6) feet long or accepted equivalent. One wheel stop shall be furnished per parking space or as shown on the Drawings. Wheel stops shall be reinforced with, at a minimum, two (2), #4 bars.

## 2.4 FORMS

The Contractor shall furnish forms for the forming of the concrete curb in accordance with the following:

A. The forms shall be wood or metal.

B. The forms shall be straight and strong enough to resist springing during placement of concrete.

C. The forms shall have sufficient bearing surface to prevent tipping.

D. The height of the forms shall be equal to full depth of section to be constructed.

E. Slip form.

# PART 3 EXECUTION

## 3.1 CONCRETE WALKS AND RAMPS

The Contractor shall construct concrete sidewalks and ramps as specified in FDOT Specifications Section 522 where shown on the Drawings.

3.2 CURBS AND GUTTERS

The Contractor shall construct concrete curbs and gutters as specified in FDOT Specifications Section 520 where shown on the Drawings.

3.3 MISCELLANEOUS CONCRETE SLABS

The Contractor shall construct miscellaneous concrete slabs for mechanical equipment as indicated on the Drawings and as specified in FDOT Specifications Section 350.

3.4 PRE-CAST CONCRETE WHEEL STOPS

The Contractor shall install pre-cast concrete wheel stops by anchoring them with at least two (2) one-half inch (#4) round reinforcing bars driven a minimum of twelve (12) inches into the pavement. Wheel stops damaged when driving rods shall be replaced with new wheel stops.

3.5 FORMS

The Contractor shall install the forms in accordance with the following:

A. Use flexible forms for all curved form lines except:

1. Curves having a radius of 200 feet or greater may be formed in ten (10) foot or shorter chords.

2. Curves having a radius of 100 feet or greater may be formed in five (5) foot or shorter chords.

B. Thoroughly clean, oil, securely stake, brace, and hold forms to line and grade.

C. Remove forms from front face of curb section at the time necessary to permit finishing concrete. Leave other forms in place not less than twelve (12) hours after placement of concrete.

3.6 JOINTS

The Contractor shall install joints in the curbs as follows:

A. Contraction Joints:

1. Construct at locations indicated and as follows:

a. Divide concrete curb into monolithic sections not greater than ten (10) feet in length.

2. Form contraction joints by any of the following methods:

a. Place one half inch thick steel separators after concrete has taken its initial set, but before final finishing.

b. Cut a groove in the fresh concrete to a depth of at one quarter the section thickness by use of a jointer having a radius of one-half inch and thickness not exceeding one-half inch.

c. Saw the hardened concrete before shrinkage cracking occurs. Depth of cut not less than one quarter the section thickness and width of key not to exceed three sixteenths inch.

B. Expansion Joints:

1. Construct at the following locations:

a. Locations as indicated on the Drawings.

b. All points of curvature and points of tangency of curves having a radius of 100 inches or less and at intervals not exceeding 60 inches in tangent section.

c. Locations where curb abuts other structures and slabs.

2. Stake, support, and secure preformed joint filler in position to prevent displacement during and finishing operations.

3. Round edges of joints with an edging tool of one quarter inch radius.

C. Construction Joints:

1. Locate to coincide with contraction, expansion or key joints.

2. When concrete placement is interrupted between joint locations for a sufficient time for the concrete to take its initial set, remove concrete to the nearest joint location before resuming placement.

-- End of Section --

# SECTION 32 17 23

# PAVEMENT MARKINGS

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish equipment, labor, and materials for the installation of pavement markings.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.3 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 248 | (1991; R 2012) Standard Specification for Ready-Mixed White and Yellow Traffic Paints |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D6628 | (2003; R 2015) Standard Specification for Color of Pavement Marking Materials |

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

| | |
|---|---|
| ICRI 03732 | (1997) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays |

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

| | |
|---|---|
| MUTCD | (2009) Manual on Uniform Traffic Control Devices |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS TT-B-1325 | (Rev D; Notice 1; Notice 2 2017) Beads (Glass Spheres) Retro-Reflective (Metric) |
| FS TT-P-1952 | (2015; Rev F) Paint, Traffic and Airfield Markings, Waterborne |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Construction, latest edition |

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Surface Preparation Equipment List

Application Equipment List

Material Safety Data Sheets (MSDS)

Reflective media for roads

Waterborne Paint

Solvent Borne Paint

SD-06 Test Reports

Reflective Media for Roads

Waterborne Paint

Solvent Borne Paint

Test Reports

SD-07 Certificates

Qualifications

Reflective Media for Roads

Waterborne Paint

Solvent Borne Paint

Volatile Organic Compound

SD-08 Manufacturer's Instructions

Waterborne Paint

Solvent Borne Paint

## 1.5 QUALITY ASSURANCE

### 1.5.1 Regulatory Requirements

Submit certificate stating that the proposed pavement marking paint meets the Volatile Organic Compound, (VOC) regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Submit Material Safety Data Sheets (MSDS) for each product.

### 1.5.2 Qualifications

Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of applicable chemicals. The documentation should include experience on five projects of similar size and scope with references for all personnel.

## 1.6 DELIVERY AND STORAGE

Deliver paint materials, thermoplastic compound materials, and reflective media in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer.

Provide storage facilities at the job site for maintaining materials at temperatures recommended by the manufacturer. Make available paint stored at the project site or segregated at the source for sampling not less than 30 days prior to date of required approval for use to allow sufficient time for testing. Notify the District when paint is available for sampling.

## 1.7 PROJECT/SITE CONDITIONS

### 1.7.1 Environmental Requirements

#### 1.7.1.1 Weather Limitations for Application

Apply pavement markings to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 5 degrees F above the dew point and the air and pavement temperatures are within the limits recommended by the pavement marking manufacturer. Allow pavement surfaces to dry after water has been used for cleaning or rainfall has occurred prior to striping or marking. Test the pavement surface for moisture before beginning work each day and after cleaning. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the District. Employ the "plastic wrap method" to test the pavement for moisture as specified in paragraph TESTING FOR MOISTURE.

### 1.7.2 Traffic Controls

Place warning signs conforming to MUTCD near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Place small markers along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation.

When traffic must be rerouted or controlled to accomplish the work, provide necessary warning signs, flag persons, and related equipment for the safe passage of vehicles.

## 1.8 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 EQUIPMENT

### 2.1.1 Surface Preparation Equipment for Roads and Parking Areas

Submit a surface preparation equipment list by serial number, type, model, and manufacturer. Include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Mobile equipment must allow for removal of markings without damaging the pavement surface or joint sealant. Maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition.

### 2.1.2 Paint Application Equipment

Submit application equipment list appropriate for the material(s) to be used. Include manufacturer's descriptive data and certification for the planned use that indicates area of coverage per pass, pressure adjustment range, tank and flow capacities, and all safety precautions required for operating and maintaining the equipment. Provide and maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition, or remove them from the work site. Provide mobile and maneuverable application equipment to the extent that straight lines can be followed and normal curves can be made in a true arc.

#### 2.1.2.1 Hand-Operated, Push-Type Machines

Provide hand-operated push-type applicator machine of a type commonly used for application of water based paint or two-component, chemically curing paint, thermoplastic, or preformed tape, to pavement surfaces for small marking projects, such as legends and cross-walks, parking areas, or surface painted signs. Provide applicator machine equipped with the necessary tanks and spraying nozzles capable of applying paint uniformly at coverage specified. Hand operated spray guns may be used in areas where push-type machines cannot be used.

#### 2.1.2.2 Self-Propelled or Mobile-Drawn Spraying Machines

Provide self-propelled or mobile-drawn spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges.

#### 2.1.2.3 Road Marking

Provide equipment used for marking roads 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 three different colors of paint as specified.

#### 2.1.2.4 Hand Application

Provide spray guns for hand application of paint in areas where the mobile paint applicator cannot be used.

#### 2.1.2.5 Reflective Media Dispenser

Attach the dispenser for applying the reflective media to the paint thermoplastic dispenser. The dispenser shall be designed to operate automatically and simultaneously with the applicator through the same control mechanism. The bead applicator must 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.

## 2.2 MATERIALS

Use non-reflectorized waterborne or solvent borne paint for parking areas. The maximum allowable VOC content of pavement markings is 150 grams per liter. Color of markings are indicated on the drawings and must conform to ASTM D6628 for roads and parking areas. Provide materials conforming to the requirements specified herein.

### 2.2.1 Waterborne Paint

Provide product data, test reports, certifications, and manufacturer's instructions for the waterborne paint conforming to FS TT-P-1952, Type I or II.

### 2.2.2 Solvent Borne Paint

Provide product data, test reports, certification, and manufacturer's instructions for the solvent borne paint conforming to AASHTO M 248

### 2.2.3 Reflective Media

#### 2.2.3.1 Reflective Media for Roads

Provide product data, test reports, certification, and manufacturer's instructions for the reflective media conforming to FS TT-B-1325, Type I, Gradation A.

# PART 3 EXECUTION

## 3.1 EXAMINATION

### 3.1.1 Testing for Moisture

Test the pavement surface for moisture before beginning pavement marking after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the District or authorized representative.

Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 12 inch by 12 inch section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap. Re-test surfaces when work has been stopped due to rain.

### 3.1.2 Surface Preparation Demonstration

Prior to surface preparation, demonstrate the proposed procedures and equipment. Prepare areas large enough to determine cleanliness, adhesion of remaining coating and rate of cleaning.

## 3.2 EXTERIOR SURFACE PREPARATION

Allow new pavement surfaces to cure for a period of not less than 30 days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove rubber deposits, existing paint markings, residual curing compounds, and other coatings adhering to the pavement by water blasting or approved chemical removal method.

a. For Portland Cement Concrete pavement, grinding, light shot blasting, or light scarification, to a resulting profile equal to ICRI 03732 CSP 2, CSP 3, and CSP 4, respectively, can be used in addition to water blasting on most pavements, to either remove existing coatings, or for surface preparation.

b. Scrub affected areas, where oil or grease is present on old pavements to be marked, with several applications of trisodium phosphate solution or other approved detergent or degreaser and rinse thoroughly after each application. After cleaning oil-soaked areas, seal with shellac or primer recommended by the manufacturer to prevent bleeding through the new paint. Do not commence painting in any area until pavement surfaces are dry and clean.

### 3.2.1 Early Painting of Asphalt Pavements

For asphalt pavement systems requiring painting application at less than 30 days, apply the paint and beads at half the normal application rate, followed by a second application at the normal rate after 30 days.

## 3.3 APPLICATION

Apply pavement markings to dry pavements only.

### 3.3.1 Paint

Apply paint pneumatically with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a deficiency in drying of the markings, painting operations must cease until the cause of the slow drying is determined and corrected.

3.3.1.1 Waterborne Paint

3.3.1.1.1 Roads

Apply paint in accordance with FDOT specification section 710.

3.3.2 Reflective Media

Apply reflective media in accordance with FDOT specification section 710-4.

3.3.3 Cleanup and Waste Disposal

Keep the worksite clean and free of debris and waste from the removal and application operations. Dispose of debris at approved sites.

3.4 FIELD QUALITY CONTROL

3.4.1 Sampling and Testing

As soon as the paint materials and reflective media are available for sampling, obtain by random selection from the sealed containers, four quart samples of each batch in the presence of the District. Two quarts will be for sampling and testing by the Contractor and two quarts will be for retention by the District. Accomplish adequate mixing prior to sampling to ensure a uniform, representative sample. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use, and quantity involved.

Test samples by an approved laboratory. If a sample fails to meet specification, replace the material in the area represented by the samples and retest the replacement material as specified above. Submit certified copies of the test reports, prior to the use of the materials at the jobsite. Include in the report of test results a listing of any specification requirements not verified by the test laboratory. At the discretion of the District, samples provided may be tested by the District for verification.

3.4.2 Material Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. A certificate of compliance shall be accompanied by test results substantiating conformance to the specified requirements.

3.4.3 Dimensional Tolerances

Apply all markings in the standard dimensions provide in the drawings. New markings may deviate a maximum of 10 percent larger than the standard dimension. The maximum deviation allowed when painting over an old marking is up to 20 percent larger than the standard dimensions.

### 3.4.4 Bond Failure Verification

Inspect newly applied markings for signs of bond failure based on visual inspection.

### 3.4.5 Reflective Media and Coating Application Verification

Use a wet film thickness gauge to measure the application of wet paint. Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50 percent of the individual bead spheres embedded and 50 percent of the individual bead spheres exposed.

### 3.4.6 Retroreflective Markings

Collect and record readings for white and yellow retroreflective markings at the rate of one reading per 1000 linear feet. The minimum acceptable average for white markings is 200 millicandelas per square meter per lux (mcd/m2/lx) (measured with Retroreflectometer). The minimum acceptable average for yellow markings is 175 millicandelas per square meter per lux (mcd/m2/lx). Compute readings by averaging a minimum of 10 readings taken within the area at random locations. Re-mark areas not meeting the retroreflective requirements stated above.

-- End of Section --

# SECTION 32 31 13

# CHAIN LINK FENCES AND GATES

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all labor, equipment and materials for the construction of the chain link security fencing including but not limited to preparing the ground to receive the fence system the layout, the fencing system, the post foundations, the outrigger system, the signs, the gate locks and the grounding system.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A116 | (2011) Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric |
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A702 | (2013) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought |
| ASTM A780/A780M | (2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A90/A90M | (2013) Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings |
| ASTM C94/C94M | (2017) Standard Specification for Ready-Mixed Concrete |
| ASTM F1043 | (2017a) Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework |
| ASTM F1083 | (2016) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures |

| | |
|---|---|
| ASTM F567 | (2014a) Standard Practice for Installation of Chain Link Fence |
| ASTM F626 | (2014) Standard Specification for Fence Fittings |
| ASTM F883 | (2013) 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-191/2 | (Rev E) Fencing, Wire and Post, Metal (Chain-Link Fence Gates) |
| 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) |

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fence Assembly

Location of Gate(s), Corner, End, and Pull Posts

Gate Assembly

Gate Hardware and Accessories

Erection/Installation Drawings

SD-03 Product Data

Fabric

Line Posts

End, Corner and Pull Posts

Sleeves

Top Rail

Bottom Rail

Post-Brace Assembly

Stretcher Bars

Stretcher Bar Bands

Post Tops

Gate Posts

Gate Hardware and Accessories

Padlocks

Barbed Wire and Supporting Arms

Zinc Coating

Fence Mounted Warning Signs

Concrete

Grout

SD-07 Certificates

Certificates of Compliance

SD-08 Manufacturer's Instructions

Fence Assembly

Gate Assembly

Hardware Assembly

Barbed Wire and Supporting Arms

Accessories

## 1.5 QUALITY CONTROL

### 1.5.1 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. Gate hardware and accessories

e. Concrete

## 1.6 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.

## 1.7 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

Provide fencing materials conforming to the requirements of ASTM A116, ASTM A702, ASTM F626.

Submit shop drawings to include the fence assembly and hardware, location of gate(s), corner, end, and pull posts, gate assembly, gate hardware, including the cane bolts, and accessories and erection and installation drawings. Shop drawing shall include the location of the fence mounted "no trespassing" signs.

Submit product data for complete fence assembly and hardware, gate assembly, hardware assembly and accessories, zinc coating, fabric, stretcher bars, concrete gate hardware and accessories.

Submit report listing chain-link fencing and accessories regarding weight in ounces for zinc coating.

Submit manufacturer's catalog data for complete fence assembly, gate assembly, hardware assembly and accessories.

## 2.2 COMPONENTS

### 2.2.1 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, 9 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, with 2.0 ounces per square foot zinc galvanizing.

Provide one-piece fabric widths for fence heights up to 12 feet.

#### 2.2.1.1 Top and Bottom Selvages

Provide knuckled selvages at top and twisted selvage at the bottom.

2.2.2 Posts , 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.

2.2.3 Line Posts

Minimum acceptable line posts are as follows:

2.0 inch O.D. pipe weighing 3.65 pounds per linear foot.

2.2.4 End, Corner, and Pull Posts

Provide minimally acceptable end, corner, and pull posts as follows:
Grade A: 2.875 inch O.D. pipe weighing 5.79 pounds per linear foot.

2.2.5 Sleeves

Provide sleeves 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.

2.2.6 Top Rail

Provide top rails with 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.

2.2.7 Bottom Rail

Provide bottom rail conforming to minimum sizes specified in FS RR-F-191/3 for each class and grade unless members are to be oversized.

2.2.8 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.

2.2.9 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 F626.

2.2.10 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.

2.2.11 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 wire supporting arm. Provide caps with an opening to permit through passage of the top rail.

2.2.12 Gate Posts

Provide a gate post for supporting each gate leaf as follows:

Up to 6-feet wide:

2.875 inch O.D. pipe Grade A weighing 5.79 pounds per linear foot.

Over 6 feet wide and up to 13 feet wide:

2.875 inch O.D. pipe Grade A weighing 5.79 pounds per linear foot.

Over 13-feet and up to 18-feet wide:

Provide 6.625 inch O.D. pipe weighing 18.97 pounds per linear foot.

Over 18-feet wide:

Provide 8.625 inch O.D. pipe weighing 24.70 pounds per linear foot.

2.2.13 Gate Assembly

FS RR-F-191/2; Type I, single swing and Type II, double swing. Shape and size of gate frame, as indicated. Framing and bracing members, round of steel alloy. Steel member finish, zinc-coated. Provide gate frames and braces of minimum sizes listed in FS RR-F-191/3 for each Class and Grade, except that steel pipe frames are a minimum of 1.90 inches o.d., 0.120 inches minimum wall thickness. Gate fabric, is as specified for fencing fabric. Coating for steel latches, stops, hinges, keepers, and accessories, is galvanized. Provide intermediate members as necessary for gate leaves more than 8 feet wide, to provide rigid construction, free from sag or twist. Provide truss rods or intermediate braces for gate leaves less than 8 feet wide. Attach gate fabric to gate frame in accordance with manufacturer's standards, except that welding is not permitted. Arrange padlocking latches to be accessible from both sides of gate, regardless of latching arrangement.

For gate leaves up to 6 feet high or 6 feet wide, provide perimeter gate frames of 1.66 inch O.D. pipe Grade A weighing 2.27 pounds per linear foot.

For gate leaves over 6 feet high or 6 feet wide, provide perimeter gate frames of 1.90 inch O.D. pipe Grade A weighing 2.72 pounds per linear foot.

Provide gate frame assembly that is welded or assembled with special malleable or pressed-steel fittings and rivets to provide rigid connections. Install fabric with stretcher bars at vertical edges; stretcher bars may also be used at top and bottom edges. Attach stretcher bars and fabric to gate frames on all sides at intervals not exceeding 15 inches. Attach hardware with rivets or by other means which provides equal security against breakage or removal.

Provide diagonal cross-bracing, consisting of 3/8-inch diameter adjustable-length truss rods on welded gate frames, where necessary to obtain frame

rigidity without sag or twist. Provide nonwelded gate frames with diagonal bracing.

Where barbed wire is indicated, or specified, extend gate end members one foot above top horizontal of the gate frame to receive the barbed wire. Three strands of barbed wire, uniformly spaced, shall be attached by bands, clips or eyebolts.

### 2.2.14 Gate Hardware and Accessories

Provide gate hardware and accessories that conforms to ASTM A116 and ASTM F626, and be as specified:

Provide forged steel or pressed steel hinges to suit gate size, non-lift-off type, offset to permit 180-degree opening.

Provide latch that permits operation from either side of the gate, with a padlock eye provided as an integral part of the latch.

Provide keepers of malleable iron for vehicular gates and for gates over 5 feet wide. Provide keepers that automatically engage the gate and hold it in the open position until manually released.

Provide double gates with a cane bolt and ground-set keeper, with latch or locking device and padlock eye designed as an integral part.

### 2.2.15 Miscellaneous Hardware

Provide miscellaneous hot-dip galvanized hardware as required.

### 2.2.16 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.

### 2.2.17 Padlocks

Provide padlocks conforming to ASTM F883, with chain. All padlocks shall be keyed alike.

### 2.2.18 Barbed Wire and Supporting Arms

Supporting Arms: Provide one for each post as indicated.

1. Single arm at 45 degrees with vertical, sloping to outside of fence

2. Constructed for attaching three rows of barbed wire to each arm and designed as a weathertight closure cap

3. Designed for 250-pound minimum pull-down load

4. Attached to steel posts or integral with post top

5. Provided with openings to receive top rail

6. Pressed steel galvanized

Barbed Wire:

1. Three-strand, 12-gauge galvanized steel wire with 14-gauge, 4-point barbs 5 inches O.C.

2. Metal and finish to match fabric

3. Three rows required

Fence Mounted Warning Signs:

1. Non-metallic, 0.125" thick white polyethelene warning signs mounted to fence at locations indicated on drawings.

2. Sign size, font, color and copy to be as indicated on the drawings and approved by the District.

## 2.3 MATERIALS

### 2.3.1 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 F1083.

b. Hardware and accessories: ASTM A153/A153M, Table 1

c. Surface: ASTM F1043

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.

### 2.3.2 Tension Wire

Provide galvanized, coiled spring wire, No. 7-gage. Provide zinc coating that weighs not less than 2.0 ounces per square foot.

2.3.3 Concrete

Provide concrete conforming to ASTM C94/C94M, and obtaining a minimum 28-day compressive strength of 3,000 psi.

2.3.4 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.

PART 3 EXECUTION

Submit manufacturer's erection/installation drawings and instructions that detail proper assembly and materials in the design for fence, gate, hardware and accessories.

Provide complete installation conforming to ASTM F567.

3.1 PREPARATION

Ensure final grading and established elevations are complete prior to commencing fence installation.

3.1.1 Clearing and Grading

Clear fence line of trees, brush, and other obstacles to install fencing for a distance of 15 feet inside; and 15 feet outside the fence. Establish a graded, compacted fence line prior to fencing installation.

3.2 INSTALLATION

3.2.1 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.

Fencing shall tie in to the cattle guard wings. See Section 32 31 53 CATTLE GUARDS.

3.2.1.1 Post Spacing

Provide line posts spaced equidistantly apart, not exceeding 10 feet on center. Provide gate posts spaced as necessary for size of gate openings. 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. Submit drawings showing location of gate(s), corner, end, and pull posts.

3.2.1.2 Top and Bottom Tension Wire

Install bottom tension wires before installing chain-link fabric, and pull wires taut. Place top and bottom tension wires within 8 inches of respective fabric line.

### 3.2.2 Excavation

Provide excavations for post footings 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 6 inches below the bottoms of the posts. Set bottom of each post not less than 42 inches below finished grade when in firm, undisturbed soil. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads.

Uniformly spread soil from excavations adjacent to the fence line or on areas of District property, as directed.

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, corner, and gate 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.

### 3.2.3 Setting Posts

Remove loose and foreign materials from holes and moisten the soil 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.

Grout all posts set into sleeved holes in concrete with an approved grouting material.

Maintain vertical alignment of posts in concrete construction until concrete has set.

#### 3.2.3.1 Earth and Bedrock

Provide concrete bases of dimensions indicated. Compact concrete to eliminate voids, and finish to a dome shape.

#### 3.2.3.2 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 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 setting material.

#### 3.2.3.3 Bracing

Brace gate, corner, end, and pull posts to nearest post with a horizontal brace rail and a diagonal tension rod.

a. Tolerances

Provide posts that are straight and plumb within a vertical tolerance of 1/4 inch after the fabric has been stretched. Provide fencing and gates that are true to line with no more than 1/2 inch deviation from the established centerline between line posts. Repair defects as directed.

### 3.2.4 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 or hang gates until the concrete has attained its full design strength.

Take samples and test concrete to determine strength as specified.

### 3.2.5 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.

### 3.2.6 Brace Assembly

Provide bracing assemblies at end and gate 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.

### 3.2.7 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.

### 3.2.8 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.

3.2.9 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.

3.2.10 Gate Installation

Field verify gate opening dimensions for gate frame fabrication. Install gates plumb, level, and secure, with full opening without interference. Maintain four (4) inches maximum clearance beneath gate frames to finished grade. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricated where necessary.

3.2.11 Wire Ties

Provide wire ties that are U-shaped to the pipe diameters to which attached. Twist ends of wire ties not less than two full turns and bent so as not to present a hazard.

3.2.12 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.

3.2.13 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.

3.2.14 Accessories Installation

3.2.14.1 Post Caps

Install post caps as recommended by the manufacturer.

3.2.14.2 Padlocks

Provide padlocks for gate openings and provide chains that are securely attached to gate or gate posts. Provide padlocks keyed alike, and provide two keys for each padlock.

3.2.15 Warning Signs

Attach signs to fence fabric at locations indicated on the Drawings.

3.2.16 Barbed Wire and Supporting Arms

Install the supporting arms and the barbed wire outrigger system as recommended by the manufacturer.

3.2.17 Grounding

Ground fencing as indicated on drawings and specified.

Ground all fences crossed by overhead power lines in excess of 600 volts, and all electrical equipment attached to the fence. Ground fences on each side of all gates, 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. Bond each gate panel with a flexible bond strap to its gate post. Ground fences crossed by power lines 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. 6 AWG solid copper wire. Provide copper-clad steel rod grounding electrodes3/4 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.

## 3.3 CLOSEOUT ACTIVITIES

Remove waste fencing materials and other debris from the work site.

Submit manufacturer's data indicating percentage of recycled material content in protective fence materials, including chain link fence, fabric, and gates to verify affirmative procurement compliance.

-- End of Section --

# SECTION 32 31 26

# WIRE FENCES AND GATES

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all labor, equipment and materials for the construction of the wire fencing including but not limited to preparing the ground to receive the fence system, the layout, the fencing system, the post foundations, the gate and the grounding system. There are two types of wire fence systems. There is a barbed wire fence system that is used around the reservoir and there is a woven wire farm fence system for the horse corral.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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 WOOD PROTECTION ASSOCIATION (AWPA)

| | |
|---|---|
| AWPA U1 | (2017) Use Category System: User Specification for Treated Wood |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A116 | (2011) Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric |
| ASTM A121 | (2013) Standard Specification for Metallic-Coated Carbon Steel Barbed Wire |
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A641/A641M | (2003) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire |
| ASTM A702 | (2013) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought |
| ASTM A780/A780M | (2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |

| | |
|---|---|
| ASTM C94/C94M | (2017a) Standard Specification for Ready-Mixed Concrete |
| ASTM F1083 | (2016) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures |
| ASTM F1184 | (2016) Industrial and Commercial Horizontal Slide Gates |
| ASTM F883 | (2013) Padlocks |
| ASTM F900 | (2011; R 2017) Standard Specification for Industrial and Commercial Swing Gates |

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

- SD-02 Shop Drawings
  - Gates
  - Corner Post Assemblies
  - Pull Post Assemblies
  - Installation Drawings
- SD-03 Product Data
  - Gate Assembly
- SD-07 Certificates
  - Posts
  - Barbed Wire Fence
  - Woven Wire Farm Fence

## 1.5 SUBMITTAL REQUIREMENTS

### 1.5.1 Shop Drawings

Submit shop drawings of the gates, corner post assemblies, and pull post assemblies for the barbed wire and the woven wire farm fence systems.

### 1.5.2 Installation Drawings

Submit installation drawings clearly indicating fence installation layout, location of corner, and pull posts and gate posts; gate assembly and gate hardware.

1.5.3 Product Data

Submit gate assembly catalog data.

1.5.4 Certificates

Submit certification that the posts, barbed wire fence, and woven wire farm fence materials meet the specified requirements.

1.6 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.

1.7 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 FENCE

Provide fence materials conforming to the following:

2.1.1 Barbed Wire

The barbed wire shall conform to the requirements of ASTM A121, with two strands of 12.5 gage wire; four-point barbs, wire size 14 gage, twisted around both line wires

2.1.2 Woven Wire Farm Fabric

The woven wire farm fabric shall conform to the requirements of ASTM A116, No. 9 Farm Design Number 1047-6-9, with a Class 3 zinc coating.

2.2 GATES

Provide galvanized tube farm gates with vertical bracing and hinges. Provide latching hardware and a lock with a minimum of 2 keys. Provide gate type and swing shown conforming to ASTM F900 and/or ASTM F1184, ASTM A153/A153M. Gate frames shall conform to strength and coating requirements of ASTM F1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate leaves more than 8 feet wide shall have either intermediate members and diagonal truss rods or tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 8 feet wide shall have truss rods or intermediate braces. Provide intermediate braces on all gate frames with an electro-mechanical lock. Attach gate fabric to the gate frame by method standard with the manufacturer. Welding is not permitted. Furnish latches, hinges, stops, keepers, rollers, and other hardware items as required for the operation of the gate. Arrange latches for padlocking so that the padlock will be accessible from both sides of the gate. Provide stops for holding the gates in the open position.

## 2.3 POSTS

Posts may be either timber, steel, recycled plastic or concrete. Unless a specific post material is called for in the plans, the Contractor may elect to use either a single material or a combination of timber, steel, recycled plastic or concrete materials. Line posts of one material may be used with corner, pull and end post assemblies of a different material. Line posts of only one optional material and pull post assemblies of only one optional material will be permitted between corner and end post assemblies. Within individual corner and end post assemblies only one optional material will be permitted.

### 2.3.1 Timber Posts Posts for Farm Style Fence

Provide wood posts cut from sound and solid trees free from short or reverse bends in more than one plane. Make tops convex rounded or inclined. Provide posts free of ring shake, season cracks more than 1/4 inch wide, splits in the end, and unsound knots. Provide posts of size and shape indicated. Treat posts in accordance with AWPA U1 as applicable. Timber line posts are to be minimum 4 inch diameter. Timber corner, pull, approach and end posts are to be a minimum 5 inch diameter. Timber braces and rails are to be minimum 4 inch diameter.

### 2.3.2 Steel Posts for Farm Style Fence

Provide steel posts conforming to ASTM A702 zinc-coated, T-section, length as indicated, and accessories conforming to ASTM A702. Steel posts and braces shall be standard steel posts, galvanized at the rate of 2 oz./ft., together with necessary hardware and wire clamps and meeting the following requirements:

1. Line posts: 8 feet long; 1.33 lbs./ft.; roll formed studding; anchor plate attached (23 sq. in.).

2. Approach posts: 2-1/2 inches x 2-1/2 inches x 1/4 inch angles, 8 feet long; fabricated for attaching brace; with necessary hardware, clamps, etc. Pull, end and corner posts: 2-1/2 inches x 2-1/2 inches x 1/4 inch angles, 8 feet long; fabricated for attaching brace; with necessary hardware, clamps, etc.

3. Braces: 2 inches x 2 inches x 1/4 inch angles with necessary hardware and fabricated for attaching to post.

4. The pull, corner, approach and end posts are to be set in concrete.

## 2.4 CONCRETE

Concrete shall meet ASTM C94/C94M, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Provide grout consisting of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

## 2.5 PADLOCKS

Provide padlocks conforming to ASTM F883, TYPE P01, size 1-3/4 inch. All padlocks shall be keyed alike.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install fence to the lines and grades indicated. Clear the area on either side of the fence line to the extent indicated. Space line posts equidistant at intervals not exceeding 10 feet. Set terminal (corner, gate, and pull) posts at abrupt changes in vertical and horizontal alignment. Provide continuous fabric between terminal posts; however, runs between terminal posts shall not exceed 500 feet. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780/A780M.

Fencing shall tie in to the cattle guard wings. See Section 32 31 53 CATTLE GUARD~~S~~.

### 3.2 EXCAVATION

Clear loose material from all post holes. Spread waste material where directed. Eliminate ground surface irregularities along the fence line to the extent necessary to maintain a 1 inch clearance between the bottom of the woven wire farm fence and finish grade.

Longer posts than indicated may be required for deeper installations.

### 3.3 POST INSTALLATION

For wood posts, excavate to depth indicated and brace post until backfill is completed. Place backfill in layers of 9 inches or less, moistened to optimum condition, and compacted with hand tampers or other approved method. Set posts plumb and in proper alignment. Set steel posts in concrete. Concrete shall be a 12 inch diameter x 3 feet-3 inch footing, with a minimum 2 feet-9 inch post embedment.

Pull post assemblies shall be installed at approximately 330 foot centers except that this maximum interval may be reduced by the District on curves where the radius is less than 3 degrees.

Corner post assemblies are to be installed at all horizontal and vertical breaks in fence of 15 degrees or more.

### 3.4 BARBED WIRE

Install wire on the side of the post indicated. Pull wire taut to provide a smooth uniform appearance, free from sag. Fasten wire to line posts at approximately 15 inch intervals unless indicated otherwise.

### 3.5 WIRE INSTALLATION

The woven wire shall be stretched only until one-half the tension curl has been pulled out of the line wires.

A maximum length of 1,320 feet of wire may be installed as a unit. For pulls through a pull post assembly the fabric shall be spliced by crimping sleeves only. Pulls through a corner post assembly will not be permitted.

Staples for line posts to be 1-1/4 inch minimum length; for approach, corner and pull posts 1-1/2 inch minimum length. At approach, corner and pull posts, staple every line wire. At line posts, staple every line wire in top half and alternate line wires in bottom half. Staples shall be driven diagonally across the line wire with the points in separate grains.

The woven wire shall be attached to steel posts by a minimum of five tie wires. The single wire ties shall be applied to the top, bottom and three intermittent line wires. The ends of each tie wire shall have a minimum of two tight turns around the line wire. Tie wires shall be steel wire not less than 0.120 inch diameter, zinc coating Class 3, soft temper, in accordance with ASTM A641/A641M.

## 3.6 GATE ASSEMBLY

Unless otherwise called for in the plans gates shall be commercially available metal swing gates assembled and installed in accordance with the manufacturer's specifications as approved by the District.

## 3.7 GROUNDING

Ground fences crossed by overhead powerlines in excess of 600 volts as specified in Section 26 41 00 LIGHTNING PROTECTION SYSTEM. Ground fences on each side of all gates, 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 shall not exceed 650 feet. Each gate panel shall be bonded with a flexible bond strap to its gate post. 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. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 3/4 inch x 10 feet long copper-clad steel rod. 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. The top of the electrode shall not be 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. After installation, the total resistance of fence to ground shall not be greater than 25 ohms.

-- End of Section --

# SECTION 32 31 29

# WOOD FENCES AND GATES

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all labor, equipment and materials for the construction of the split rail fencing including but not limited to preparing the ground to receive the fence system, the layout and the fencing system.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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 WOOD PROTECTION ASSOCIATION (AWPA)

| | |
|---|---|
| AWPA U1 | (2017) Use Category System: User Specification for Treated Wood |

### 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fence System

SD-07 Certificates

Post and Rail

### 1.5 SUBMITTAL REQUIREMENTS

#### 1.5.1 Show Drawings

1. Submit shop drawings of the fence system including the posts and rails. Show drawing shall indicate the notching of the posts and the ends of the rails.

2. Submit certifications that the post and rail materials meet the specification requirements.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against damage caused by ground contact.

## 1.7 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT MATERIALS.

# PART 2 PRODUCTS

## 2.1 GENERAL REQUIREMENTS

The use category of the fence materials as defined in APWPA U1 is UC4B.

The following pressure treatment options are acceptable:

1. DOT Sodium Borate (SBX).

2.. Alkaline Copper Quaternary (ACQ-C and ACQ-D with carbonate).

3. Copper Azole (CBA-A and CA-B).

Treated timber and lumber sawed or cut after treatment shall have the cut surfaces well brush coated with preservatives. Limit the cutting of treated timber to minor fitting which might be necessary and that is authorized by the District.

## 2.2 POSTS

Posts shall be treated southern yellow pine, dimensions as indicated. Posts are to be fabricated using 2-3 inch x 6 inch boards. Mill notches to be compatible with the rail ends.

## 2.3 RAILS

Rails shall be treated southern yellow pine, dimensions as indicated.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Install fence to the lines and grades indicated. Clear the area on either side of the fence line to the extent indicated.

## 3.2 POST INSTALLATION

Posts shall be set true to line and grade. Space line posts equidistant at intervals not exceeding 10 feet. Excavate to depth indicated and brace post until backfill is completed. Place backfill in layers of 9 inches or less, moistened to optimum condition, and compacted with hand tampers or other approved method. Set posts plumb and in proper alignment.

## 3.3 RAIL INSTALLATION

Mill ends of rails so that they fit within the post notches. Install rails level and to the dimensions indicated.

-- End of Section --

# SECTION 32 31 53

# CATTLE GUARD

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Work of this Section shall consist of designing, fabrication and furnishing cattle guards and all the labor, material, and equipment necessary for installation. It also includes the design and construction of their foundations.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A36/A36M | (2014) Standard Specification for Carbon Structural Steel |
| ASTM A992/A992M | (2011) Standard Specification for Structural Steel Shapes |
| ASTM A500/A500M | (2013) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A325 | (2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A563 | (2015) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A1064 | Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| ASTM F436 | (2011) Hardened Steel Washers |
| ASTM F593 | Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F594 | Standard Specification for Stainless Steel Nuts |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Constructions |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC SP16 | Brush-Off Blast Cleaning of Coated and uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals |

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings for Cattle Guard

Fabrication Drawings for Cattle Guard Wings

Concrete Foundation

Drainage System

SD-06 Test Reports

Mill test reports

Weld inspection and testing reports

Bolted connection inspection and testing reports

SD-07 Certificates

Manufacturer's certificate

Welding Work

Filter fabric

Course aggregate

SD-08 Manufacturer's Instructions

Installation instructions

## 1.5 QUALITY CONTROL

The dimensions of the cattle guard foundations shall be verified with the dimensions of the fabricated cattle guards and approved by the District prior to placing the reinforcement and the concrete.

Welding qualifications shall meet those described in Section 05 05 23.16 STRUCTURAL WELDING, Article QUALITY REQUIREMENTS. Submit certificates of qualifications for welding work.

## 1.6 SUBMITTAL REQUIREMENTS

The Contractor shall submit fabrication drawings for cattle guard and fabrication drawings for cattle guard wings. The shop drawings shall also include details for connecting the cattle guard wings with the adjacent fencing. Contractor shall submit shop drawings for the concrete foundation and the drainage system.

Contractor shall submit mill test reports attesting that materials meet the requirements of this and referenced specifications.

The Contractor shall submit a notarized manufacturer's certificate stating that the manufacturer has fabricated steel cattle guards with steel wing attachments for a minimum of 5 consecutive years.

The Contractor shall submit a certificate for the filter fabric and the course aggregate stating that the materials meet the requirements found in this specification.

The Contractor shall provide written installation instructions from the manufacturer for the proper installation of the fabricated cattle guard and wings.

## 1.7 DESIGN REQUIREMENTS

The cattle guard shall be designed and fabricated using steel and shall meet HL93 AASHTO design load and FL120 permit load requirements.

The design shall include details for preventing hogs and other hoofed animals from using any part of the cattle guard to cross from one side to the other including but not limited to wide flanged cattle guard components.

The cattle guard shall be a minimum 8 feet in the direction of travel (length). The Contractor shall confirm the fence opening (width) dimension at each of the cattle guard locations. See Table 1 for estimated widths. The depth of the cattle guard to be determined during the design.

Table 1 - Estimated Cattle Guard Widths

| Location | Number of each | Width (ft) |
|---|---|---|
| Local Access Bridge | 1 | 16 |
| S-476 Pump Station | 2 | 16 |
| S-476 Pump Station at Perimeter Maintenance Road | 1 | 24 |
| S-481A Structure | 1 | 24 |
| Site Access Bridge | 1 | See Drawings |
| S-477 Structure | 1 | 15 |

The cattle guard shall be a flat cattle guard that can be inserted in the ground bearing on a reinforced concrete foundation. The top of the concrete foundation and the rails shall be installed flushed with the adjacent finished grade elevations.

The flat cattle guard shall be designed and fabricated so that it can be bolted to the foundation. It shall also be designed as a removable boxed cattle guard so that it can be removed from the foundation for the purposes of cleaning out the foundation of dirt, leaves and other debris.

Steel wings shall be fabricated so they can be bolted to the cattle guard. The wings shall be designed to prevent feral hogs and gopher tortoise from passing between the cattle guard and the adjoining fence.

The foundation for the cattle guard shall be constructed of reinforced concrete. The foundation shall support the cattle guard so that the interior of the foundation is open and can be excavated and backfilled with a course aggregate for drainage.

## 1.8 DELIVERY, STORAGE, AND HANDLING

Deliver fabrications and all materials to the site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact. Each cattle guard shall be clearly marked as to its installation location.

## 1.9 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 CATTLE GUARD

The manufacturer must have a minimum of 5 years' experience in fabricating cattle guards. See Section 05 05 23.16 STRUCTURAL WELDING for welding requirements and welder qualifications.

The Contractor is responsible for the selection of a qualified manufacturer. The cattle guard and the wings shall be of fabricated using steel beams for the beams or trusses and round steel pipe for the rails.

The cattle guard shall be painted.

Structural Steel:

Wide flange and WT shapes, ASTM A992/A992M with at least a 50 ksi yield specified. Angles, Channels and Plates, ASTM A36/A36M.

Structural Steel Tubing:

Steel tubing shall conform to ASTM A500/A500M, Grade B 42 ksi for round tubing.

Stainless Steel Fasteners:

a. Bolts: All stainless steel bolts, nuts, and washers shall comply with ASTM F593.

b. Nuts: Nuts for stainless steel bolts shall conform to ASTM F594. ASTM F594 nuts alloy group shall match the stainless steel bolt alloy group.

c. Washers: Flat, circular, and square washers for stainless steel bolts shall conform to ASTM F593 and meet the dimensional requirements of ASTM F436. ASTM F593 washers alloy group shall match the stainless steel bolt alloy group.

d. Anchors: Anchors for connecting concrete to steel shall be stainless steel conforming to ASTM A1064.

## 2.2 FOUNDATION

The foundation shall be reinforced concrete. See Section 03 31 01.00 10 CAST-IN-PLACE CONCRETE FOR CIVIL WORKS for the concrete foundation.

## 2.3 DRAINAGE SYSTEM

The drainage system shall be similar to a French drain. It shall occupy the interior of the concrete foundation. The filter fabric material shall be Type D-3 meeting the requirements of the FDOT specification section 985. The course aggregate shall be a size no. 4 and meet the requirements of the FDOT specification section 901.

# PART 3 EXECUTION

## 3.1 EARTHWORK

Excavation and backfill shall be in accordance with the requirements for appurtenances found in Section 31 00 00 EARTHWORK.

## 3.2 CONCRETE FOUNDATION

The foundation shall be cast in place reinforced concrete. The foundation shall be formed to create vertical walls on all four sides with the long sides supporting the cattle guard. The interior of the foundation shall be open to allow for additional excavation below the foundation bottom.

The foundation shall be designed to allow for bolting on the steel wingwall to each end of the foundation.

## 3.3 CATTLE GUARD

The Contractor is responsible for developing the cattle guard design for each of the cattle guards. The design shall be completed under the supervision of and signed and sealed by a qualified Florida registered professional engineer.

## 3.4 CATTLE GUARD WINGS

The Contractor is responsible for developing the cattle guard wing design for each of the cattle guards. The wings shall be designed to connect to

the adjacent fencing, so they prevent feral hogs and gopher tortoise from passing between the cattle guard and adjacent fence. The wings shall be constructed of steel. The wings shall be designed so they can be bolted to the cattle guard once the cattle guard is in place. Paint the cattle guard wings using the same system as noted for the cattle guard.

## 3.5 PAINTING

Prior to shop painting the cattle guard surfaces shall be prepared in conformance with SSPC SP16 standard. Paint the cattle guard and all associated hardware using a three-coat system.

First Coat: Single component, zinc rich moisture cure urethane, 4 mils

Second Coat: Single component moisture cure urethane, 4 mils

Third Coat: Single component moisture cure urethane, gloss, 2 mils

Paint color shall be selected by the Owner.

## 3.6 FENCING

Connect the adjacent fence fabric/material to each cattle guard wing so that there is no access from one side of the fence to the other at the cattle wings. The connection to the cattle guard wing must prevent feral hogs and gopher tortoise from crossing from one side of the fence to the other.

## 3.7 DRAINAGE

Excavate inside the concrete foundation to a depth that is 3 feet below the bottom of the footing. The horizontal limits of the excavation shall be no closer than 2 feet from the inside edge of the foundation. Line the excavation with the filter fabric material leaving enough material to completely cover the excavation with at least 2 feet of overlapping filter material.

Backfill the excavation with the FDOT No. 4 course aggregate material. Bring the course aggregate up to the bottom of the foundation elevation. Close the excavation by completely covering the course aggregate by placing and overlapping the filter fabric across the top of the aggregate. Complete the backfilling up to the bottom of the footing elevation with suitable material.

## 3.8 TESTING

The Contractor shall submit weld inspection and testing reports. At a minimum, the reports shall contain information required by IBC and the following:

a. Inspecting agency, inspector, inspector's AWS certification, materials inspected, date of inspection, if materials conformed to contract requirements, repair work and follow-up inspection results.

b. Fabricator's AISC shop certification.

c. Weld test reports.

The Contractor shall submit bolted connection inspection and testing reports. The reports shall contain following information:

a. Inspecting agency, inspector, and inspector's qualifications.

b. Connections tested and inspected, and date of test and inspection.

3.9 CLEAN UP

After installation has been completed, Contractor shall thoroughly clean metal components, interior and exterior, exposed surfaces in a manner acceptable to the District. Cleaning procedures shall be in accordance with cattle guard Manufacturer's recommendations.

Work that is damaged or defective shall be replaced at no additional cost to the District.

-- End of Section --

# SECTION 32 90 00

# PLANTING

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall provide all labor, equipment and materials for planting Florida native plant species as required, shown and specified.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.3 REFERENCES

The following Standard Specifications shall apply to the work of this section as indicated.

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.

FLORIDA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES (FDACS)

| | |
|---|---|
| FDACS | Grades and Standards for Nursery Plants/Division of Plant Industry, 1998 |

AMERICAN JOINT COMMITTEE ON HORTICULTURAL NOMENCLATURE (AJCHN)

| | |
|---|---|
| AJCHN | Standardized plant names, prepared for the American Joint Committee on Horticultural Nomenclature by the Editorial Committee - 1942 Edition |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI A300 | Guidelines |

### 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sources or Suppliers

Spraying, Dusting Materials or Insecticide Soaps

SD-02 Shop Drawings

Staking and Guying

SD-04 Samples

Soil Types

Mulch

SD-07 Certifications

Fertilizer

Control Measures

Personnel

Plants

1.5 SUBMITTAL REQUIREMENTS

A. Submit a written schedule of sources or suppliers of all materials for inspection and approval by the District before they are delivered and installed on the project. Color photographs of plant material shall be submitted, if requested.

B. A sample and analysis including pH of all planting soil types for approval by the District before the material is delivered and installed on the project.

C. A sample and analysis of mulch before the material is delivered and installed on the project.

D. Copies of the manufacturer's certification or analysis for all fertilizer, including data substantiating that proposed materials comply with specified requirements. Tags from bags of fertilizer used on the site shall also be provided.

E. Shop drawings for all staking and guying methods to be used if the ones indicated in the Contract, Plans, Specifications, or other referenced documents are not to be implemented or there are no details provided.

F. Provide a schedule of spraying, dusting materials or insecticide soaps to be used to control pests and disease infestation, the reason for their use, and the method to be used to apply the materials and the method of application before it is delivered and used on the project. Furnish certification that the implementation of these control measures for pests and disease infestation is in strict compliance with all applicable regulations.

G. The Contractor shall provide certifications for indicating that the plants used in the Work meet or exceed the requirements of the specifications. As a minimum, the certifications shall indicate that the plants comply with the grade, size, and quality of the planting material specified or shown and that the plants are Florida native landscaping materials, unless otherwise specified.

## 1.6 SUBSTITUTIONS

When the specified type, grade, quality, size, quantity, etc. of a material is not available, the Contractor shall submit a written request to the District for a substitution, along with written, documented proof that the material is not available. All substitutions considered must be Florida native species appropriate for the planting area. Before they are installed, all substitutions shall receive the approval of the District.

## 1.7 QUALIFICATIONS

The Contractor shall provide certification that personnel handling planting chemicals are appropriately licensed to do so and that the application of such chemicals is in compliance with the manufacturer's printed literature and/or directions on the label.

## 1.8 RESPONSIBILITIES

A. The Contractor shall be responsible for receiving, storing, maintaining (before and after planting), planting soil, fertilizer, mulch, water, temporary irrigation system, miscellaneous landscape accessories, bracing, etc.

B. The Contractor shall provide all plants required to perform the work covered by this section, including all shrubs and trees. All shrubs, trees, and groundcovers other than sod shall be Florida native plants, unless otherwise specified in the Contract Documents.

C. The Contractor shall be responsible for making site subsurface investigations and examinations as he or she chooses in order to become familiar with the construction conditions under which the work will be performed.

D. Work Covered by Contract Documents: The Contractor shall provide all supervision, labor, materials, equipment, and tools, and perform all operations necessary to excavate, grade, plant, and backfill all landscape material indicated in the Drawings.

E. The Contractor shall procure all necessary permits to accomplish all of the work.

F. The Contractor is responsible for performing all work in accordance with all applicable regulations, ordinances, and code requirements from the appropriate city, county, state and/or federal jurisdiction the project is located in.

## 1.9 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide 48 hours' notice of its intention to begin new Work activities.

## 1.10 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

A. All plants shall be of the same grade and standard, as set forth in the latest revision of the Florida Grades & Standards for Nursery Plants (FDACS), at the end of the warranty period as they were originally specified prior to installation.

B. An inspection will be made six (6) months prior to the end of the specified Warranty Periods to determine the status of landscape elements and plant materials.

C. The warranty shall become null and void for plant material which is damaged or dies as a result of "Acts of Nature" limited to hail, freeze, lightning, winds that exceed hurricane force, lethal yellowing or any other non-preventable and incurable plant diseases, provided that the plant was in a healthy growing condition prior to these "Acts of Nature".

D. If replacement plant material that meets the requirements of size, quality, and grade cannot be found the Contractor shall notify the District, who will recommend one of the following courses of action:

1. Do not replace the material, or if the plants have not yet been installed, do not install them. Full credit for plant cost, including installation, based on the proposal values, will be given to the District.

2. Delay installation of the plant material until material that meets the specifications is available.

3. Accept smaller sizes of the native plant material specified, and negotiate any fee adjustment prior to installation.

E. The warranty of plant material shall be construed to mean the complete and immediate replacement of plant material within seven (7) calendar days if:

1. It is not in a healthy growing condition and thus renders it below the minimum quality indicated in the FDACS Specifications.

2. There is a question as to its ability to survive after the end of the guarantee period that would render it below the minimum quality indicated in the FDACS Specifications.

3. It is dead.

F. The seven (7) calendar days may be extended due to seasonal conditions, availability, preparation time such as root pruning, etc., only if approved by the District in advance. The extended time shall be negotiated between all parties concerned but must receive final approval by the District. After the 7-day replacement period, the District may perform the work and charge said Contractor in accordance with Section 00700 GENERAL TERMS AND CONDITIONS.

G. Size, Quality and Grade:

1. Provide replacement of the same species of equal size and quality as the damaged plant.

2. If an equal-sized plant cannot be found, then other methods of compensation shall be determined in negotiation with the District. They may include, but not be limited to:

   a. Replacement with plant(s) of another species of same size as original plant

   b. Replacement with more than one plant to equal the canopy, trunk diameter, or overall height

   c. Payment in lieu of replacement, with value determined by replacement value

3. Replacements shall be guaranteed for a period equal to the originally specified warranty and shall begin again at time of acceptable replacement.

4. The Contractor or its designated landscaping provider shall be responsible for watering the replacement upon installation and as required for sixty (60) calendar days after planting.

1.11 MAINTENANCE CONTRACT

Contractor shall provide a one-year paid maintenance contract for the care and watering of landscaping elements and plant materials for this contract commencing at Final Completion. Cost of the Maintenance Contract shall be included in Contractor's Bid Price. The Maintenance Contract shall be assigned to the District upon project Final Completion and acceptance. Responsibility for replacement of guaranteed plant materials shall be assigned with the provision of the Maintenance Contract.

PART 2 PRODUCTS

2.1 PLANT GRADE

Any supplier of materials misrepresenting the grade or quality of their materials (i.e., a higher grade than they actually are) as determined by the District, shall not be allowed to supply any material for the project. All material already supplied and received from such a supplier shall be removed and replaced at the Contractor's sole cost. This requirement for removal and replacement shall also include any installed materials. No further materials will be accepted from such supplier until written evidence is submitted and confirmed that all material for delivery is of the grade or quality represented.

2.2 NOMENCLATURE

The Contractor shall supply plant material conforming to the names given in the AJCHN, prepared by the American Joint Committee on Horticultural Nomenclature. Names of varieties not included therein shall conform generally with names accepted in the nursery trade.

2.3 GRADE STANDARDS

The Contractor shall furnish plant material nursery grown Florida native species and shall comply with all required inspections, grading standards and plant regulations as set forth in the latest edition of the FDACS's

manual for Grades and Standards for Nursery Plants or with any superseding specifications that may be called out on the plans. All plants not listed in the FDACS Grades and Standards for Nursery Plants shall conform to FDACS as to: (1) health and vitality; (2) condition of foliage; (3) root system; (4) freedom from pest or mechanical damage; and (5) heavily branched and densely foliated according to the accepted normal shape of the species.

## 2.4 PLANT DESIGNATIONS

The Contractor shall furnish plants as designated on the Drawings and conforming to the following.

A. Balled and Burlapped (B&B) and Wire Balled and Burlapped (WB&B) Plants:

1. Only burlap and other wrapping materials made of natural biodegradable materials shall be used. These plants shall be properly protected until they are planted. The plants shall be handled by both the trunk and root ball at the same time and not by the trunk only. Any B&B or WB&B plant, which shows evidence of having been handled by a method other than the method, outlined above and resulting in damage to the plant, such as a cracked root ball, broken root ball, or the roots that have been loosened within the ball, shall be rejected.

2. For plants grown in soil of a loose texture that does not readily adhere to the root system, especially in the case of large plant material, wired B&B plants shall be used. For WB&B plants, before the plant is removed from the hole, hog wire with approximately 1 to 1-1/2 inch openings or a Kerr's wire basket (Vermeer Standard, Caretree Standard, Caretree Truncated or Clegg) shall be placed around the burlapped ball and looped and tensioned until the burlapped ball is substantially packaged by preventing disturbance of the loose soil around the roots during handling.

B. Any Container Grown (CG) plants that have become root bound or which the foliar system is out of proportion (larger) to the size of the container will not be accepted.

1. With metal containers, unless the root ball system slips easily and unbroken from the can, a nursery can-cutter shall be used to slit the can in such a way that the can may be opened fully.

2. CG plants shall not be removed from the container until immediately before planting and with all due care to prevent damage to the root system.

C. Collected Plants: When collected plants are proposed, the District shall be given at least two days' written notice before the digging to allow the District the opportunity to inspect the plants prior to digging. Included in this written notice shall be a copy of the appropriate permits secured from the Florida Department of Agriculture for the collected plants. Collected plants shall be dug with a root spread at least 10 percent greater than nursery grown plants of the same species and size. No collected plant shall be planted prior to the District's approval and inspection.

D. Specimen Plants (Florida Fancy): When specimen or Florida Fancy plants are specified, they will be labeled as such on the Plans.

E. Grade: Except where another grade is specifically called for in the Contract and/or Plans, all plant material shall be Florida No. 1, or better, at the time of installation, final acceptance, and at the end of the guarantee period.

F. Habit of Growth: All plant material shall have a habit of growth that is normal for that species and shall be sound, healthy, vigorous, and free from insects, plant diseases, and injuries.

G. Measurement of Trees, Palms, Shrubs, and Ground Cover:

1. Trees, Shrubs, and Ground Cover:

a. Root ball: Requirements for the measurement of root ball diameter and depth shall comply with requirements as set forth in the latest edition of the FDACS (Division of Plant Industry) manual Grades and Standards for Nursery Plants:

| **CALIPER (in.)** | **MIN. BALL DIA. (in.)** | **MIN. BALL DEPTH (% of diameter)** |
|---|---|---|
| 1.00 - 1.50 | 16 | 75% of dia. |
| 1.50 - 1.75 | 20 | 65% of dia. |
| 1.75 - 2.00 | 22 | 65% of dia. |
| 2.00 - 2.50 | 24 | 65% of dia. |
| 2.50 - 3.50 | 26 | 65% of dia. |
| 3.50 - 4.00 | 28 | 65% of dia. |
| 4.00 - 4.50 | 30 | 60% of dia. |
| 4.50 - 5.00 | 32 | 60% of dia. |
| 5.00 - 5.50 | 34 | 60% of dia. |
| 5.50 or more increase in proportion up to 48 | | 60% of dia. |
| Then decrease in proportion for larger size diameter. | | |

b. Height: The height of plant material shall be measured from finished grade and continue up to where the main mass of the plant uniformly ends. The height shall not include any singular or isolated parts of the plant, such as leaves, shoots, branches, limbs, or fronds that extend out beyond the main mass of the plant.

c. Width: The width of plant material shall be measured from one side of where the main mass uniformly ends and continue to the other side of where the main mass of the plant uniformly ends. The width shall not include any singular or isolated parts of the plant, such as leaves, shoots, branches, limbs, or fronds that extend out beyond the main mass of the plant.

d. Caliper: The caliper of tree trunks shall be measured 4.5 feet above the ground unless:

i. The landscape regulations, ordinances, and code requirements from the appropriate local jurisdiction the project is located in indicate another method of measurement.

ii. Another method of measurement is indicated otherwise on the Plans.

iii. Palms: Requirements for the measurement of clear trunk, clear wood, greywood, root ball diameter, and depth shall comply with requirements as set forth in the latest edition of the FDACS manual Grades and Standards for Nursery Plants.

H. All sizes shown for plant material on the Plans are to be considered as minimums. All plant material must meet or exceed these minimum requirements for height, spread, etc. as indicated on the Plans. When plant sizes are specified as a range of size, installed material shall average the mean of the range specified.

2.5 SEEDING

The Contractor shall furnish and install seeding in accordance with Section 32 92 19 SEEDING.

2.6 PLANTING SOIL

General Type: The Contractor shall plant all new transplanted landscaping plant material (excluding seed and sod) with the general type planting soil, unless otherwise stated. The planting soil shall be a sandy loam (50 percent sand and 50 percent Everglades peat (muck)), by volume. The sand shall be well-washed lawn sand, free of silt and sludge. Cyclone sand is not acceptable. The planting soil pH shall range between 6.5 and 7.2.

Soil for Backfilling Root-Pruning Trenches: The Contractor shall backfill root-pruning trenches with a soil mixture consisting of 70 percent planting soil (by volume) as described in Paragraph SEEDING above and 30 percent mulch with 0-0-20 fertilizer added at a rate of 1/3 pound per cubic yard of soil, thoroughly mixed prior to backfilling.

The Contractor shall submit sample of sand and muck separately and/or soil analysis(es) if requested and as needed.

2.7 MULCH

The Contractor shall mulch all new plant materials and associated planting beds with mulch at the time of installation, final acceptance, and at the end of the guarantee period UNLESS OTHERWISE STATED. The mulch layer shall exceed a depth of two inches within a one-foot radius of the plant materials or exceed a depth of four inches in areas beyond the one-foot radius. All mulch material shall be grade A Recycled Mulch approved by the District. It shall be uniformly shredded and free from foreign matter, large pieces of bark, tree stump material, and insects such as burrowing nematodes and ants. Submit sample of mulch if requested and as needed at no additional cost to the District.

Florimulch: If Florimulch is to be used in the installation, the Contractor shall submit a written statement prior to the installation of the mulch guaranteeing that there will not be any germination of melaleuca seed that may be present in the mulch.

## 2.8 FERTILIZER

A. If requested by the District, the Contractor shall submit copies of the manufacturer's specifications or analysis of all fertilizer for the District's approval.

B. Unless otherwise specified on the Plans, commercial fertilizer shall be Ammonium Sulfate (21-0-0-24S) containing 21 percent nitrogen and 24 percent sulfur. Fertilizer containing phosphorus is not acceptable. Fertilizer shall be applied in accordance with manufacturer's recommendations.

C. The Contractor shall furnish fertilizer that is uniform in composition and dry. Granular fertilizer shall be free flowing and delivered in unopened bags. Tablet fertilizer shall be delivered in unopened containers or boxes. All bags, containers, or boxes shall be fully labeled with the manufacturer's analysis.

D. The Contractor shall furnish fertilizer complying with the State of Florida fertilizer laws. The Contractor shall handle and store fertilizer in compliance with these specifications and all applicable laws and regulations.

## 2.9 STAKING AND GUYING MATERIALS

A. The Contractor shall furnish wood for staking that is new, #2 grade yellow Pine, or #2 Cedar, free of knot holes, splinters, or cracks, or recycled pressure treated pine as approved by the District, sized as shown on details or approved shop drawings.

B. The Contractor shall furnish wire for guying that is double strand #12 gauge.

C. The Contractor shall furnish hose material that is a minimum of 25 percent larger than diameter of attached tree.

## 2.10 HERBICIDES

A. The Contractor shall furnish herbicides to kill existing weeds. Near water bodies where the chemical could runoff into the water, the Contractor shall use an herbicide approved for use on aquatic and emergent plants.

B. The Contractor shall furnish pre-emergent herbicides based on the type of weeds present.

C. Herbicide spray application will not be permitted when wind velocity exceeds 10 miles per hour.

## 2.11 TREE PROTECTION BARRICADES

The Contractor shall provide tree protection barricades as indicated on the plans.

## 2.12 INSPECTIONS

A. Inspection at the growing site does not preclude the right of rejection at the project site.

B. The Contractor shall request inspections in writing at least 48 hours in advance.

C. In the event the District has made an early inspection, the District shall not be barred from subsequently rejecting such work that is discovered to be faulty work or work omitted or work performed which is not in accordance with the contract requirements.

D. Die-Back and Leaf-Drop: Plant material showing signs of die-back or leaf-drop will not be accepted and must be removed from the project immediately if so directed by the District. Any plant material with tendencies toward leaf-drop or die-back must be root pruned early enough to provide a sound network of hair roots prior to relocation.

E. Mechanical Destruction of Foliage: Mechanical destruction of foliage resulting from root pruning shall not affect more than 10 percent of the total foliage prior to planting on the project. Loss of foliage caused by seasonal change will be accepted.

F. Spanish Moss: If Spanish Moss (Tillandsia useoides) exists on plant material, it shall be completely removed prior to planting on the project.

G. Palms: The Contractor shall comply with the following with regards to palms.

1. Before Transporting: See Paragraph DELIVERY, HANDLING, STORAGE AND SUBMITTALS for requirements related to wrapping of root balls.

2. Prepare Cabbage Palms by pruning in a hurricane cut and remove a maximum of fronds from the crown without damage or exposure to the central bud to facilitate transporting and handling.

3. Palms with burn marks and frond boots on trunk will not be accepted unless noted on Plans.

4. Tying shall be as set forth in the latest edition of the FDACS manual for Grades and Standards for Nursery Plants. Tying of other palms shall be at the option of the Contractor.

5. To reduce head volume, palm fronds may be taper trimmed by not more than one-third.

6. Palms showing cable or chain marks and equipment scars shall be rejected.

H. Chlorosis: The allowable level of Chlorosis in foliage shall be set forth in the latest edition of the FDACS manual, "Grades and Standards for Nursery Plants".

I. Plant material shall not be accepted when the ball of earth surrounding its roots has been cracked, broken, or otherwise damaged.

J. The Contractor shall, when necessary, perform root pruning of plant material conforming to guidelines provided by an arborist or certified landscape professional to ensure the health, stability and longevity of the plant material. Prior to root pruning, the Contractor shall give 48 hour advance notice to the District advising of the date to root prune any plant

material. This shall allow for any inspections during or after the root pruning, if necessary.

2.13 DELIVERY, HANDLING, STORAGE AND SUBMITTALS

Delivery and Handling: The Contractor shall comply with the following regarding delivery, handling, and storage of planting materials.

1. Movement of nursery stock shall comply with all Federal, State, and local laws, regulations, ordinances, codes, etc.

2. The Contractor shall be responsible for protecting plant material from adverse environmental conditions including drying and sunburn during all phases of delivery and storage. Further, the Contractor shall be responsible for protecting plant material from any damage, theft, or deterioration of health or appearance during all phases of delivery and storage.

3. The Contractor shall wire wrap burlap if root ball is not sufficiently compacted. Palms will not require burlap wrapping if the following requirements are met:

   a. The Palm is dug from marl or heavy soil that adheres to roots and retains shape without shattering.

   b. Moistened material is used to cover root ball and not exposed to wind or allowed to dry out.

   c. The palm is planted within 24 hours after being dug.

   d. Palms are stored in shade and protected from weather.

   e. Maintain and protect plant material that will not be planted within four hours of delivery.

4. Transport materials on vehicles large enough to allow plants not be crowded and damaged. Plants shall be covered to prevent wind damage during transit.

5. Protect plant material during shipping to prevent damage to the root system and desiccation of leaves. Trees shall be protected during shipping by tying in the branches and covering all exposed branches as necessary. Do not bend or bind-tie plant material in such a manner as to damage bark, break branches, or alter the natural shape.

6. The Contractor shall exercise care in handling, loading, unloading, storing, and transporting all material to prevent damage. The Contractor shall assume full responsibility for protection and safekeeping of materials.

2.14 DAMAGE TO EXISTING VEGETATION AND/OR IRRIGATION

A. The Contractor shall exercise caution when working in the vicinity of existing vegetation and/or irrigation system components to prevent damage caused by the use of tools or equipment (mechanical), chemicals, grade changes, and excavation.

B. If the Contractor damages existing plants and/or vegetation due to his own negligence, he shall be responsible to replace them at his cost, within seven calendar days.

C. If tree damage results when the Contractor employed the appropriate preventive measures, those damages may, at the discretion of the District, be rectified by pruning in conformance with the American National Standards Institute ANSI A300 guidelines or as directed by the District.

PART 3 EXECUTION

3.1 WORK SITE

The Contractor shall keep areas free of all trash, debris, loose and excess material, unsecured equipment or tools, etc., which may be subject to theft or vandalism, or which may create a passive or active danger to the safety of the public or an unnecessary eyesore.

3.2 MATERIAL INSPECTION

The Contractor shall carefully inspect all plants delivered to the site to verify that they meet the requirements of the Contract as to grading, condition, size, and species. The Contractor shall reject all plants that do not comply with the requirements.

3.3 PREPARATION OF SITE PRIOR TO PLANTING

Before any disturbance of the actual planting areas is performed, the Contractor and the District shall conduct an inspection and evaluation of these sites. Most of the planting areas are sodded to prevent soil erosion on the steep slopes. The Contractor shall remove a circular area of sod three to four feet in diameter for trees and field-grown shrubs; and two feet in diameter for three-gallon material. All sod shall be removed completely from the area and immediately disposed of off-site.

3.4 TREE AND PLANTS PLANTING PITS

The Contractor shall prepare planting pits as follows.

A. Planting pits shall be excavated to the dimensions required to comply with the requirements for soil amendments and to include the following:

1. For balled and burlapped trees and shrubs, excavations shall be 24 inches larger in diameter than the root ball.

2. For container grown stock, excavate as specified for balled and burlapped stock, adjusted to comply with same diameter dimensions. For three gallon containerized plants, excavate with a hole 12 inches larger in diameter. For one gallon containerized plants, excavate with a hole three inches larger in diameter.

3. Stabilize excavations for trees and shrubs with water and allow to percolate out before planting.

## 3.5 TREE AND PLANTS PLANTING

The Contractor shall plant trees and plants in accordance with industry standards and as follows.

A. Set balled and burlapped stock on a six-inch (minimum thickness) layer of compacted planting soil mixture, plumb and in center of pit, with top of ball at same elevation as adjacent finished landscape grades. Remove burlap from sides of balls; retain on bottoms. Set plants in pits at such level that after settlement they bear the same relationship to the finished grade of the surrounding ground as they did in their natural state. Proper turning of all plants to take advantage of the best and most natural growth appearance will be practiced at all times and will be subject to the approval of the District. Place backfill around base and sides of ball and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately one half full, water thoroughly. Repeat watering until no more is absorbed. Water again after placing final layer of backfill. Flush amended soil mixture into place with a slow full hose stream eliminating all air pockets and fill pit to form a broad saucer to surrounding grade.

B. Set container grown stock as specified for balled and burlapped stock.

C. Provide additional backfill berm around edge of excavations to form a shallow planting saucer to contain water with a minimum of three to five inch berm.

D. Mulch planting saucer and the areas as indicated herein with two to four inches of mulch.

## 3.6 STAKING AND GUYING

The Contractor shall stake and guy trees and plants as follows.

A. Palm trees are to be staked with three 2-inch by 4-inch wood braces, toe nailed to cleats, which are securely banded by two points to the palm at one half the height of the trunk. The trunk shall be padded with five layers of burlap under the cleats. Braces shall be approximately 120 degrees apart and secured underground by two-inch by four inch by 12-inch stale pads.

B. Trees larger than one inch caliper and smaller than two inch caliper shall be staked with a two inch stake set at least 24 inches in the ground and extending to the crown of the plant. The plant shall be firmly fastened to the stake with two strands of 12-gauge soft wire, enclosed in a rubber hose or other approved covering. The wire shall be nailed or stapled to the stake to prevent slippage.

C. Trees larger than two-inch caliper and smaller than three and one-half inch caliper shall be staked with two two-inch by four-inch stakes, eight feet long, set two feet in the ground. The tree shall be midway between the stakes and held firmly in place by two strands of 12-gauge wire, applied as specified above for single stakes. Tie wires will be tightened and kept tight by twisting.

D. Understory plants do not need staking.

E. Nails or spikes in trunks are prohibited

3.7 PRUNING AND REPAIR

The Contractor shall limit pruning to the minimum necessary to remove dead or injured twigs and branches. The Contractor shall prune so as not to change the natural habit or shape of the plant. The Contractor shall not prune any plant back to such an extent that it no longer meets specifications.

3.8 GRASSING GENERAL

The Contractor shall establish a stand of grass on slopes, shoulders, and other areas shown on the Drawings by seeding, fertilizing, mulching and maintaining the area as specified herein. See Section 32 92 19 SEEDING for the grassing requirements.

-- End of Section --

# SECTION 32 92 19

# SEEDING ~~AND SODDING~~

## PART 1 GENERAL

### 1.1 SCOPE

A. Summary of Work: The Contractor shall furnish all labor, equipment, hauling and materials as necessary for seeding and establishing a stand of turf. The Contractor shall be responsible for establishing and maintaining the stand of turf throughout construction and until final acceptance by the District.

### 1.~~1~~ 2 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D4972 | (2013) pH of Soils |

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| AMS Seed Act | (1940; R 1988; R 1998) Federal Seed Act |
| DOA SSIR 42 | (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0 |

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (FDEP)

| | |
|---|---|
| FDEP | Florida Stormwater, Erosion and Sedimentation Control Inspector's Manual |

FLORIDA DEPARTMENT OF TRANSPORTATION

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Construction |
| FM 1-T 267 | Florida Method of Test For Determination of Organic Content In Soils By Loss On Ignition |

### 1.~~2~~ 3 DEFINITIONS

#### 1.~~2~~3.1 Stand of Turf

95 percent ground cover ~~(seed or sod)~~ of the established species. Turf may also be noted as "seed", "sod" or "grass" on the drawings.

### 1.~~3~~ 4 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein such as paragraph SEEDING in Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICAL ANODE).

1.~~4~~5 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wood Cellulose Fiber Mulch

Fertilizer

SD-06 Test Reports

Topsoil Composition Tests (reports and recommendations).

SD-07 Certificates

State Certification and Approval for Seed

~~State Certification and Approval for Sod~~

1.~~5~~6 DELIVERY, STORAGE, AND HANDLING

1.~~5~~6.1 Delivery

1.~~5~~6.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.~~5~~6.1.2 Fertilizer Delivery

Submit product data for fertilizer prior to delivering the fertilizer. 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~~6.2 Storage

1.~~5~~6.2.1 Seed, Fertilizer Storage

Store in cool, dry locations away from contaminants.

1.~~5~~6.2.2 Topsoil

Use stockpiled topsoil from earthwork operations. Submit topsoil composition tests.

1.~~5~~6.2.3 Handling

Do not drop or dump materials from vehicles.

1.~~5~~6.2.4 Compost

Compost is organic matter that has been decomposed and recycled as a fertilizer and soil amendment.

1.~~6~~7 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.~~6~~7.1 Restrictions

Do not plant when the ground is muddy.

1.~~7~~8 TIME LIMITATIONS

1.~~7~~8.1 Seed

Apply seed within twenty four hours after seed bed preparation.

1.~~8~~9 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Classification

Provide State-certified certification and approval for the seed. Provide the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, ~~weedseed~~weed seed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Field mixes will be acceptable when field mix is performed on site in the presence of the District.

2.1.2 Planting Dates

Year round.

2.1.3 Seed Purity

| **Botanical Name** | **Common Name** | **Minimum Percent Pure Seed** | **Minimum Percent Germination and Hard Seed** | **Maximum Percent Weed Seed** | **Lbs (PLS) per Acre** |
|---|---|---|---|---|---|
| Cynodon dactylon | Bermuda grass | 95 | 80 | 1 | 15 |
| Paspalum notatum | Argentine Bahia grass | 95 | 80 | 1 | 30 |

~~2.2 SOD~~

~~2.2.1 Classification~~

~~a. The sod shall be Argentine Bahia with well matted roots.~~

~~b. The sod shall be commercial size rectangular measuring twelve 12 inches by 24 inches or larger.~~

~~c. The sod shall be sufficiently thick to secure a dense stand of live grass, with a minimum thickness of two (2) inches.~~

~~d. The sod shall be live, fresh and uninjured at the time of planting.~~

~~e. The sod shall have a soil matt of sufficient thickness adhering firmly to the roots to withstand all necessary handling and be reasonably free of weeds and other grasses.~~

~~f. The sod shall be planted as soon as possible after being harvested, and shall be shaded and kept moist from the time of harvesting until it is planted.~~

~~g. The source of the sod may be inspected for approval by the DISTRICT prior to construction.~~

2.~~3~~ 2 TOPSOIL

2.~~3~~2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK - EARTH DAM.

2.~~3~~2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor.

2.~~3~~2.3 Composition

Containing from 2 to 4 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4-inch screen. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Provide composition tests. Other components shall conform to the following limits:

| | |
|---|---|
| Silt | 5-20 percent |
| Clay | 5-20 percent |
| Sand | 60-90 percent |
| pH | 5.5 to 7.0 |
| Soluble Salts | 600 ppm maximum |

2.~~4~~ 3 COMPOST

All material shall be suitable for plant growth and have a minimum organic content of 50 percent. The organic matter content of the prepared soil layer

after mixing topsoil and compost shall be a minimum of 10 percent, and a maximum of 20 percent, in accordance with FDOT FM 1-T 267 and have a pH value of 4.5 or greater and less than or equal to 8.5. Mixing 2 to 3 inches of compost with 6 inches of topsoil is expected to provide an organic content within the specified range.

Compost shall meet the requirements of FDEP Rule 62.709.550 Type Y (yard waste), Type YM (yard waste and manure), Type A (municipal solid waste compost) or Rule 62.640.850 Type AA (composted biosolids) and have unrestricted distribution.

Sources of compost in SW Florida that are near the project site include:

MW Horticulture Recycling Facility
6250 Thomas St.
Fort Myers, FL 33912
(239) 332-1188

Forestry Resources Landscape Supply
4325 Michigan Ave Link
Fort Myers, FL 33916
(239) 332-3966

R & D Soil Builders, Inc.
10410 Hwy 858
Immokalee, FL 34143
(239) 633-7242

2.~~5~~ 4 WATER

Water shall be free from substances harmful to seed ~~or sod~~ growth. Provide water from a source approved by District prior to use. Source of water shall be approved by District and be of suitable quality for irrigation, containing no elements toxic to plant life.

2.~~6~~ 5 FERTILIZER

2.~~6~~5.1 Granular Fertilizer

Organic compound or hydrated lime is not permitted in mixed fertilizer. Nitrogen shall be slow release. Unless otherwise specified on the drawings, commercial fertilizer shall be Ammonium Sulfate (21-0-0-24S). Provide a fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

21 percent available nitrogen
0 percent available phosphorus
0 percent available potassium
24 percent sulfur

Fertilizer containing phosphorus is not acceptable. Provide product data for the fertilizer including physical characteristics and recommendations.

2.~~7~~ 6 MULCH

Mulch shall be free from noxious weeds, mold, and other deleterious materials.

2.~~7~~6.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw shall contain no fertile seed.

2.~~7~~6.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay shall be sterile, containing no fertile seed.

2.~~7~~6.3 Wood Cellulose Fiber Mulch

Submit product data for the wood cellulose fiber mulch. Use recovered materials of either paper-based (100 percent) or wood-based (100 percent) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2. Use with hydraulic application of grass seed and fertilizer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation (including soil conditioners as required), fertilizing, seeding~~, sodding~~ and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.1.1 Amend Topsoil

Thoroughly blend the compost with the stockpiled topsoil from the earthwork operations according to the following rates:

| **Mixing Rates** | **Topsoil** | **Compost** |
|---|---|---|
| Minimum | 10 cubic yards | 2 cubic yards |
| Maximum | 10 cubic yards | 4 cubic yards |

3.1.1.2 Placing Amended Topsoil

Provide 6 inches amended topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer, as required, into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the District. 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.

When using track vehicles to place the amended topsoil drive the track equipment so that the final impressions left by the tracks are parallel with the contours of the slope of the prepared surface.

3.1.1.3 Fertilizer Application Rates

Apply fertilizer in accordance with the Manufacturer's recommendations.

Incorporate fertilizer into the soil to a depth of at least two (2) inches by disking, harrowing or raking, except on slopes steeper than two (2) horizontal to one (1) vertical.

3.2 SLOPE EROSION

The Contractor shall be responsible for controlling erosion in accordance with the requirements described in Specification Sections 31 00 00 EARTHWORK - EARTH DAM, ~~and~~ 31 25 13 SLOPE PROTECTION WITH SOIL-CEMENT and 31 32 11 SOIL SURFACE EROSION CONTROL. All erosional gullies and rills shall be reshaped immediately prior to seeding ~~and/or sodding~~, and these slopes shall be protected from erosion following seeding ~~and/or sodding~~. Areas that experience erosion after seeding ~~and/or sodding~~ shall be repaired at no additional cost to the District.

CONTROL OF EROSION AND MITIGATION OF IMPACTS TO CONSTRUCTION RESULTING FROM EROSION IS THE SOLE RESPONSIBILITY OF THE ~~CONTRACTOR, AND~~CONTRACTOR AND SHALL NOT FORM THE BASIS OF A CHANGE IN CONTRACT PRICE OR TIME. THE EROSION AND SEDIMENT CONTROL REQUIREMENTS STATED IN THE DRAWINGS AND SPECIFICATIONS REPRESENT THE MINIMUM ANTICIPATED EFFORT REQUIRED AND SHALL BE SUPPLEMENTED AS REQUIRED.

DAM EMBANKMENT SLOPES PLACED AT FINAL GRADE SHALL RECEIVE PERMANENT EROSION CONTROL MEASURES AS SOON AS PRACTICAL BUT NOT LONGER THAN TWO WEEKS. IN NO CASE SHALL MORE THAN 5 ACRES PER WORKING FRONT BE EXPOSED WITHOUT TEMPORARY OR FINAL EROSION CONTROL MEASURES. CONTRACTOR SHALL INSTALL TEMPORARY EROSION CONTROL MEASURES ON SURFACES TO RECEIVE PERMANENT MEASURES OTHER THAN GRASSING. SEE SPECIFICATION SECTION 31 32 11 SOIL SURFACE EROSION CONTROL FOR TEMPORARY EROSION CONTROL MEASURES.

3.3 SEEDING

3.3.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the District stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.3.2 Seed Application Method

Seeding method shall be broadcasted and drop seeding.

3.3.2.1 Broadcast and Drop Seeding

Seed mix shall be uniformly broadcast at the rate of not less than 45 pounds per acre. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of 1/4 inch in clay soils and 1/2 inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

3.3.3 Mulching

3.3.3.1 Hay or Straw Mulch

Hay or straw mulch shall be spread uniformly at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

3.3.4 Rolling

Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width.

3.3.5 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

~~3.4 SODDING~~

~~3.4.1 Laying Sod~~

~~a. Moisten prepared surface immediately prior to laying sod.~~

~~b. Lay sod tight with no open joints visible. Do not overlap. Stagger end joints twelve inches minimum. Do not stretch or overlap sod pieces.~~

~~c. Do not use sod which has been cut for more than 48 hours.~~

~~d. Peg sod at locations where sod may slide, as directed by the District.~~

~~e. Roll sod using a lightweight turf roller to provide and true and even surface.~~

3.~~5~~ 4 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other potential sources of degradation of the planted areas.

3.~~6~~ 5 TURF ESTABLISHMENT

Perform all work necessary, including watering and fertilizing, to sustain an established turf until final acceptance, at no additional expense to the

District. Provide the filling, leveling, and repairing of any washed out or eroded areas, as may be necessary.

Established turf is defined as follows:

1. An established root system (leaf blades break before seedlings ~~or sod~~ can be pulled from the soil by hand).

2. No bare spots larger than one square foot.

3. No continuous streaks running perpendicular to the face of the slope.

4. No bare areas comprising more than 1 percent of any given 1,000 square foot area.

5. No deformation of the turf areas caused by mowing or other Contractor equipment.

~~6. No exposed sod netting.~~

~~7~~6. No pests or noxious weeds.

3.~~7~~ 6 MAINTENANCE

Contractor shall be responsible for proper care of turfed areas from time of completion of turfing operations on any part of project and for duration of turf establishment period. Turf establishment period shall not begin until planting on entire Project is approved by the District. Turf establishment period shall be for 45 consecutive growing days, or until final acceptance, whichever period is less.

Monitor turf areas and remove all competing vegetation, pest plants, and noxious weeds (as listed by the Florida Exotic Pest Plant Council, Category I "List of Invasive Species", Current Edition, http://www.fleppc.org). Remove such vegetation regularly by manual, mechanical, or chemical control means, as necessary. When selecting herbicides, pay particular attention to ensure use of chemicals that will not harm desired turf or wildflower species.

If at the time that all other work on the project is completed, but all turf areas have not met the requirements for established turf, continuously maintain all turf areas until the requirements for established turf have been met.

During the entire establishment period and until turf is established in accordance with this specification, continue inspection and maintenance of erosion and sedimentation control items in accordance with Section ~~104~~31 32 11 SOIL SURFACE EROSION CONTROL. Take responsibility for the proper removal and disposal of all erosion and sedimentation control items after turf has been established.

Notify the District, with a minimum of seven calendar days advance notice, to conduct inspections of the turf at approximate 14-day intervals during the establishment period to determine establishment. Results of such inspections will be made available to the Contractor within seven calendar

days of the date of inspection. Determination of an established turf will be based on the entire project and not in sections.

Costs of returfing or remulching required because of faulty operations or negligence on part of Contractor shall be borne by Contractor. Any areas reseeded ~~or resodded~~ shall have turf establishment period beginning upon reseeding or ~~resodding~~ and of duration as hereinbefore specified.

Upon the determination by the District that the turf establishment requirements have been met and an established turf has been achieved and all erosion and sedimentation control items have been removed, the District will release the Contractor from any further responsibility provided for in this specification.

The Contractor's establishment obligations of this specification will not apply to deficiencies due to the following factors, if found by the District to be beyond the control of the Contractor, his subcontractors, vendors or suppliers:

1. Determination that the deficiency was due to the failure of other features of the Contract.

2. Determination that the deficiency was the responsibility of a third party performing work not included in the Contract or its actions. The District will only pay for replanting as necessary due to factors determined by the District to be beyond the control of the Contractor.

Upon final acceptance of turf area, remove temporary fences, barriers, and signs installed for protection of that area. Contractor will be relieved of further responsibility for care and maintenance of accepted area.

3.~~8~~ 7 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense.

Seed and mulch all areas disturbed by construction activities that are not addressed otherwise. Seed and mulch all agriculture ditches that have been cleaned out and are to remain in operation.

-- End of Section --

# SECTION 32 92 ~~19~~23

## ~~SEEDING AND~~ SODDING

## PART 1 GENERAL

~~1.1 REFERENCES~~

### 1.1 SCOPE

A. Summary of Work: The Contractor shall furnish all labor, equipment, hauling and materials as necessary for sodding and establishing a stand of turf. The Contractor shall be responsible for establishing and maintaining the stand of turf throughout construction and until final acceptance by the District.

### 1.2 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D4972 | (2013) pH of Soils |

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| ~~AMS Seed Act~~ | ~~(1940; R 1988; R 1998) Federal Seed Act~~ |
| DOA SSIR 42 | (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0 |

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (FDEP)

| | |
|---|---|
| FDEP | Florida Stormwater, Erosion and Sedimentation Control Inspector's Manual |

FLORIDA DEPARTMENT OF TRANSPORTATION

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Construction |
| FM 1-T 267 | Florida Method of Test For Determination of Organic Content In Soils By Loss On Ignition |

### 1.~~2~~3 DEFINITIONS

#### 1.~~2~~3.1 Stand of Turf

95 percent ground cover (seed or sod) of the established species. Turf may also be noted as "seed", "sod" or "grass" on the drawings.

1.~~3~~ 4 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein such as paragraph 3.8 in Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICAL ANODE).

1.~~4~~ 5 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

~~Wood Cellulose Fiber Mulch~~

Fertilizer

SD-06 Test Reports

Topsoil Composition Tests (reports and recommendations).

SD-07 Certificates

~~State Certification and Approval for Seed~~

State Certification and Approval for Sod

1.~~5~~ 6 DELIVERY, STORAGE, AND HANDLING

1.~~5~~6.1 Delivery

1.~~5~~6.1.1 ~~Seed~~ Sod Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.~~5~~6.1.2 Fertilizer Delivery

Submit product data for fertilizer prior to delivering the fertilizer. 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~~6.2 Storage

1.~~5~~6.2.1 ~~Seed~~Sod~~, Fertilizer~~ 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.~~Store in cool, dry locations away from contaminants.~~

1.~~5~~6.2.2 Topsoil

Use stockpiled topsoil from earthwork operations. Submit topsoil composition tests.

1.~~5~~6.2.3 Handling

Do not drop or dump materials from vehicles.

1.~~5~~6.2.4 Compost

Compost is organic matter that has been decomposed and recycled as a fertilizer and soil amendment.

1.~~6~~ 7 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.~~6~~7.1 Restrictions

Do not plant when the ground is muddy.

1.~~7~~ 8 TIME LIMITATIONS

1.~~7~~8.1 ~~Seed~~Sod

Place sod a maximum of thirty six hours after initial harvesting, in accordance with TPI GSS as modified herein.~~Apply seed within twenty four hours after seed bed preparation.~~

1.~~8~~ 9 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

~~2.1 SEED~~

~~2.1.1 Classification~~

~~Provide State-certified certification and approval for the seed. Provide the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Field mixes will be acceptable when field mix is performed on site in the presence of the District.~~

~~2.1.2 Planting Dates~~

~~Year round.~~

~~2.1.3 Seed Purity~~

| ~~Botanical Name~~ | ~~Common Name~~ | ~~Minimum Percent Pure Seed~~ | ~~Minimum Percent Germination and Hard Seed~~ | ~~Maximum Percent Weed Seed~~ | ~~Lbs (PLS) per Acre~~ |
|---|---|---|---|---|---|
| ~~Cynodon dactylon~~ | ~~Bermuda grass~~ | ~~95~~ | ~~80~~ | ~~1~~ | ~~15~~ |

| ~~Botanical Name~~ | ~~Common Name~~ | ~~Minimum Percent Pure Seed~~ | ~~Minimum Percent Germination and Hard Seed~~ | ~~Maximum Percent Weed Seed~~ | ~~Lbs (PLS) per Acre~~ |
|---|---|---|---|---|---|
| ~~Paspalum notatum~~ | ~~Argentine Bahia grass~~ | ~~95~~ | ~~80~~ | ~~1~~ | ~~30~~ |

2.~~2~~1 SOD

2.~~2~~1.1 Classification

a. The sod shall be Argentine Bahia with well matted roots. Submit State Certification and Approval for Sod.

b. The sod shall be commercial size rectangular measuring twelve 12 inches by 24 inches or larger.

c. The sod shall be sufficiently thick to secure a dense stand of live grass, with a minimum thickness of two (2) inches.

d. The sod shall be live, fresh and uninjured at the time of planting.

e. The sod shall have a soil matt of sufficient thickness adhering firmly to the roots to withstand all necessary handling and be genetically pure, free of weeds, pests, and disease~~reasonably free of weeds and other grasses~~.

f. The sod shall be planted as soon as possible after being ~~harvested, and~~harvested and shall be shaded and kept moist from the time of harvesting until it is planted.

g. The source of the sod may be inspected for approval by the DISTRICT prior to construction.

2.~~3~~2 TOPSOIL

2.~~3~~2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK - EARTH DAM.

2.~~3~~2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor.

2.~~3~~2.3 Composition

Containing from 2 to 4 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4-inch screen. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other

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debris and objectionable materials. Provide composition tests. Other components shall conform to the following limits:

| | |
|---|---|
| Silt | 5-20 percent |
| Clay | 5-20 percent |
| Sand | 60-90 percent |
| pH | 5.5 to 7.0 |
| Soluble Salts | 600 ppm maximum |

2.~~4~~3 COMPOST

All material shall be suitable for plant growth and have a minimum organic content of 50 percent. The organic matter content of the prepared soil layer after mixing topsoil and compost shall be a minimum of 10 percent, and a maximum of 20 percent, in accordance with FDOT FM 1-T 267 and have a pH value of 4.5 or greater and less than or equal to 8.5. Mixing 2 to 3 inches of compost with 6 inches of topsoil is expected to provide an organic content within the specified range.

Compost shall meet the requirements of FDEP Rule 62.709.550 Type Y (yard waste), Type YM (yard waste and manure), Type A (municipal solid waste compost) or Rule 62.640.850 Type AA (composted biosolids) and have unrestricted distribution.

Sources of compost in SW Florida that are near the project site include:

MW Horticulture Recycling Facility
6250 Thomas St.
Fort Myers, FL 33912
(239) 332-1188

Forestry Resources Landscape Supply
4325 Michigan Ave Link
Fort Myers, FL 33916
(239) 332-3966

R & D Soil Builders, Inc.
10410 Hwy 858
Immokalee, FL 34143
(239) 633-7242

2.~~5~~4 WATER

Water shall be free from substances harmful to ~~seed or~~ sod growth. Provide water from a source approved by District prior to use. Source of water shall be approved by District and be of suitable quality for irrigation, containing no elements toxic to plant life.

2.~~6~~5 FERTILIZER

2.~~6~~5.1 Granular Fertilizer

Organic compound or hydrated lime is not permitted in mixed fertilizer. Nitrogen shall be slow release. Unless otherwise specified on the drawings, commercial fertilizer shall be Ammonium Sulfate (21-0-0-24S). Provide a

fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

21 percent available nitrogen
0 percent available phosphorus
0 percent available potassium
24 percent sulfur

Fertilizer containing phosphorus is not acceptable. Provide product data for the fertilizer including physical characteristics and recommendations.

~~2.7 MULCH~~

~~Mulch shall be free from noxious weeds, mold, and other deleterious materials.~~

~~2.7.1 Straw~~

~~Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw shall contain no fertile seed.~~

~~2.7.2 Hay~~

~~Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay shall be sterile, containing no fertile seed.~~

~~2.7.3 Wood Cellulose Fiber Mulch~~

~~Submit product data for the wood cellulose fiber mulch. Use recovered materials of either paper-based (100 percent) or wood-based (100 percent) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2. Use with hydraulic application of grass seed and fertilizer.~~

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation (including soil conditioners as required), fertilizing, ~~seeding,~~ sodding and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.1.1 Amend Topsoil

Thoroughly blend the compost with the stockpiled topsoil from the earthwork operations according to the following rates:

| **Mixing Rates** | **Topsoil** | **Compost** |
|---|---|---|
| Minimum | 10 cubic yards | 2 cubic yard |

| Mixing Rates | Topsoil | Compost |
|---|---|---|
| Maximum | 10 cubic yards | 4 cubic yards |

3.1.1.2 Placing Amended Topsoil

Provide 6 inches amended topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer, as required, into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the District. 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.

When using track vehicles to place the amended topsoil drive the track equipment so that the final impressions left by the tracks are parallel with the contours of the slope of the prepared surface.

3.1.1.3 Fertilizer Application Rates

Apply fertilizer in accordance with the Manufacturer's recommendations.

Incorporate fertilizer into the soil to a depth of at least two (2) inches by disking, harrowing or raking, except on slopes steeper than two (2) horizontal to one (1) vertical.

3.2 SLOPE EROSION

The Contractor shall be responsible for controlling erosion in accordance with the requirements described in Specification Sections 31 00 00 EARTHWORK - EARTH DAM, ~~and~~ 31 25 13 SLOPE PROTECTION WITH SOIL-CEMENT and 31 32 11 SOIL SURFACE EROSION CONTROL. All erosional gullies and rills shall be reshaped immediately prior to ~~seeding and/or~~ sodding, and these slopes shall be protected from erosion following ~~seeding and/or~~ sodding. Areas that experience erosion after ~~seeding and/or~~ sodding shall be repaired at no additional cost to the District.

CONTROL OF EROSION AND MITIGATION OF IMPACTS TO CONSTRUCTION RESULTING FROM EROSION IS THE SOLE RESPONSIBILITY OF THE ~~CONTRACTOR, AND~~CONTRACTOR AND SHALL NOT FORM THE BASIS OF A CHANGE IN CONTRACT PRICE OR TIME. THE EROSION AND SEDIMENT CONTROL REQUIREMENTS STATED IN THE DRAWINGS AND SPECIFICATIONS REPRESENT THE MINIMUM ANTICIPATED EFFORT REQUIRED AND SHALL BE SUPPLEMENTED AS REQUIRED.

DAM EMBANKMENT SLOPES PLACED AT FINAL GRADE SHALL RECEIVE PERMANENT EROSION CONTROL MEASURES AS SOON AS PRACTICAL BUT NOT LONGER THAN TWO WEEKS. IN NO CASE SHALL MORE THAN 5 ACRES PER WORKING FRONT BE EXPOSED WITHOUT TEMPORARY OR FINAL EROSION CONTROL MEASURES. CONTRACTOR SHALL INSTALL TEMPORARY EROSION CONTROL MEASURES ON SURFACES TO RECEIVE PERMANENT MEASURES OTHER THAN GRASSING. SEE SPECIFICATION SECTION 31 32 11 SOIL SURFACE EROSION CONTROL FOR TEMPORARY EROSION CONTROL MEASURES.

~~3.3 SEEDING~~

~~3.3.1 Seed Application Seasons and Conditions~~

~~Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the District stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.~~

~~3.3.2 Seed Application Method~~

~~Seeding method shall be broadcasted and drop seeding.~~

~~3.3.2.1 Broadcast and Drop Seeding~~

~~Seed mix shall be uniformly broadcast at the rate of not less than 45 pounds per acre. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of 1/4 inch in clay soils and 1/2 inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.~~

~~3.3.3 Mulching~~

~~3.3.3.1 Hay or Straw Mulch~~

~~Hay or straw mulch shall be spread uniformly at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.~~

~~3.3.4 Rolling~~

~~Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width.~~

~~3.3.5 Watering~~

~~Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.~~

3.4 SODDING

3.4.1 Finished Grade and Topsoil~~Laying Sod~~

~~a.~~ Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of amended topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 31 00 00 EARTHWORK - EARTH DAM.

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 16 mm 5/8 inch in any dimension.

3.4.2 Placing

Place sod a maximum of 36 hours after initial harvesting, in accordance with TPI GSS as modified herein.

3.4.3 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. For slopes 2:1 and greater 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.

3.4.4 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.

3.4.5 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. ~~Moisten prepared surface immediately prior to laying sod.~~

~~b. Lay sod tight with no open joints visible. Do not overlap. Stagger end joints twelve inches minimum. Do not stretch or overlap sod pieces.~~

~~c. Do not use sod which has been cut for more than 48 hours.~~

~~d. Peg sod at locations where sod may slide, as directed by the District.~~

~~e. Roll sod using a lightweight turf roller to provide and true and even surface.~~

3.4.6 Watering

Start watering areas sodded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.5 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other potential sources of degradation of the planted areas.

~~3.6 TURF ESTABLISHMENT~~

~~Perform all work necessary, including watering and fertilizing, to sustain an established turf until final acceptance, at no additional expense to the District. Provide the filling, leveling, and repairing of any washed or eroded areas, as may be necessary.~~

~~Established turf is defined as follows:~~

1. ~~An established root system (leaf blades break before seedlings or sod can be pulled from the soil by hand).~~

2. ~~No bare spots larger than one square foot.~~

3. ~~No continuous streaks running perpendicular to the face of the slope.~~

4. ~~No bare areas comprising more than 1 percent of any given 1,000 square foot area.~~

5. ~~No deformation of the turf areas caused by mowing or other Contractor equipment.~~

6. ~~No exposed sod netting.~~

7. ~~No pests or noxious weeds.~~

## 3.7 MAINTENANCE

Contractor shall be responsible for proper care of turfed areas from time of completion of turfing operations on any part of project and for duration of turf establishment period. Turf establishment period shall not begin until planting on entire Project is approved by the District. Turf establishment period shall be for 45 consecutive growing days, or until final acceptance, whichever period is less.

Monitor turf areas and remove all competing vegetation, pest plants, and noxious weeds (as listed by the Florida Exotic Pest Plant Council, Category I "List of Invasive Species", Current Edition, http://www.fleppc.org). Remove such vegetation regularly by manual, mechanical, or chemical control means, as necessary. When selecting herbicides, pay particular attention to ensure use of chemicals that will not harm desired turf or wildflower species.

If at the time that all other work on the project is completed, but all turf areas have not met the requirements for established turf, continuously maintain all turf areas until the requirements for established turf have been met.

During the entire establishment period and until turf is established in accordance with this specification, continue inspection and maintenance of erosion and sedimentation control items in accordance with Section 104. Take responsibility for the proper removal and disposal of all erosion and sedimentation control items after turf has been established.

Notify the District, with a minimum of seven calendar days advance notice, to conduct inspections of the turf at approximate 14-day intervals during the establishment period to determine establishment. Results of such inspections will be made available to the Contractor within seven calendar

days of the date of inspection. Determination of an established turf will be based on the entire project and not in sections.

Costs of returfing ~~or remulching~~ required because of faulty operations or negligence on part of Contractor shall be borne by Contractor. Any areas ~~reseeded or~~ resodded shall have turf establishment period beginning upon ~~reseeding~~ resodding ~~or resodding~~ and of duration as hereinbefore specified.

Upon the determination by the District that the turf establishment requirements have been met and an established turf has been achieved and all erosion and sedimentation control items have been removed, the District will release the Contractor from any further responsibility provided for in this specification.

The Contractor's establishment obligations of this specification will not apply to deficiencies due to the following factors, if found by the District to be beyond the control of the Contractor, his subcontractors, vendors or suppliers:

1. Determination that the deficiency was due to the failure of other features of the Contract.

2. Determination that the deficiency was the responsibility of a third party performing work not included in the Contract or its actions. The District will only pay for replanting as necessary due to factors determined by the District to be beyond the control of the Contractor.

Upon final acceptance of turf area, remove temporary fences, barriers, and signs installed for protection of that area. Contractor will be relieved of further responsibility for care and maintenance of accepted area.

## 3.8 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense.

~~Seed and mulch all areas disturbed by construction activities that are not addressed otherwise. Seed and mulch all agriculture ditches that have been cleaned out and are to remain in operation.~~

-- End of Section --

# SECTION 33 03 00

# TURBIDITY CONTROL AND MONITORING

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish all necessary equipment, labor and materials and utilize appropriate means and methods of turbidity controls necessary and sufficient to ensure that the more restrictive and protective of the following are achieved at all times: (1) all applicable State water quality standards, as prescribed in Chapter 62-302.530, Florida Administrative Code (F.A.C.), incorporated by reference, (2) all applicable environmental permit conditions, as prescribed in the permits appended to the Contract, and (3) all stormwater and erosion control shall be in accordance with the Florida Department of Environmental Protection (FDEP) Florida Stormwater Erosion and Sedimentation Control Inspector's Manual. Turbidity barriers are required in the Townsend Canal, Roberts Canal, Banana Branch Canal, Ft. Simmons Branch, the North Rim Canal and the LPDD Header Canal during any and all work in or adjacent to the any of these respective canals.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.3 APPLICABLE STANDARDS AND PUBLICATIONS

Standards or Codes: The edition of the standards or codes of the organizations listed below in effect at the time of the advertisement for bids form a part of this Section to the extent referenced.

The environmental protection rules and standards in the applicable sections of the Florida Administrative Code (F.A.C.) incorporated herein by reference are:

1. Florida Administrative Code (F.A.C.)
   http://www.dep.state.fl.us/legal/Rules/rulelistnum.htm

2. Design and Performance Standards - 62-25.025 F.A.C.

3. Quality Assurance - 62-160 F.A.C.

4. Surface Waters of the State - 62-301 F.A.C.

5. Surface Water Quality Standards - 62-302 F.A.C.

6. Generic Permits - 62-621.300(2)&(4) F.A.C.

Florida Department of Environmental Protection (FDEP)

1. Erosion and Sedimentation Control Inspector's Reviewer Manual

Florida Department of Transportation (FDOT)

1. Standard Specification for Road and Bridge Construction

U.S. Army Corps of Engineers (USACE)

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Site Plan

SD-02 Shop Drawings

Floating Turbidity Barrier

SD-03 Product Data

Floating Turbidity Barrier

SD-06 Test Reports

Monitoring Data

SD-07 Certificates

Inspector Qualifications

## 1.5 SUBMITTAL REQUIREMENTS

The Contractor shall make submittals for the turbidity control and monitoring system in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and the requirements herein.

A. Provide details of the turbidity controls proposed.

B. Provide proposed layout of the turbidity controls and monitoring system on the site plan.

C. Obtain the monitoring data and prepare quarterly reports in accordance with Paragraph MONITORING.

## 1.6 QUALIFICATIONS

The Contractor shall have at least one (1) employee, on-site, certified by the Florida Department of Environmental Protection as a Stormwater Erosion and Sedimentation Control Inspector. The inspector qualifications shall be submitted to the District for review prior to the installation, inspection, maintenance, repair, or replacement of any erosion or sedimentation control Best Management Practices, including but not limited to the turbidity controls. The turbidity monitoring shall be conducted according to the FDEP-approved procedures.

## 1.7 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide at least 48 hours advance notice of its intention to begin new Work activities.

# PART 2 PRODUCTS

## 2.1 FLOATING TURBIDITY BARRIER

The Contractor shall submit for review and approval floating turbidity barrier shop drawings. Provide floating turbidity barriers where indicated on the drawings and similar to the turbidity barriers as shown on Figures V-9 and V-10 in the FDOT/FDEP's Erosion and Sediment Control Designer and Reviewer Manual. The floating turbidity barrier shall be capable of having buoys attached. Submit product data for the floating turbidity barrier.

## 2.2 FABRIC

The Contractor shall provide floating turbidity barriers with fabric that is flexible and of sufficiently fine mesh to prevent passage of suspended material through the fabric. The floating turbidity barriers shall extend to within a foot of the bottom of the canal except in the areas with the potential for the presence of manatees the barriers shall be two (2) feet above the bottom.

## 2.3 FLOATS

The Contractor shall provide floats for the turbidity barriers of sufficient buoyancy to prevent the top of the barrier from submerging under any water and wind conditions. If the top of the barrier becomes submerged for any reason, the Contractor shall suspend construction operations until the condition is corrected.

## 2.4 ANCHORS AND WEIGHTS

The Contractor shall provide and maintain an anchor system to secure the turbidity barrier in position. Attach weights to the barrier as necessary to keep the fabric at an angle to the vertical of 30 degrees or less. Fabric material shall not be attached to the canal bottom.

# PART 3 EXECUTION

General: Surface water elevations in the Townsend Canal are subject to considerable fluctuation as a result of ongoing farming operations to the south, and the size of the drainage basin that drains through the Townsend Canal. Following the passage of hurricane Irma in September 2017, the Townsend Canal stage was estimated to be above elevation +8 feet NAVD. The Contractor shall regularly and intentionally coordinate work activities along the Townsend Canal with local farmers and land owners to limit the impact of potential high stages in the Townsend Canal that may affect the timing, progress, the need for removal of damaged work, and associated re-work. Additional temporary cofferdams may be required provided they do not impede flow in the Townsend Canal. The Contractor shall pay all additional costs for the required coordination and potential rework as necessary.

## 3.1 TURBIDITY BARRIERS

Prior to the start of the work submit a site plan indicating the proposed locations of the turbidity barriers. Indicate in the plan the approach for turbidity control as the work sections in the Townsend Canal progress.

Install and maintain floating turbidity barriers as indicated and where necessary to maintain turbidity releases at or below the permit compliance levels. Turbidity barriers shall be installed prior to any backfilling, clearing and grubbing, dredging, or excavation and be maintained in place until construction is complete and turbidity from construction has dissipated. All barriers shall be adequately marked and appropriate signage erected to identify them as obstructions to navigation.

The turbidity barriers shall be made of material in which manatees cannot become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. The barriers must not impede manatee movement.

The applicable U.S. Army Corps of Engineers in-water work protection guidelines for the endangered West Indian Manatee incorporated herein by reference are:

http://www.saj.usace.army.mil/Portals/44/docs/regulatory/sourcebook/endangeredspecies/manatee/2011StandardConditionsForin-waterwork.p
Any rips or tears that occur in the turbidity barrier material during use shall be repaired or replaced immediately by the Contractor at its expense. Rips or tears that occur in the turbidity barrier material in use that are not repaired or replaced immediately by the Contractor will result in a suspension of excavation and/or construction operations and shall require repairs and replacements as a prerequisite to the resumption of Work.

The Contractor shall keep in place and maintain all barriers until the work is complete (construction areas stabilized with vegetation) and turbidity levels return to the background levels based on the monitoring results. Upon completion of use, the Contractor shall remove the turbidity barriers and associated items to an off-site location at the Contractor's own expense.

Maintaining the barriers includes monitoring them for weed and debris buildup. Weeds and debris shall be removed and disposed of, at a minimum, on a weekly basis or as directed by the District. Weed build up shall not be permitted at the manatee barrier.

The Contractor shall conduct its operations at all time in a manner that minimizes turbidity. The Contractor is required to conform to the State Water Quality standards as prescribed in Chapter 62-302.530, F.A.C., and to meet the special requirements of any environmental permits that have been issued.

The turbidity controls shall be inspected by the Contractor every work day, after every rainfall event of 0.5 inches or greater in a 24-hour period, and after every extreme weather event that could dislodge or damage the turbidity controls, to assure that the turbidity controls remain properly installed, undamaged, and fully functional at all times.

## 3.2 MONITORING

The Contractor shall conduct and record the results of turbidity monitoring appropriate to the conditions and at the locations, times, and frequencies specified below. An FDEP approved Turbidity Monitoring Log is included as Appendix A to this specification section.

1. Background Monitoring Location: At least 100 feet (or as specified in the applicable environmental permit) upstream of any construction activities that may generate turbidity within a canal or conveyance feature outside the construction area, in the middle of the canal, at mid-depth in the water column, and outside of any visible turbidity plume.

2. Compliance Monitoring Location: Located in the canal or water body adjacent to each Work area, downstream or radial to the construction or maintenance work area, directly outside of the turbidity barriers, and within the densest portion of any visible plume.

3. Sampling Time:

    a. During Activities or Environmental Conditions that Can Generate Construction-Related Turbidity: Water samples for the turbidity measurement shall be collected beginning no sooner than one (1) hour after and no later than two (2) hours after construction activity commences (or as specified in the applicable environmental permit) and every four (4) hours thereafter until the work day ends. Water samples shall be collected at the same time(s) every work day according to this schedule. Any substantial deviation from this schedule must be approved by the District, unless otherwise compelled by force majeure, in which case, an explanation must be provided verbally as soon as possible and in writing within 48 hours of the deviation.

    b. During Activities and Conditions That Cannot Generate Construction-Related Turbidity: Once daily at 10:00 AM or as specified in the applicable environmental permit.

4. Equipment: The turbidity monitoring equipment shall meet the specifications and be calibrated, maintained, repaired, and replaced according to the methods, procedures, and frequencies set forth in Chapter 62-160, F.A.C.

5. Records Management: The individual conducting the turbidity monitoring shall transcribe the readings to the approved Daily Turbidity Monitoring Log form, sign and date the form at the close of each monitoring day. The notebook containing the signed and dated daily turbidity monitoring log forms shall be accessible at the construction Site during the work day.

The Contractor shall submit the quarterly monitoring data (Turbidity Monitoring Log forms), to the District. Documents submitted shall contain the following information:

1. Permit number

2. Project name

3. Dates of sampling and analysis

4. A statement describing the methods used in collection, handling, storage and analysis of the samples

5. A map indicating the sampling locations

6. A statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, limits of detection and accuracy of the data.

The Contractor shall submit monitoring reports that also include the following information for each sample that is taken:

1. Date and time of the day samples were taken

2. Depth of the water body

3. Depth of the sample

4. Antecedent weather conditions

5. Water level stage

6. Direction of flow

3.3 EXCEEDANCES OF WATER QUALITY STANDARDS

If at any time, monitoring reveals the turbidity level, at the compliance sampling station is greater than 29 NTUs above the corresponding background sample in Class I or III receiving waters or greater than 0 NTU above background samples in receiving waters classified as OFW (Outstanding Florida Waters), construction activities shall cease immediately and not resume until corrective measures have been taken and turbidity has returned to an acceptable level. Turbidity violations and corrective measures shall be documented in the monitoring reports. For each exceedance occurrence the Contractor shall comply with the permit conditions and as a minimum perform the following:

1. Notify the District and the District's Permitting and Compliance Staff immediately who then, per the permit, must notify the permitting agency of the exceedance.

2. If known, the Contractor may also contact the District's assigned Permitting and Compliance Staff for the Project directly.

3. Document the date and time the condition is identified.

4. Corrective actions must be conducted with due diligence, as soon as possible in most cases, after the condition triggering the action has been discovered. The goal of the corrective action is to attain the effluent limits required by the permit and prevent potential impacts to water quality.

5. Corrective actions implemented should be measurable in that an action is defined and can be documented as having occurred.

6. Take all reasonable steps to address the condition (e.g. cleaning up contaminated surfaces so the material(s) is not discharged in subsequent storm events).

7. Complete the corrective action by the close of the next business day.

-- End of Section --

**APPENDIX A**

**DAILY TURBIDITY MONITORING LOG**

**Multiple work areas that may contribute to turbidity in receiving waters must be monitored separately. A Site map depicting sampling locations must accompany the quarterly turbidity monitoring reports.**

| | |
|---|---|
| Project Name: | Permit No.: |
| Collector Name: | Collection Date: |
| Meter/Sonde Identification No. | |

| Water Observations | | Weather Observations |
|---|---|---|
| Water Level Stages | | Temperature: |
| Direction of Flow | | Conditions: |
| Water Depth | | |

| Activity Taking Place During Sampling | Yes | No |
|---|---|---|
| Excavation or Filling within 50 ft radius of surface waters or wetlands? | | |
| Please describe: | | |
| Other In-Water Work? (e.g., dewatering; installing piling or forms; injecting concrete; sand blasting; painting) | | |
| Please describe: | | |
| Other Activity? (e.g., materials transfer; washdown; interim stabilization) | | |
| Please describe: | | |

| Turbidity Monitoring Data | | | | | | |
|---|---|---|---|---|---|---|
| **Background Location Description:** | **Background** | **Compliance** | **Background** | **Compliance** | **Background** | **Compliance** |
| **Compliance Location Description:** | **A.M. Mid-Depth** | | **Mid-Day Mid-Depth** | | **P.M. Mid-Depth** | |
| Collection Time | | | | | | |
| Analysis Time | | | | | | |
| Turbidity (NTU) | | | | | | |
| Did Compliance Sample exceed 29 NTU's above Background Sample? | ☐ Yes* ☐ No | | ☐ Yes* ☐ No | | ☐ Yes* ☐ No | |
| ***If the 29 NTU limitation is exceeded, please describe cause and corrective actions taken on reverse side of this form. Immediately stop activities contributing to turbidity and notify the SFWMD Construction Manager and Permit Compliance Staff.** | | | | | | |
| Explanation of gaps in sampling activity (e.g., rained out, phased activity, etc.): | | | | | | |
| Construction activity complete and slopes stabilized? ☐ Yes ☐ No | | | | | | |

| Statement of Authenticity | |
|---|---|
| I certify this test was performed as required by Chapter 62-160, F.A.C., conducted with an approved instrument calibrated in accordance with the appropriate FDEP-SOPs. The results are complete and accurate. | |
| Print Name: | |
| Signature: | Date: |

Additional Comments:

***Explain turbidity water quality standard exceedance (>29 NTU above background for Class III or > 0 NTU above background for an Outstanding Florida Water (OFW)) and describe corrective actions taken.**

# SECTION 33 11 53

# MONITORING WELLS

## PART 1 GENERAL

### 1.1 RELATED SECTIONS

Related Sections include but are not necessarily limited to:

1. DIVISION 1 General Requirements
2. 01 33 00 SUBMITTAL PROCEDURES
3. Section 31 09 00 GEOTECHNICAL INSTRUMENTATION AND MONITORING OR EARTHWORK
4. Section 02 33 00 STANDARD PENETRATION TEST

### 1.2 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C136/C136M | (2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C150/C150M | (2017) Standard Specification for Portland Cement |
| ASTM C387/C387M | (2015) Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete |
| ASTM D1586 | (2011) Penetration Test and Split-Barrel Sampling of Soils |
| ASTM D1785 | (2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D2216 | (2010) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass |
| ASTM D2487 | (2011) Soils for Engineering Purposes (Unified Soil Classification System) |
| ASTM D2488 | (2009a) Description and Identification of Soils (Visual-Manual Procedure) |
| ASTM D422 | (1963; R 2007; E 2014; E 2014) Particle-Size Analysis of Soils |

| | |
|---|---|
| ASTM D4318 | (2010; E 2014) Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D4750 | (1987; R 2001) Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well) |
| ASTM D5088 | (2015) Decontamination of Field Equipment Used at Nonradioactive Waste Sites |
| ASTM D5092 | (2004; E 2010; R 2010) Design and Installation of Ground Water Monitoring Wells in Aquifers |
| ASTM D5299 | (1999; E 2012; R 2012) Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities |
| ASTM D5521/D5521M | (2013) Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers |
| ASTM F480 | (2014) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80 |

U.S. ARMY CORPS OF ENGINEERS (USACE)

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|---|---|
| ER 1110-1-1807 | (2014) Drilling in Earth Embankment Dams and Levees |

NSF INTERNATIONAL (NSF)

| | |
|---|---|
| NSF/ANSI 14 | (2016a) Plastics Piping System Components and Related Materials |

## 1.3 SYSTEM DESCRIPTION

Construct each monitoring well to allow for the accurate measurement of ground water depths relative to the top of the well riser, by use of electrical, wetted tape, or acoustical methods. The screened interval is that portion of a monitoring well which is directly open to the host aquifer by way of openings in the well screen and indirectly open to the aquifer by way of the filter pack (or other permeable material) extending continuously below and/or above the screen.

### 1.3.1 Monitoring Well Installation Plan

Submit a plan, describing the drilling methods, sampling, and monitoring well construction and well development 30 calendar days prior to beginning drilling operations. Mobilization activities may start prior to submittal of the plan. Provide the plan approved and signed by a geologist as specified in paragraph QUALIFICATIONS. Incorporate the following requirements into the Contractor's Monitoring Well Installation Plan and follow in the field:

a. Description of well drilling methods, and installation procedures, including any temporary casing used, placement of filter pack and seal materials, disposal of development water, drill cuttings and fluids, and soil/rock sample disposition.

b. Description of well construction materials, including well screen, riser pipe, centralizers, tailpiece (if used), filter pack and filter pack gradation, drilling fluid additives (Revert), drilling water, cement, and well protective measures.

c. Description of quality control procedures to be used for placement of filter pack and seals in the boring, including depth measurements.

d. Forms to be used for written boring logs, installation diagrams of wells, well development records, well sampling data records, state well registration forms, and well abandonment records.

e. Description of contamination prevention and well materials and equipment decontamination procedures.

f. Description of protective cover surface completion procedures, including any special design criteria/features relating to frost heave prevention. Include the maximum frost penetration for the site in this description.

g. Description of well development methods to be used and locations for disposal of development waters.

h. List of applicable publications, including state and local regulations and standards.

i. List of personnel assignments for this project, and personnel qualifications.

j. Description of well decommissioning/abandonment/grouting procedures.

k. Description of in-situ permeability determination techniques, if testing is required.

l. Description and discussion of geophysical techniques to be employed at the site.

### 1.3.2 Performance Requirements

Install each monitoring well to prevent aquifer contamination by the drilling operation and equipment, and seepage of surface water adjacent to the well into the subsurface, especially the monitoring well intake zone.

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Diagrams

Survey Maps and Notes

SD-03 Product Data

Borehole Logs

Installation Diagrams

Well Development Records

Well Decommissioning/Abandonment Records

Qualifications

Permits

Monitoring Well Installation Plan

Documentation and Quality Control Reports

SD-06 Test Reports

Water Source

Filter Pack

Drilling Fluid Additive

## 1.5 QUALITY REQUIREMENTS

### 1.5.1 Notification

Notify the District 14 days prior to drilling.

### 1.5.2 Qualifications

Submit personnel qualification documentation. Provide an onsite engineer or geologist with at least 3 years of experience in soil and rock logging, and monitoring well installation, registered in the State of Florida, responsible for all borehole logging, drilling, well installation, developing and testing activities. Provide a driller licensed in the state of Florida, according to the state requirements. Furnish Contractor documentation proving a minimum of 5 years of monitor well installation experience, and appropriate health and safety personnel on staff.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Store and maintain monitoring well materials in a clean, uncontaminated condition throughout the course of the project.

## 1.7 SITE CONDITIONS

Access to each monitoring well site, including any utility clearance, permits, licenses, or other requirements and the payment thereof necessary for execution of the Work is the responsibility of the Contractor. Each monitoring well (and subsequent abandonment) will need to be permitted through the District. Submit a copy of all permits, licenses, or other requirements necessary for execution of the Work. Before beginning Work, notify the District of the type and location of wells to be constructed, the method of construction and anticipated schedule for construction of the wells. Furnish a copy of all such correspondence. Obtaining rights-of-entry is the responsibility of the Contractor. Visit each proposed well location to observe any condition that may hamper transporting equipment or personnel to the site. If clearing or relocation is necessary, the Contractor and the District shall agree on a suitable clearing, or relocation plan and the location of any required access road.

# PART 2 PRODUCTS

## 2.1 WELL CASING

Provide new monitoring well casing/riser 2 inch nominal internal diameter, schedule 40 flush-joint threaded ASTM D1785 polyvinyl chloride (PVC) pipe, meeting the requirements of NSF/ANSI 14, with required fittings conforming to ASTM F480 flush thread male by female fittings. Do not use pop rivets or screws. Provide a PVC locking cap, that threads or slips onto the top of the well casing.

## 2.2 CENTRALIZERS

Attach PVC centralizers to the well casing when monitoring wells are over 20feet in length. Centralizers are not required if the monitoring wells are installed through hollow-stem augers.

## 2.3 WELL SCREEN

Provide monitoring well screen, designed and constructed in accordance with paragraph SYSTEM DESCRIPTION, consisting of new commercially fabricated flush-joint threaded 2 inch nominal internal diameter polyvinyl chloride (PVC)schedule 40 slotted, non-clogging design. Provide required fittings conforming to ASTM F480, flush thread male by female. Provide screen slot size 0.010 inch, and screen length of 3 feet or as determined by the Contractor. Seal the bottom section of the screen watertight by means of a flush threaded end cap of the same material as the well screen, within 6 inches of the open portion of the screen.

## 2.4 FILTER PACK

Provide filter pack consisting of clean, washed, rounded to sub-rounded siliceous material free from calcareous grains or material. Submit filter pack material test results; sieve and chemical analyses. Organic matter, soft, friable, thin, or elongated particles are not permissible. Determine

the gradation of the filter pack using the grain size analysis data obtained as required in paragraph Sampling. Use a uniformity coefficient for the filter pack material not exceeding 2.5. Fill an airtight pint size glass container with a sample of filter pack material and furnish to the District for each well to serve as a quality control.

## 2.5 BENTONITE SEAL

Provide a bentonite seal, intended to keep grout from entering the filter pack, consisting of hydrated granular, or pelletized, sodium montmorillonite furnished in sacks or buckets from a commercial source, free of impurities which adversely impact the water quality. If the bentonite seal is located above any borehole fluid levels, place a layer of fine sand at the top of the bentonite seal, to provide an additional barrier to any downward migration of grout.

## 2.6 CEMENT AND BENTONITE GROUT

Provide cement grout with a mixture of a maximum of 6 gallons of approved water per 94 lb bag of Portland cement, conforming to ASTM C150/C150M, Type I. Add no more than 5 percent by weight of bentonite powder to reduce shrinkage, hold the cement in suspension prior to the grout set. Use sodium bentonite powder and/or granules for high-solids bentonite grout. Mix water from an approved source with these powders or granules to form a thick bentonite slurry, consisting of a mixture of bentonite and the Manufacturer's recommended volume of water to achieve an optimal seal. The slurry shall have a density of not less than 15 lb per gallon.

## 2.7 CONCRETE PAD

Construct a concrete pad around the protective cover at the ground surface.

## 2.8 PROTECTIVE COVERS

Equip monitoring wells with a aluminum lockable protective casing/enclosure set over the well casing, set in the concrete pad or surface seal. Provide weather resistant padlocks which use the same key (keyed-alike) on the protective covers, or lockable caps for all wells. Cap any well that is to be temporarily removed from service or left incomplete due to delay in construction with a watertight cap and equipped with a vandal resistant cover. Note that permanent piezometers for dam safety monitoring shall have protective covers as shown on the drawings.

## 2.9 SAMPLE CONTAINERS

a. Place soil-rock samples for geotechnical purposes, in air-tight half-pint size glass Contractor furnished containers and labeled with the project name, date of sample, monitoring well number and depth at which the sample was taken.

b. Label both the container and lid in permanent indelible ink. Place jars in partitioned cardboard Contractor furnished boxes. Label boxes with project number and well number.

# PART 3 EXECUTION

## 3.1 PROTECTION OF EXISTING CONDITIONS

Maintain all existing survey monuments and monitoring wells, and protect them from damage from equipment and vehicular traffic. Immediately report and repair any items damaged by the Contractor. Re-install monitoring wells requiring replacement due to Contractor negligence according to these specifications. Protect wells scheduled for abandonment from damage so that abandonment may be performed according to these specifications. Prior to excavation, obtain written approval from the local utility companies to drill at each site, to avoid disturbing buried utilities.

## 3.2 PREPARATION

### 3.2.1 Decontamination

a. Clean the drill rig, drill rods, drill bits, augers, temporary casing, well developing equipment, tremie pipes, grout pumping lines, and other associated equipment with high-pressure hot water/steam prior to drilling at each monitoring well location. Perform decontamination in accordance with ASTM D5088, at a central decontamination station located in an area that is remote from, and cross- or down-gradient from the well being drilled.

b. Clean screen and well casing with high-pressure hot water immediately prior to installation in the well. The use of factory sealed (plastic wrapped) screen and well casing does not waive this requirement for pre-installation cleaning.

c. Use only water for cleaning from a District approved source.

### 3.2.2 Decontamination Station

a. Construct a temporary decontamination pad onsite, bermed and slightly inclined towards a sump located in one of the back corners of the pad.

b. Make the minimum dimensions of the pad the length and width of the drill rig, plus 4 feet per side to allow access and steam cleaning. Use yellow ribbon to encircle the decontamination pad.

### 3.2.3 Water Source

Groundwater and surface water at the project site has been tested by the District and found to be generally acceptable for use in the installation of monitoring wells. Prior to its use at the site, Contractor shall sample and test the water source, and obtain approval from the District. Submit decontamination and drilling water source analytical test results. The Contractor is responsible for locating the source, obtaining the water from the source, transporting it to, and storing it at the site. Obtain a water sample from the container used in transporting the water to the site before the water is used for decontamination, and sample, test, and secure approval in accordance with the above requirements.

## 3.3 INSTALLATION

### 3.3.1 Drilling Method

a. Use a drilling method which prevents the collapse of formation material against the well screen and casing during installation of the well. Make the inside diameter of any temporary casing used sufficient to allow accurate placement of the screen, riser, centralizer(s), filter pack, seal and grout. Monitoring wells located in the dam at any time must be installed using hollow stem auger, Sonic methods, or using rotary wash with temporary casing. Use of rotary wash methods are to consider the potential for hydro-fracture of the dam or foundation soils and follow criteria set forth in ER 1110-1-1807. Contractor shall submit a Monitoring Well Installation Plan prior to initiation of the Work.

b. Any drilling fluid additive such as drilling mud shall consist of Revert. Grease or oil on drill rods, casing, or auger joints are not permitted; however, PTFE tape or vegetable oil (in solid phase form) are acceptable. Submit Manufacturer's data, if available, including analytical test results of the additive, if not a part of the Manufacturer's data.

c. Provide a drill rig free from leaks of fuel, hydraulic fluid, and oil which may contaminate the borehole, ground surface or drill tools. During construction of the wells, use precautions to prevent tampering with the well or entrance of foreign material, and prevent runoff from entering the well during construction. If there is an interruption in work, such as overnight shutdown or inclement weather, close the well opening with a watertight uncontaminated cover. Secure the cover in place or weighted down so that it cannot be removed except with the aid of the drilling equipment or through the use of drill tools.

### 3.3.2 Test Hole Requirements

Drill one test hole for every monitoring well or well cluster installed. A well cluster, as defined in this specification, is two or more wells completed (screened) to different depths in a single borehole or in a series of boreholes in close proximity (10 feet or less) to each other. Log test holes in accordance with paragraph BOREHOLE LOGS, and if temporary casing is used, use in accordance with paragraph Decontamination.

### 3.3.3 Sampling

#### 3.3.3.1 Sampling for Geotechnical Analysis

a. Take samples of all materials penetrated by each drilled well/test hole. Perform soil sampling with a steel split tube sampler using standard sampling techniques in accordance with ASTM D1586. Extract samples from their in-situ environment in as near an intact, minimally disturbed condition as technically practical. Retrieve samples according to ASTM D1586 at least every 2.5 feet from each test hole.

b. Place drive-sampled materials in airtight containers and label as specified in paragraph SAMPLE CONTAINERS, and deliver to the District designated facility. Test representative soil samples for grain-size distribution by mechanical means ASTM D422 (sieves down to the No. 200

size according to ASTM C136/C136M), moisture content according to ASTM D2216 and Atterberg limits according to ASTM D4318. Prepare description and identification of soils in accordance with ASTM D2488, laboratory classification of soils in accordance with ASTM D2487, and perform sampling to allow completion of the documents described in paragraph Borehole Logs.

3.3.4 Borehole Diameter and Depth

Provide sufficient diameter in borings for monitoring well installation to permit at least 2 inches of annular space between the boring wall and all sides of the centered riser pipe and screen. Determine depths of individual borings as specified in the approved Monitoring Well Installation Plan.

3.3.5 Screen, Well Casing/Riser Pipe Placement

a. Provide the monitoring well screen in length as determined by the Contractor and approved by the District, with specified bottom cap securely attached, set to the appropriate depth.

b. Place the bottom of the well screen no more than 2 feet above the bottom of the drilled borehole. Place the well screen in the appropriate location in the borehole so that the completed monitoring well functions in accordance with paragraphs SYSTEM DESCRIPTION and WELL ACCEPTANCE.

c. Provide sieve analyses of representative drive sampled material, conducted in accordance with ASTM C136/C136M. Place the well screen as specified by the Contractor as part of the Dewatering Plan and/or as shown on the drawings. Join the screen and well casing/riser pipe sections by flush threaded watertight joints, with the well casing/riser pipe extending upwards from the screen to an elevation appropriate for the surface completion described in paragraph Protective Cover Placement. Do not allow the well screen and riser pipe to drop or fall uncontrolled into the borehole. Clean the screen and well casing/riser pipe with high pressure hot water/steam just prior to installation; allowing no foreign material to remain on the screen and well casing before installation. The use of factory-sealed (plastic wrapped) screen, free from painted markings, does not waive requirements for pre-installation cleaning.

d. Provide watertight flush threaded joints and fastenings; solvent glue or set screws are not permitted.

e. Make the well centered and plumb by the use of stainless steel centralizers, in accordance with paragraph CENTRALIZERS, spaced 120 degrees apart at intervals not exceeding 20 feet along the length of the casing. Do not place centralizers on the screened interval or within the bentonite seal. Verify the alignment of the well by passing a 5 foot long section of rigid pipe 1/4 inch smaller in diameter than the inside diameter of the casing through the entire well. If the pipe does not pass freely, the well will not be accepted. Use temporary casing, hollow stem augers or other measures, as necessary, to prevent collapse of the boring against the well screen and well casing/riser pipe prior to placement of the filter pack and sealing materials. Install a cap on the top of the riser pipe, either vented, or a telescopic fit, constructed to preclude binding to the well casing

caused by tightness of fit, unclean surfaces, or weather conditions. Make cap secure enough to preclude the introduction of foreign material into the well, yet allow pressure equalization between the well and the atmosphere.

### 3.3.6 Filter Pack Placement

a. After the screen and well casing have been concentrically placed in the hole, construct the approved filter pack around the screen by filling the entire space between the screen and the wall of the hole over the selected screened interval. Place the lowermost 1 foot of filter pack in the boring prior to installation of the well screen, serving as a base on which to place the screen. Lower a tremie pipe having an inside nominal diameter of not less than 1 inch, to the bottom of the annulus between the hole and well. Clean the tremie pipe with high pressure hot water/steam prior to each use. Arrange the tremie pipe so that water and filter pack material fed at uniform rates are discharged as the filter pack material fills the hole from the bottom up. Raise the tremie pipe at a rate that will keep the bottom of the tremie pipe no more than 5 feet above the top of the surface of the filter pack level, and no more than 2 feet below the surface of the filter pack level at all times.

b. Dumping filter pack material from the surface of the ground and agitating the well in an effort to settle the filter material is not allowed. Install the filter pack continuously and without interruption until the filter pack has been placed to a minimum of 3 feet above the top of the screen in the monitoring well. Directly measure the depth to the top of the filter pack and record. Obtain any additional water required to be added to the filter pack material in accordance with paragraph Water Source.

c. Protect filter pack material from contamination prior to placement by either storing it in plastic lined bags, or in a location protected from the weather and contamination on plastic sheeting. Transport filter pack material to the well site in a manner which prevents contamination by other soils, oils, grease, and other chemicals. Remove temporary drill casing, if installed, or auger simultaneously with the above operation. Minimize lifting of the riser pipe when withdrawing the temporary casing/auger. Place filter pack material in lifts no greater than 3 foot prior to retraction of the temporary casing/auger. Leave a minimum of 6 inches of filter pack in the temporary casing/auger at all times during filter pack installation. Take frequent measurements inside the annulus during retraction to ensure that the filter pack is properly placed.

### 3.3.7 Bentonite Seal

Place a minimum 3 foot thick hydrated bentonite seal on top of the filter pack in a manner which prevents bridging of the bentonite in the annulus, such that the bottom of the bentonite seal is a minimum of 3 feet above the top of the filter pack. Directly measure the depth to the top of the bentonite seal and record immediately after placement, without allowance for swelling.

### 3.3.8 Grout Placement

Mechanically mix a non-shrinking cement grout, in accordance with paragraph CEMENT AND BENTONITE GROUT, and placed in one continuous operation into the annulus above the bentonite seal to within 2 feet of the ground surface. Make grout injection in accordance with ASTM D5092. Place grout using a tremie pipe in a bottom to top manner. If the casing interval to be grouted is less than 15 feet, and without fluids after any drill casing is removed, place the grout either by pouring or pumping. Thoroughly clean the tremie pipe with high pressure hot water/steam before use in each well. Construct the bottom of the tremie pipe to direct the discharge to the sides rather than downward, keeping the discharge end of the tremie pipe submerged at all times. Add additional grout from the surface to maintain the level of the grout at the land surface as settlement occurs. Work is not permitted in the well within 24 hours after cement grouting.

### 3.3.9 Concrete Pad Placement

Construct a concrete pad with a minimum radius of 1 foot from the protective casing at the final ground level elevation. Furnish pre-packaged, dry, combined concrete materials for the well pads conforming to ASTM C387/C387M normal weight, normal strength concrete. Combine the dry materials with potable water and mix in an approved mixer or container until uniform in consistency and color. Limit water to the minimum amount possible. The pad shall have a minimum thickness of 6 inches.

### 3.3.10 Protective Cover Placement

Provide all monitoring wells with an aluminum lockable protective enclosure set in the annular seal over the well casing with keyed-alike locks on the protective covers for all wells.

#### 3.3.10.1 Protective Steel Casing

a. Install a protective steel casing around the well casing/riser pipe by placing the protective casing into the annular seal. Provide a protective casing with an inside diameter of at least 4 inches greater than the nominal diameter of the well riser. Fit the protective casing with a locking cap and install so that there is a maximum 0.2 foot clearance between the top of the in-place inner well casing cap and the bottom of the protective casing locking cap when in the locked position.

b. Position and maintain the protective casing in a plumb position. Extend the bottom of the protective casing a minimum of 2.5 feet below the top of the ground surface; extending a minimum of 2.5 feet below the prevailing ground surface elevation and anchored into the cement grout annular seal; and also extending at least 2.5 feet above the surface of the ground. Seal and immobilize the protective casing in concrete placed around the outside of the protective casing, then place dry bentonite pellets, or granules, in the annular space below ground level within the protective casing.

c. Provide the protective casing with a 1/4 inch diameter drain hole installed just above the top of the concrete pad. Place coarse sand or pea gravel in the annular space between the protective casing and the

riser pipe, above the drain hole, to within 3 inches from the top of the riser pipe.

3.3.11 Well Identification

Affix a corrosion resistant metal tag to the exterior and interior of the protective cover. Provide the metal tag stamped with the well identification number, elevation of the highest point on the rim of the well casing or riser pipe, elevation of the ground surface at the well, well coordinates, date of well installation, and the top of the protective casing elevation in feet as determined according to paragraph SURVEYS. Use identification numbers for the monitoring wells as indicated on the drawings.

3.3.12 Well Development

Within 7 days of completion of each well, but no sooner than 48 hours after cement grouting is completed, develop the well. Perform development using only mechanical surging or over pumping or a combination thereof in accordance with ASTM D5521/D5521M. Include details of the proposed development method in the Monitoring Well Installation Plan. Maintain a well development record in accordance with paragraph Well Development Records. Development is complete when:

a. Well water is clear to the unaided eye,

b. Sediment thickness in the well is less than 1 percent of the screen length.

c. A minimum of three times the standing water volume in the well plus three times the volume of all added water and drilling fluid lost during drilling and installation of the well is removed.

3.3.13 Drilling Waste Disposal

Dispose of slurry, drill cuttings, rock core; other solid or liquid material bailed, pumped, or otherwise removed from the borehole during drilling, installation, completion, and well development procedures; and fluids from material/equipment decontamination activities in area on the project site approved by the District.

3.4 SURVEYS

Establish coordinates and elevations for each monitoring well/test hole. Determine horizontal coordinates to the closest 1.0 foot and referenced to the State Plane Coordinate System. Obtain a ground elevation to the closest 0.1 foot at each well. The highest point on the top of the riser pipe serves as a measurement point; reference this elevation and survey to the nearest 0.01 foot using the North American Vertical Datum of 1988. Plot the location, identification, coordinates, and elevations of the well and monuments on maps with a scale large enough to show their location with reference to other structures.

3.5 WELL DECOMMISSIONING/ABANDONMENT

Any well disapproved by the District, or any well decommissioned/abandoned by the Contractor for any reason shall be decommissioned/abandoned according

to the requirements of the State of Florida, ASTM D5299, and the requirements of these specifications. Well decommissioning/abandonment includes the removal of all materials left in the borehole/well, excluding the filter pack, and including backfill materials, casing, screen, and any other material placed into the hole before the decision was made to abandon the borehole/well. Grout test holes decommissioned/abandoned for any reason from the bottom to within 2 feet of the top of the ground surface according to the protocol for grout/bentonite placement established in paragraph Grout Placement, using the grout mix specified in paragraph CEMENT AND BENTONITE GROUT. Backfill the top 2 feet with embankment material appropriate for the intended land use. Maintain a well decommissioning/abandonment record as specified in paragraph Well Decommissioning/Abandonment Records. Measure groundwater levels, if encountered before the decision is made for decommissioning/abandonment, in all borings prior to backfilling. Include these water levels in the well decommissioning/abandonment records. No well may be decommissioned/abandoned without the approval of the District.

## 3.6 WELL ACCEPTANCE

It is the responsibility of the Contractor to properly design, construct, install, develop, and test all monitoring wells according to the requirements of this specification so that they are suitable for the intended purpose. If the Contractor installs wells that are not functional or not in accordance with these specifications, the District will disapprove the well and direct the Contractor to repair or replace it, and to abandon the disapproved well in accordance with this specification.

## 3.7 SITE CLEANUP

After completion of the Work, remove tools, appliances, surplus materials, temporary drainage, rubbish, and debris incidental to Work. Backfill excavation and vehicular ruts and dress to conform with the existing landscape or terrain. Utilities, structures, roads, fences, or any other pre-existing item which must be repaired or replaced due to the Contractor's negligence are the Contractor's responsibility; accomplish repair or replacement prior to completion of this contract.

## 3.8 DOCUMENTATION AND QUALITY CONTROL REPORTS

Submit reports for well construction and development. Establish and maintain documentation and quality control reports for well construction and development to record the desired information and to assure compliance with contract requirements, including, but not limited to, the following:

### 3.8.1 Borehole Logs

Submit original borehole logs, within 14 working days after completion of the boring and well installation procedures. Prepare and complete a borehole log for each boring drilled, prepared by the geologist present onsite during all well drilling and installation activities. Provide the log scale at 1 inch equals 10 feet. Keep copies current and complete of all well logs in the field at each well site and make available at all times for inspection by the District. Include, as a minimum, the following:

a. Name of the project and site.

b. Boring/well identification number.

c. Location of boring (State Plane coordinates).

d. Make and Manufacturer's model designation of drilling equipment and name of drilling firm.

e. Date boring was drilled.

f. Reference data for all depth measurements.

g. Name of driller and name and signature of geologist preparing log.

h. Nominal hole diameter and depth at which hole diameter changes.

i. Total depth of boring.

j. Method of drilling, including sampling methods and sample depths, including those attempted with no recovery. Indication of penetration resistance such as drive hammer blows given in blows per 6 inches ASTM D1586. Include in information hammer weight and drop distance. Record information such as rod size, bit type, pump type, etc.. Also include a description of any temporary casing used, drill fluids and fluid additives used, if any, including brand name and amount used, along with the reason for and start (by depth) of its use, and, if measured, mud viscosities and weight.

k. Depth of each change of stratum. If location of strata change is approximate, it shall be so stated.

l. Description of the material of which each stratum is composed, in accordance with ASTM D2488, and/or standard rock nomenclature, as necessary. Include in soil parameters for logging , but do not limit to, classification, depositional environment and formation, if known, Unified Soil Classification Symbol, secondary components and estimated percentages, color, plasticity, consistency (cohesive soil), relative density (cohesionless soil), moisture content, structure and orientation, and grain angularity.

m. Include in rock core parameters for logging , but do not be limit to, rock type, formation, modifier denoting variety (calcareous, siliceous, etc.), color, hardness, degree of cementation, texture, crystalline structure and orientation, degree of weathering, solution or void conditions, primary and secondary permeability, and lost core.

n. Also include the results of any chemical field screening on the boring log. Prepare classification in the field at the time of sampling. Also duly note and record the results of visual observation of the material encountered, and any unusual odor detected.

o. Depth of any observed fractures, weathered zones, or any abnormalities encountered.

p. Depth and estimated percent of drill fluid loss or lost circulation. Measures taken to regain drill water circulation. Significant color changes in the drilling fluid return.

q. Depth to water, and any non-aqueous phase liquids (NAPLs) and date measured before, during, and after each drilling shift, and prior to well installation. Provide and maintain at each well under construction a portable water level measuring device of sufficient length to measure the water level to 100 foot depth. Keep the device onsite at all times and provide graduated measuring wire in 0.01 foot. Take water level measurements to the nearest 0.01 foot.

r. Box or sample number. Depths and the number of the core boxes and/or samples shall be recorded at the proper interval.

s. Percent Rock Core Recovery. The percent core recovery for the individual drill runs, if rock is cored, shall be shown.

### 3.8.2 Installation Diagrams

Submit installation diagram for each monitoring well within 14 working days of the completion of the installation. The well will not be accepted before the geologic logs and installation diagrams are received. Submit as-built installation diagram for each monitoring well installed, prepared by the engineer or geologist present during well installation operations, within 14 working days of the completion of the well installation procedure. Clearly illustrate in the diagram the as-built condition of the well and include, but do not limit to the following items:

a. Name of the project and site.

b. Well identification number.

c. Name of driller and name and signature of the engineer or geologist preparing diagram.

d. Date of well installation.

e. Description of material from which the well is constructed, including well casing/riser pipe and screen material, centralizer composition, if used, diameter and schedule of casing and screen, gradation of filter pack, lithologic description, brand name (if any), source, and processing method, and method of placement of the filter pack, bentonite seal type (pellets, granules, chips, or slurry), grout type (cement or high-solids bentonite) and type of protective cover (protective casing or flush-to-ground).

f. Total depth of well.

g. Nominal hole diameter.

h. Depth to top and bottom of screen, and filter pack.

i. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).

j. Type of cement and/or bentonite used, mix ratios of grout, method of placement and quantities used.

k. Elevations/depths/heights of key features of the well, such as top of well casing/riser pipe, top and bottom of protective casing, ground

surface, the depth of maximum frost penetration (frost line), bottom of well screen, top and bottom of filter pack, and top and bottom of seal.

l. Other pertinent construction details, such as slot size and percent open area of screen, type of screen, and Manufacturer of screen.

m. Well location by coordinates. A plan sheet shall also be included showing the coordinate system used and the location of each well. A plan sheet is not required for each well installation diagram; multiple wells may be shown on the same sheet.

n. Static water level upon completion of the well.

o. Special problems and their resolutions; e.g., grout in wells, lost casing, or screens, bridging, etc.

p. Description of surface completion.

### 3.8.3 Well Development Records

Prepare and submit a monitoring well development record for each monitoring well installed under the supervision of the geologist present during well installation operations, within 14 working days of the completion of development. Include the following information on the well development record, but do not limit to the following:

a. Date, time, and elevation of water level in the well, before development.

b. Depth to bottom of well, name of project and site, well identification number, and date of development.

c. Method used for development, to include size, type and make of equipment, bailer, and/or pump used during development.

d. Time spent developing the well by each method, to include typical pumping rate, if pump is used in development.

e. Volume and physical character of water removed, to include changes during development in clarity, color, particulates, and odor.

f. Volume of water added to the well, if any.

g. Volume and physical character of sediment removed, to include changes during development in color, and odor.

h. Source of any water added to the well.

i. Clarity of water before, during, and after development. Nephelometric turbidity unit (NTU) measurements.

j. Total depth of well and the static water level in accordance with ASTM D4750 from top of the casing, immediately after pumping/development, and 24 consecutive hours after development.

k. Readings of pH, specific conductance, and temperature taken before, during, and after development.

l. Name and job title of individual developing well.

m. Name and/or description of the disposal facility/area, for the waters removed during development.

### 3.8.4 Well Decommissioning/Abandonment Records

Submit well decommissioning record, for each monitoring well abandoned, within 14 working days of the completion of the abandonment procedure. Include in decommissioning/abandonment records, as a minimum, the following:

a. Project name.

b. Well or test hole number.

c. Well/boring location, depth and diameter.

d. Date of decommissioning/abandonment.

e. Method of decommissioning/abandonment.

f. All materials used in the decommissioning/abandonment procedure and the interval in which test materials were placed.

g. Casing, and or other items left in hole by depth, description, and composition.

h. Description and total quantity of grout used initially.

i. Description and daily quantities of grout used to compensate for settlement.

j. Water or mud level (specify) prior to grouting and date measured.

k. The reason for decommissioning/abandonment of the monitoring well/test hole.

### 3.8.5 Survey Maps and Notes

Prepare and submit a tabulated list of all monitoring wells and monuments, copies of all field books, maps showing the locations, and elevations of all monitoring wells, and all computation sheets, consisting of the designated number of the well or monument, the X and Y coordinates, and all the required elevations within 30 working days after completion of the survey.

-- End of Section --

# SECTION 33 30 20

# STAFF GAUGES

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work: The Contractor shall provide all necessary equipment, labor, and materials and perform all Work necessary to complete installation of staff gauges, including steel pipe posts or concrete support piles for the staff gauges.

Related Work Specified Elsewhere:

1. Section 01 33 00 SUBMITTAL PROCEDURES

### 1.2 REFERENCES

~~Standards or Codes: The edition of the standards of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. In the case of a conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail~~Not used.

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

### 1.3 DEFINITIONS

Not Used

### 1.4 SUBMITTALS

All submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-03 Product Data

Weekly Progress Reports

Staff Gauges

SD-11 Closeout Submittals

Surveyor's Report

### 1.5 SUBMITTAL REQUIREMENTS

The Contractor shall submit weekly progress reports to the District during the time of staff gauge installation.

The Contractor shall submit Surveyor's Report as specified in Section 01 71 23 FIELD ENGINEERING AND SURVEYING.

1.6 QUALIFICATIONS

Not Used

1.7 RESPONSIBILITIES

Not Used

1.8 CERTIFICATIONS

Not Used

1.9 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide at least 48 hours advance notice of its intention for inspection or to begin new Work activities.

1.10 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 DATUM SIGN, DATUM HEIGHT OFFSET, NUMBER FIGURES AND HASH MARKS

The Contractor shall furnish materials conforming to the following provisions:

1. For concrete pile mounted staff gauges, staff gauge board shall be Tangent Technologies, LLC PolyForce - color extruded structural recycled plastic lumber or District approved equal, two (2) inches x ten (10) inches white skin over black core.

2. Hash marks, number figures, and adjustment channel shall be routed into staff gauge board by use of a computer numerical control (CNC) machine to the depth where black core is clearly visible within the entire routed area. Hash marks shall be graduated in tenths of a foot.

3. Datum sign (NAVD 88 SFWMD) panel with white and red color core material. Sign shall have a red border and be permanently mounted into routed cavity at the top off staff gauge board.

4. Datum height offset (+1.27 TO NGVD 29) shall be routed in staff gauge board to the depth where black core is clearly visible within the entire routed area.

2.2 CONCRETE PILES

The Contractor shall furnish materials conforming to the following provisions.

1. Concrete piles shall conform to Section 31 62 13.20 PRECAST/PRESTRESSED CONCRETE PILES.

## PART 3 PERFORMANCE

### 3.1 CONCRETE PILES

Pre-punching or pilot-drilling holes shall be performed when necessary to allow piles to be driven through rock.

Concrete piles shall be capped with a one (1) inch minimum thick layer of non-shrink epoxy grout (see Section 03 31 01.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE CIVIL WORKS) applied after driving the pile. Prepare the surface of the pile in accordance with grout Manufacturer's instructions.

### 3.2 STAFF GAUGES

The Contractor shall install permanent slide mounted staff gauge(s) on concrete pile(s) with elevations referenced to NAVD 88 as shown on the Drawings. A 5-inch high x 8.5-inch wide sign with two (2) inch Series B alphabet height shall be permanently mounted into a routed cavity at the top off staff gauge board to identify the NAVD 88 reference datum.

The Contractor shall level staff gauge elevations to within +/- 0.01 feet or less. All leveling will be performed under the direct supervision of a Professional Surveyor or Mapper licensed in the State of Florida in accordance with Section 01 71 23 FIELD ENGINEERING AND SURVEYING. Leveling will meet or exceed the National Geodetic Survey Standards for third order leveling (12mm square root of distance in km)). Field notes for each site shall be reviewed by surveyor and certified as meeting the leveling standards. Field notes shall be incorporated into a Surveyor s Report and shall be submitted in accordance with Section 01 71 23 FIELD ENGINEERING AND SURVEYING.

-- End of Section --

# SECTION 33 40 00

# STORM DRAINAGE UTILITIES

## PART 1 GENERAL

### 1.1 SUMMARY

SUMMARY OF WORK: The contractor shall furnish all labor, materials, and equipment necessary for the installation of the storm drainage system(s) including inlets, pipes, end treatments, excavation, bedding, and backfill, as shown on the drawings and/or specified.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A126 | (2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM C1103 | (2014) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines |
| ASTM C139 | (2014) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes |
| ASTM C231/C231M | (2017) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C270 | (2014a) Standard Specification for Mortar for Unit Masonry |
| ASTM A276/A276M | (2017) Standard Specification for Stainless Steel Bars and Shapes |
| ASTM B21/B21M | (2014) Standard Specification for Naval Brass Rod, Bar, and Shapes |

| | |
|---|---|
| ASTM A536 | (1984; R 2014) Standard Specification for Ductile Iron Castings |
| ASTM B584 | (2014) Standard Specification for Copper Alloy Sand Castings for General Applications |
| ASTM C32 | (2017) Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale) |
| ASTM C425 | (2004; R 2013) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings |
| ASTM C443 | (2017) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C55 | (2016) Standard Specification for Concrete Building Brick |
| ASTM C62 | (2013a) Building Brick (Solid Masonry Units Made from Clay or Shale) |
| ASTM C76 | (2015) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe |
| ASTM C969 | (2017) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines |
| ASTM C990 | (2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM D1557 | (2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D1751 | (2004; E 2013; R 2013) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |
| ASTM D2000 | (2012; R 2017) Standard Classification System for Rubber Products in Automotive Applications |
| ASTM D2167 | (2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method |
| ASTM D6938 | (2017) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

| | |
|---|---|
| ASTM F593 | (2017) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F594 | (2009; E 2015) Standard Specification for Stainless Steel Nuts |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specification for Road and Bridge Construction - Current Edition |

## 1.4 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

Mitered End Sections

Headwalls

Flap Gate

SD-03 Product Data

Concrete Pipe

Flap Gate

SD-07 Certificates

Concrete Pipe

Oil Resistant Gasket

Hydrostatic Test on Watertight Joints

Determination of Density

Drainage Inlets

Frame and Cover for Gratings

Post-Installation Inspection Report

Pipeline Testing

SD-08 Manufacturer's Instructions

Placing Pipe

Flap Gate

## 1.5 QUALITY REQUIREMENTS

Submit printed copies of the manufacturer's recommendations for installation procedures for placing pipe, prior to installation.

The Contractor shall submit the following for the flap gate to the District for approval prior to fabrication:

1. Product data showing flap gate principal parts and materials.

2. Spare parts list.

3. Manufacturer's assembly and disassembly or repair instructions for the flap gate.

4. Shop drawings of the flap gate showing detailed layout dimensions.

5. Protective coating system.

6. Installation, operation, and maintenance manuals.

## 1.6 DELIVERY, STORAGE, AND HANDLING

### 1.6.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the District. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

### 1.6.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

# PART 2 PRODUCTS

## 2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

### 2.1.1 Concrete Pipe

Manufactured in accordance with and conforming to ASTM C76, Class IV. Submit product data and certification that the concrete pipe meets the specification requirements.

## 2.2 DRAINAGE STRUCTURES

### 2.2.1 Drainage Inlets

Ditch bottom inlets shall conform to the FDOT Design Standards Index as indicated. Submit certification stating that the structure meets the FDOT requirements.

### 2.2.2 End Treatment

#### 2.2.2.1 Mitered End Sections

Mitered end sections shall conform to FDOT Design Standards Index as indicated for the cross-drain culverts and the side drain culverts. Submit shop drawings of the mitered end sections for review and approval.

#### 2.2.2.2 Headwalls

Headwalls are required at each seepage collection system outfall. The reinforced headwall are detailed in the drawings. The headwalls may be cast-in-place or precast. Submit shop drawings of the headwalls for review and approval.

#### 2.2.2.3 Flap Gates

##### 2.2.2.3.1 General

a. Flap gates shall be of the pipe flange type. A cushion block/bumper shall be provided to allow the gate to close by design. Flap gates shall have a machined seating surface inclined from vertical at a minimum angle per Manufacturer's recommendations to assure positive closure.

b. The flap valve shall be designed to ensure a minimum (25) year service life with all components to be corrosive resistant (except cast iron body). All components shall be designed for minimum maintenance or shall provide a means of maintenance form the surface such as grease lines.

c. The flap valve shall be provided with a means to limit and cushion the opening of the valve as well as cushion its closure. The valve design shall prevent the slamming of the valve under all operating conditions.

d. Nuts, bolts, studs, cotter pins, hinge pins and all other assembly hardware shall be Type 316L stainless steel per ASTM A276/A276M, ASTM F593, and ASTM F594. Bushings shall be ultra-high molecular weight polyethylene (UHMWPE). Commercial grade bronze washers and ASTM B21/B21M Alloy 482 bronze seats shall be used. Quantity and size of the fasteners shall be in accordance with the recommendation of the Manufacturer unless modified by the District.

e. The "gasket" (when required) shall be a minimum of nominal one half inch thick neoprene.

f. The "sealant" (when required) shall be a Sikaflex 201 Industrial Sealant or approved equal.

g. The Contractor shall furnish flap gate(s) designed and constructed to withstand a minimum seating head of 3 feet and shall be adjustable (in both the vertical and horizontal directions) to be free flowing on the unseating head side.

h. The Contractor shall take special care to ensure that dissimilar metals of flap gate, the mounting hardware and the concrete reinforcing rods are isolated from one another using non-conductive sleeves, washers, gaskets, spacers, or other devices as prescribed by the Manufacturer.

i. The Contractor shall require the flap gate Manufacturer to package the flap gate(s) in a secure manner to reduce movement and eliminate damage during shipping and handling.

2.2.2.3.2 Body

a. The body shall be cast-iron and conform to ASTM A126C - Gray Iron Castings for Valves, Flanges and Pipe Fittings.

b. A resilient seat, neoprene conforming to ASTM D2000, shall be bonded in a groove machined in the body to provide a wide contact surface for the seat machined in the cover.

c. Provide a steel spring and stop attached to the body and extended over the cover to safely limit the travel of the cover during discharge operation. A rubber pad on the spring shall protect cover during contact.

d. Bolts or studs for attaching the frame to the pipe flange shall be ASTM F593 Type 316 stainless steel.

2.2.2.3.3 Hinge Arms

a. The hinge arms shall be high-tensile bronze and conform to ASTM B584, Alloy C865 or ASTM A276/A276M Type 316L stainless steel.

b. Each arm shall have two (2) pivot points, an adjustable lower pivot with limited rotation and an upper hinge post to adjust flap sensitivity. The gates double pivoted hinge linkage shall be designed to permit complete seating, full opening and with stops or other arrangement to prevent the cover from rotating sufficiently to become wedged in the open position. Pivot lugs mounted to the frame shall be adjustable to allow adjustment of hinge links without having to remove cover from gate. Hinge bushings shall be provided to limit lateral mobility during gate operation.

c. Pins, bolts, fasteners, and studs shall be ASTM F593, Type 316 stainless steel.

2.2.2.3.4 Cover (Flap)

a. The cover shall be either a spherical dish design or a flat design with reinforcing ribs and shall be capable of withstanding maximum operating loads.

b. The cover shall be cast-iron and conform to ASTM A126C or Ductile Iron ASTM A536.

c. A lifting eye shall be provided as an integral part of the cover (flap).

## 2.3 MISCELLANEOUS MATERIALS

### 2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 3,000 psi concrete under Section 03 31 01.00 10 CAST-IN-PLACE CONCRETE FOR CIVIL WORKS. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches 1-1/2 inches. Air content shall be determined in accordance with ASTM C231/C231M. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D1751.

### 2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalis, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

### 2.3.3 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to ASTM C139, not more than 8 inches thick, not less than 8 inches long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

### 2.3.4 Brick

Brick shall conform to ASTM C62, Grade SW; ASTM C55, Grade S-I or S-II; or ASTM C32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.

### 2.3.5 Frame and Cover for Gratings

Submit certification on the ability of frame and cover or gratings to carry the imposed live load. Frame and cover for gratings shall be cast gray iron, conforming to FDOT specification Section 425-3.2.

2.3.6 Joints

2.3.6.1 Flexible Watertight Joints

a. Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe. The design of joints and the physical requirements for preformed flexible joint sealants shall conform to ASTM C990, and rubber-type gaskets shall conform to ASTM C443. Factory-fabricated resilient joint materials shall conform to ASTM C425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

b. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443. Certified copies of test results shall be delivered to the District before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

2.4 STEEL LADDER

Steel ladder shall be provided where the depth of the storm drainage structure exceeds 12 feet. These ladders shall be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A123/A123M.

2.5 EROSION CONTROL RIP RAP

For riprap protection see Section 35 31 19 RIPRAP SYSTEM.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 24 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified, without any over excavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the District.

### 3.1.2 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the District, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the District.

## 3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

### 3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in granular material minimum 4 inch in depth in trenches with soil foundation. Depth of granular bedding in trenches with rock foundation shall be 1/2 inch in depth per foot of depth of fill, minimum depth of bedding shall be 8 inches up to maximum depth of 24 inches. The middle third of the granular bedding shall be loosely placed. Bell holes and depressions for joints shall be removed and formed so entire barrel of pipe is uniformly supported. The bell hole and depressions for the joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

## 3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary.

Maximum deflection of the concrete pipe is 0 percent.

Note post installation requirements of paragraph DEFLECTION TESTING in PART 3 of this specification for all pipe products.

### 3.3.1 Concrete Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

### 3.3.2 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

## 3.4 JOINTING

### 3.4.1 Concrete

#### 3.4.1.1 Cement-Mortar Bell-and-Spigot Joint

The first pipe shall be bedded to the established grade line, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

Reinforce each concrete pipe joint with concrete as indicated on the drawings.

## 3.5 DRAINAGE STRUCTURES

### 3.5.1 Inlets

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

### 3.5.2 Headwalls

Construct cast-in-place headwalls to the dimensions indicated. Place pre-cast headwalls in the locations and line and grade indicated.

### 3.5.3 Mitered End Sections (MES)

Construct in accordance with the FDOT Design Standard requirements of Index No. 272 for the cross-drain culverts and Index No. 273 for the side drain culverts.

## 3.6 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be installed to provide at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

## 3.7 BACKFILLING

### 3.7.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in

compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation equal to the midpoint (spring line) of concrete pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the District and as a result of no over excavation or other avoidable wrong doing by the Contractor, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

### 3.7.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches.

### 3.7.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

### 3.7.4 Compaction

#### 3.7.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

#### 3.7.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.7.5 Flap Gate Installation

A. The Contractor shall install the flap gate(s) in accordance with the installation instructions and recommendations of the Manufacturer unless modified by the District.

B. The Contractor shall mount the frames and gates plumb in both vertical planes and level in horizontal plane.

C. The Contractor shall ensure that the installed gate provides sufficient separation between dissimilar materials which may promote corrosion, through the use of gaskets, coatings, or similar, where required.

3.8 FIELD QUALITY CONTROL

3.8.1 Tests

Testing is the responsibility of the Contractor. Perform all testing and retesting at no additional cost to the District

3.8.1.1 HYDROSTATIC TEST ON WATERTIGHT JOINTS

Watertight joints shall be tested and shall meet test requirements. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443. Certified copies of test results shall be delivered to the District before gaskets or jointing materials are installed.

A hydrostatic test shall be made on the watertight joint types as specified. Only one sample joint for each run of pipe of each type and size needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to ASTM C990 or ASTM C443. Submit hydrostatic test certifications.

3.8.1.2 Leakage Test

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate, prior to completing backfill. Low pressure air testing for concrete pipes shall conform to ASTM C969. Testing of individual joints for leakage by low pressure air or water shall conform

to ASTM C1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the District. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 250 gallons per inch in diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.

#### 3.8.1.3 Determination of Density

Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Perform a minimum of one (1) test per run of pipe. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D2167 or ASTM D6938. When ASTM D6938 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D6938 results in a wet unit weight of soil and ASTM D6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D6938. Test results shall be furnished to the District. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

#### 3.8.1.4 Deflection Testing

Conduct deflection test no sooner than 30 days after completion of final backfill and compaction testing. Clean or flush all lines prior to testing. Deflection of pipe in the installed pipeline under external loads shall not exceed limits in paragraph PLACING PIPE above as percent of the average inside diameter of pipe. Use a laser profiler to determine if allowable deflection has been exceeded.

##### 3.8.1.4.1 Laser Profiler

Inspect pipe interior with laser profiling equipment. Utilize low barrel distortion video equipment for pipe sizes 48 inches or less. Use a camera with suitable lighting to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally. The camera must be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the

camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll static or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe. For initial post installation inspections for pipe sizes larger than 48 inches, a visual inspection shall be completed of the pipe interior.

3.8.1.4.2 Warranty Period Test

Pipe found to have a deflection of greater than allowable deflection in paragraph PLACING PIPE above, just prior to end of one-year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection. Inspect 100 percent of all pipe systems under the travel lanes. Random inspections of the remaining pipe system outside of the travel lanes shall represent at least 10 percent of the total pipe footage of each pipe size. Inspections shall be made, depending on the pipe size, with video camera or visual observations.

3.9 INSPECTION

3.9.1 Post-Installation Inspection

Visually inspect each segment of concrete pipe for alignment, settlement, joint separations, soil migration through the joint, cracks, buckling, bulging and deflection. The District must evaluate all defects to determine if any remediation or repair is required.

3.9.1.1 Concrete

The District must evaluate all pipes with cracks with a width greater than 0.01 inches but less than 0.10 inches to determine if any remediation or repair is required.

3.9.1.2 Post-Installation Inspection Report

The deflection results and final post installation inspection report must include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, inspector notes, condition of joints, condition of pipe wall (e.g. distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

3.9.2 Repair of Defects

3.9.2.1 Leakage Test

When leakage exceeds the maximum amount specified, correct source of excess leakage by replacing damaged pipe and gaskets and retest.

3.9.2.2 Deflection Testing

When deflection readings are in excess of the allowable deflection of average inside diameter of pipe are obtained, remove pipe which has excessive deflection and replace with new pipe. Retest 30 days after completing backfill, leakage testing and compaction testing.

3.9.2.3 Inspection

Replace pipe or repair defects indicated in the Post-Installation Inspection Report.

3.9.2.3.1 Concrete

Replace pipes having cracks with a width greater than 0.1 inches.

3.9.3 Certification

Contractor shall submit pipeline testing certification certifying that the system meets specifications.

3.10 PROTECTION

Protect storm drainage piping and adjacent areas from superimposed and external loads during construction.

3.11 WARRANTY PERIOD

Pipe segments found to have defects during the warranty period must be replaced with new pipe and retested.

3.12 FLAP GATE TESTING

Fully assembled flap gates shall be shop inspected before shipping.

After installation, the Manufacturer shall field-test the gates in the presence of authorized representatives of the District. All field tests including but not limited to those specified herein shall be made at the expense of the Contractor:

1. The gates shall be inspected to ensure flap seats are properly installed against the frame.

2. Conduct operational tests as necessary to determine that the performance of equipment is as specified.

3. Test will generally consist of placing equipment in operation and observing performance.

4. Each gate shall be tested from the closed position to fully open position and back to the closed position at least twice and verify gate is properly seated.

5. Leakage Tests: Leakage shall not exceed 0.1 gpm/ft of wetted seal perimeter in seating head condition.

6. Make all necessary equipment adjustments and corrective Work indicated by tests.

The Contractor shall furnish the cost of reinstallation and retesting if field tests do not meet the above-mentioned specifications.

-- End of Section --

# SECTION 33 42 14

# CORRUGATED ALUMINUM-ALLOY PIPE AND RISER

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work: The Contractor shall furnish all labor, materials, and equipment for installation of the corrugated metal pipe and furnishing such appurtenances as may be required to complete the Work as indicated on the Drawings and as specified herein.

### 1.2 APPLICABLE PUBLICATIONS

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B361 | (2016) Standard Specification for Factory-Made Wrought Aluminum and Aluminum-Alloy Welding Fittings |
| ASTM B745/B745M | (2015) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains |
| ASTM B746 | (2016) Standard Specification for CORRUGATED ALUMINUM Alloy Structural Plate for Field-Bolted PIPE, PIPE-Arches, and Arches |
| ASTM B788 | (2014) Standard Practice for Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe |
| ASTM B789 | (2016) Standard Practice for Installing CORRUGATED ALUMINUM Structural Plate PIPE for Culverts and Sewers |
| ASTM B790 | (2012) Standard Practice for Structural Design of Corrugated Aluminum Pipe, Pipe-Arches, and Arches for Culverts, Storm Sewers, and Other Buried Conduits |
| ASTM B864 | (2013) Standard Specification for Corrugated Aluminum Box Culverts |
| ASTM D698 | (2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)) |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Constructions |
| FDOT 430 | Pipe Culverts and Storm Sewers |

| | |
|---|---|
| FDOT 945 | Aluminum Pipe, Including Underdrain, Pipe Arch and Structural Plate and Pipe Arch |

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M196 | Standard Specification for Corrugated Aluminum Pipe for Sewer and Drain |

1.3 DEFINITIONS

Not Used

1.4 SUBMITTALS

SD-02 Shop Drawings

Manufacturer's Shop Drawings

Culvert Installation Plan

SD-06 Test Reports

Laboratory Test Results

SD-07 Certificates

Manufacturer's Certification

SD-11 Closeout Submittals

Field Measured Cross-sections

1.5 SUBMITTAL REQUIREMENTS

A. The Contractor shall submit manufacturer's shop drawings and data for the culvert and riser.

B. The Contractor shall submit manufacturer's certification that corrugated aluminum-alloy pipe and riser meet the requirements of this specification and the Contract Drawing

C. The Contractor shall submit a culvert installation plan. The plan shall include at a minimum the following:

1. Details on the methods used to restrain the pipe to prevent floatation and movement during the installation of the backfill material, excavatable flowable fill.

2. Details on the placement of the flowable fill to include the number and thickness of individual lifts.

3. Calculations demonstrating that the culvert pipe restraint system is adequate to counteract the effects of floatation during the placement of the individual lifts of flowable fill

D. The Contractor shall submit laboratory test results on the materials proposed to be used (whether native or imported) as and Silica Filter Sand. At a minimum the laboratory testing shall include sieve analysis, organic content, USCS classification and modified proctor per ASTM D1557, as applicable. Prior to construction, the Contractor shall provide the source of each material proposed to be used.

1. Silica Filter Sand: Silica Filter Sand shall be in accordance with the General Characteristics for ASTM C-33 and the size gradation tabulated below.

| **SILICA FILTER SAND GRADATION LIMITS** | |
|---|---|
| **SIEVE SIZE** | **PERCENT PASSING (%)** |
| 3/8" [9.5 mm] | 100 |
| No. 4 [4.75 mm] | 95-100 |
| No. 8 [2.36 mm] | 80-100 |
| No. 16 [1.18 mm] | 50-96 |
| No. 30 [0.60 mm] | 25-60 |
| No. 50 [0.30 mm] | 5-30 |
| No. 100 [0.15 mm] | 0-10 |
| No. 200 [0.075 mm] | 0-2 |

2. The size gradation when tested at the supplier shall have a maximum fines (<#200 mesh) content of not more than 2%. The in-place compacted filter sand shall have a maximum fines content of not more than 5%. Testing of in-place filter sand may be required if there is reason to believe that the particle gradation was altered or contaminated during handling or placement.

E. The Contractor shall submit two (2) copies of field measured cross-sections at each design cross-section for record purposes for canal excavations. The submittal of the field measured cross-sections shall be signed and sealed by a Professional Surveyor and Mapper licensed in the State of Florida.

1.6 QUALIFICATIONS

Not Used

1.7 RESPONSIBILITIES

Not Used

1.8 CERTIFICATIONS AND TESTING

Not Used

1.9 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide the District at least 48 hours advance notice of its intention to begin new Work activities.

1.10 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 CORRUGATED ALUMINUM-ALLOY PIPE AND RISERS

The Contractor shall furnish corrugated aluminum-alloy pipe and risers as shown on the Drawings conforming to the requirements of ASTM B745 and FDOT Specification Section 945. Corrugated aluminum-alloy pipe and risers shall have a full circular cross section, with a single thickness of corrugated sheet, fabricated with helical corrugations. The pipe and risers shall be of aluminum-alloy sheet metal of the gauge specified in FDOT Specification Section 945. All pipe~~, coupling bands,~~ and risers shall have a bituminous coating where in contact with concrete or flowable fill per FDOT/AASHTO Specifications. The nominal diameter of the pipe shall be as stated on the Drawings and shall not vary more than one percent or one-half inch, whichever is greater, when measured on the inside crest of the corrugations. The dimensions of the riser shall be coordinated with the dimensions of the gate assembly furnished. Aluminum Pipe end sections and toe plate extensions shall conform to ASTM B745 and B789.

2.2 JOINTS

The Contractor shall continuously weld ~~the first section of the pipe to the riser.~~ all pipe joints per Section 05 50 14.

**Commented [MB1]:** Note to DP: New spec reference

~~2.3 COUPLING BANDS AND GASKETS~~

~~The Contractor shall provide pipe with coupling bands for joining pipe sections that meet the applicable requirements of FDOT Specification 430 and the following.~~

~~1. Each end of a pipe section that will be coupled to an adjacent pipe section shall have a 2 foot section of pipe with annular corrugations welded to the pipe end. The annular corrugations shall match the annular corrugations of the coupling band. Re-rolling of the end of the pipe to form the annular corrugations is not permitted.~~

~~2. Coupling bands shall be two-piece lap-type couplings with annular corrugations that match the corrugations of the pipe ends.~~

~~3. The coupling bands shall be two (2) feet in width minimum and constructed to lap an equal portion of each culvert section being joined.~~

4. All ~~banded connections~~joints shall be wrapped with two layers of filter fabric to extend a minimum of two feet past the ~~ends of the coupling band.~~ joint.

**Commented [MB2]:** Make this 2.2.1

~~The CONTRACTOR shall furnish gaskets of either neoprene continuous bands or O-ring type gaskets as specified in ASTM B745/B745M-97 and FDOT Section 430.~~

## 2.4 BEDDING MATERIAL

The Contractor shall furnish coarse sand or other granular bedding material approved by the District.

## 2.5 PIPE BACKFILL

The Contractor shall furnish pipe backfill as shown on the Drawings or as specified herein. Flowable fill shall be used from the bedding material up to the center line of the pipe. The Contractor shall adequately secure the pipe prior to placement of the flowable fill to avoid floatation.

# PART 3 EXECUTION

## 3.1 EXCAVATION

### 3.1.1 General

The Contractor shall perform all excavation of every description and of whatever substances encountered to the depths indicated on the Drawings, or as necessary. Excavation shall be unclassified regardless of material encountered.

This shall include all necessary clearing and grubbing of any foreign substances encountered within the structure or trench area. No separate payment for excavation as such will be made. The cost thereof shall be included in the prices for the pipe installation.

The Contractor shall stockpile excavated material suitable for backfill in an orderly manner at a sufficient distance from the trench to avoid overloading and to prevent slides or cave-ins. The Contractor shall perform excavation in accordance with the following:

1. Excavation in rock shall be made by a method accepted by the District.

2. All muck below pipes and structures shall be completely removed to the width of the trenches at the pipe center line and to the depths where sand or other acceptable material is encountered. After removal of all muck, the trench shall be filled to the invert of the pipe with select fill placed and tamped in not greater than eight-inch layers. Each layer shall be compacted to not less than 95 percent of the maximum density as determined by ASTM D698.

3. The Contractor shall dispose of the excavated materials not required or suitable for backfill, and shall perform such grading as may be necessary to prevent surface water from flowing into the trenches. Hauling or disposal of the material will be the responsibility of the CONTRACTOR. Sheeting and shoring shall be installed as may be necessary for the protection of the work, for the preservation of adjoining property and structures, and for the safety of the employees. Unless otherwise indicated, excavation shall be by open cut.

4. The Contractor shall provide adequate equipment for the removal of storm or subsurface waters that may accumulate in the excavated areas. If subsurface water is encountered, the CONTRACTOR shall utilize approved means to adequately dewater the excavation so that it will be dry for working and pipe laying. A wellpoint system or other approved

dewatering method shall be utilized, if necessary, to maintain the excavation in a dry condition for preparation of the trench bottom and for pipe laying. All existing improvements such as pavements, conduits, poles, pipes and other structures shall be carefully supported and fully protected from damage and, in case of damage; they shall be restored by the Contractor without compensation. Existing utilities and other underground obstructions are shown on the plans, but the accuracy of the locations and depths is not guaranteed. The Contractor shall be responsible for all utilities prior to the commencement of excavation. The Contractor shall be responsible for damages to these existing utilities and shall, in case they are damaged, restore them to their original condition.

3.1.2 Trench Excavation

The Contractor shall excavate trenches to such a width as is necessary for proper laying of the pipe with banks as nearly vertical as practicable, but at all times maintaining a safe trench condition for workers and the WORK. The bottom of trenches shall be accurately graded by the Contractor to provide uniform bearing on undisturbed soil for the entire length of each section of pipe. The trench may be as wide as necessary for sheeting and bracing and the proper performance of the work. Unauthorized over-excavation of the trench shall be backfilled by the Contractor at its sole cost with selected gravel and compact to obtain suitable bedding all as directed and to the satisfaction of the District. Whenever the presence of incipient slides is noted during excavation, the trench walls shall be restrained with adequate sheeting, shoring and bracing. Either steel or wood sheeting shall protect trench excavation in the proximity of certain existing sanitary sewers and other utility lines. Should used sheet pile be used, it will be the Contractor's responsibility to guarantee the integrity of the used sheet piles. A professional engineer retained by the Contractor shall certify the sheet pile used.

3.1.3 Removal of Rock

Where rock is encountered, the Contractor shall remove the rock and replace it with suitable selected materials as directed and to the satisfaction of the District. Select materials shall be placed in such manner as to provide a compacted earth cushion having a thickness under the pipe of not less than eight inches or one half inch per foot height of fill over the top of the pipe, whichever is greater.

3.1.4 Removal of Unsuitable Material

The Contractor shall provide all pipe and appurtenances with a stable foundation. Any material encountered at the elevation shown on the Drawings or specified for pipe that will not or cannot be improved to provide a stable foundation for the pipe, shall be considered unsuitable and removed and replaced by the Contractor. All unsuitable material below the grade line of the pipe shall be removed for the full width of the trench and replaced with suitable select material compacted as specified elsewhere in these specifications. For the purpose of this specification, muck, peat, other highly organic soils, and any other materials with high plasticity shall be considered to be unsuitable materials. Unless otherwise specifically approved by the District, any soil which is or might become wet to such a degree that its moisture content is equal to or greater than 90%

of its liquid limit will be considered unsuitable and shall removed and replaced with suitable material.

3.1.5 Bedding

The Contractor shall provide (native or imported) bedding material for the pipe that shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2 INSTALLATION OF PIPE

3.2.1 General

The Contractor shall install piping and appurtenances for storm sewers that are of the type and material specified in these specifications or on the Drawings. All pipe and other appurtenances and materials shall be new material to be included in the work and, if not specifically described herein, shall be of the best quality and entirely suitable for the service intended. The Contractor shall submit shop drawings and manufacturers' specifications for all such materials for the District's approval, prior to installation.

3.2.2 Handling and Storage

The Contractor shall protect the pipe during shipping, storage, handling, and installation against impact shocks, free fall or other damage. Any damaged pipe shall be removed from the job site immediately.

3.2.3 Pipe Laying

The Contractor shall execute pipe laying that meets the requirements of FDOT Specification 430 and as required and specified herein:

1. The trench shall be prepared as specified herein and each pipe section shall be laid in strict conformance to the line and grade shown on the Drawings.

2. As pipe laying progresses, the interior of the pipe shall be cleaned of all dirt and superfluous materials. The Contractor shall at all times take whatever measures are necessary to prevent the entrance of dirt and other foreign matter into the drainage system. In the event that it is necessary to clean the pipe before final acceptance, the Contractor shall do so without additional compensation.

3. Contractor shall prevent pipe buoyancy during installation.

3.2.4 Open Trench

The Contractor shall leave no more than 200 linear feet, or the length of the trench between consecutive drainage structures, open behind pipe laying, whichever distance is greater. In no instance shall any trench be left open for more than 24 hours before backfilling in accordance with these specifications.

## 3.3 BACKFILLING

### 3.3.1 Under Pipe

The Contractor shall take care to prevent pipe flotation movement during the placement of the flowable fill.

### 3.3.2 Over Pipe

From the centerline of the pipe, fittings and appurtenances, to an elevation one foot above the top of the pipe, the Contractor shall backfill the trench by hand or by approved mechanical methods. The backfill material shall be as indicated on the Drawings and as specified herein, and shall be compacted by use of tampers.

## 3.4 WATER CONTROL

Unless specifically authorized by the District, the Contractor shall lay all pipes in the dry, and the Contractor shall do such pumping as is required for proper execution of the work and to dispose of the water without damage or undue inconvenience of the work, the surrounding area or the public. The Contractor shall not dam, divert or cause water to flow in excess in existing gutters, pavements or other structures, and to this end may be required to conduct the water to a suitable place of discharge. Wellpoint system or other approved equipment shall be used to maintain excavations in a dry condition for pipe laying.

## 3.5 SILICA FILTER SAND

The Contractor shall place and compact silica filter sand to the limits shown on the Drawings. The silica filter sand shall be placed in 1-foot loose lifts and compacted to not less than 90% of maximum dry density per ASTM D698.

-- End of Section --

# SECTION 33 46 13

# FOUNDATION DRAINAGE SYSTEM

## PART 1 GENERAL

Related Sections include but are not necessarily limited to:

1. DIVISION 1 General Requirements
2. Section 01 33 003 SUBMITTAL PROCEDURES
3. Section 31 00 00 EARTHWORK
3. Section 31 25 13 SLOPE PROTECTION WITH SOIL CEMENT

### 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 FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM D2665 | Standard Specification for Poly Vinyl Chloride (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings |
| ASTM D1600 | Terminology for Abbreviated Terms Relating to Plastics |
| ASTM D1784 | Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D2122 | Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings |
| ASTM D2564 | Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM D3311 | Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns |
| ASTM D4396 | Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM F402 | Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings |

| | |
|---|---|
| ASTM F412 | Definitions of Terms Relating to Plastic Piping Systems |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT Section 901 | COARSE AGGREGATE |
| FDOT Section 902 | FINE AGGREGATE |

## 1.2 SYSTEM DESCRIPTION

### 1.2.1 Extent

Furnish and install dam foundation drainage piping and surrounding porous medium (filter, sand, etc.) as a complete system.

### 1.2.2 Outlet Connections

Foundation pipe shall be terminated as shown on the Drawings.

### 1.2.3 Drainage Lines

Construct drainage lines of slotted and/or perforated PVC pipe as shown on the Drawings.

### 1.2.4 Outlet Lines

Construct outlet lines of closed-joint nonperforated, nonporous pipe.

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Drain Pipe Installation Plan

Summary of Proof of Concept

SD-03 Product Data

Pipe Materials

Filter Sand Quality Data

No. 89 Stone Quality Data

SD-07 Certificates

Pipe Materials

## 1.4 DELIVERY, STORAGE, AND HANDLING

Protect materials placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Do not expose

plastic pipe to direct sunlight for more than 6 months from time of manufacturer to installation.

# PART 2 PRODUCTS

## 2.1 PIPE MATERIALS

Pipe for foundation drainage system shall be of the type and size indicated. Use appropriate transitions, adapters, or joint details where pipes of different types or materials are connected. Two randomly selected samples of pipe materials of each type of pipe and fitting, shall be submitted not less than two weeks prior to start of the work. The samples shall be accompanied by pipe material certificates from the manufacturers attesting that materials meet specification requirements.

### 2.1.1 PVC Pipe

#### 2.1.1.1 Materials

The pipe shall be made of virgin PVC compounds meeting or exceeding the requirements of Class 12454 as defined in ASTM D1784. The fittings shall be made of virgin PVC compounds meeting or exceeding the requirements of Class 12454 as defined in ASTM D1784 or Class 11432 as defined in ASTM D4396. The pipe and fittings shall be homogeneous throughout and essentially uniform in color, opacity, and density. The pipe walls shall be free of cracks, holes, foreign inclusions, and any other visible defects that may affect serviceability.

#### 2.1.1.2 Diameter and Schedule

Toe drain, Blanket drain and Underdrain collector pipes shall consist of 6 or 12-inch diameter, as indicated on the Drawings, Schedule 80 PVC pipe. Toe drain outlet pipes shall consist of solid Schedule 80 PVC pipe. Toe drain collection piping shall be either slotted with 0.020 inch slots, or perforated with 1/8-inch diameter perforations, as shown on the drawings.

### 2.1.2 Fittings

Fittings shall be of compatible materials for pipe, of corresponding weight and quality, and as specified herein. Close tolerances are required to insure satisfactory "interference" fit between the pipe and fitting during the solvent cement joining. Contractor shall use only pipe and fitting combinations that give interference fits to assure a forced fit when solvent is applied.

### 2.1.3 Solvent

The solvent cement used to join pipe and fittings shall meet the requirements of ASTM D2564. Discard cement that has thickened. Cement shall not be thinned.

### 2.1.4 Slotted Plastic Pipe

Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots shall be 0.020 inch. The water inlet area shall be at least 1.28 square inches per foot of pipe for 6 inch diameter tubing.

Rows of slots shall be symmetrically spaced so that they are fully contained in quadrants of the pipe. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the District.

2.1.5 Perforated Plastic Pipe

Toe drain pipe shall be perforated as shown on the drawings. Diameter of perforations shall be 1/8-inch. The water inlet area shall be at least 2.78 square inches per foot of pipe for 12 inch diameter tubing. Perforations shall be spaced 1 inch on center in a five dot pattern as shown on the drawings. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the District.

2.1.6 Cleanouts

Cleanout pipe and fittings and piping shall be PVC pipe. Each cleanout shall have a socket or raised head for wrench.

2.1.7 Check Valves

Contractor shall provide and affix Flap Gates or Duck Bill Valves on discharge piping as shown on the drawings.

2.2 AGGREGATE MATERIALS

Bedding and pervious backfill shall be coarse aggregate conforming to FDOT Section 901, size number 89 Stone, and silica based fine aggregate conforming to FDOT Section 902-4 Filter Sand (Types I through IV). Contractor shall submit Filter Sand Quality Data and No. 89 Stone Quality Data in the form of certified laboratory test results verifying that the materials meet the specification requirements.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Drain Pipe Installation Plan

The Contractor shall submit a Drain Pipe Installation Plan inclusive of the means and methods to be utilized for the work, quality control methods and engineering controls, a description of the communications protocols for pre-work meetings and inspections, and a summary of the progress reporting methods to be utilized during the work.

3.1.2 Summary of Proof of Concept

A written narrative with associated graphics as needed to summarize the means and methods utilized by the contractor for each aspect of the work, to achieve the quality objectives of the contract, and to document the work. Acceptance by the District of the Summary of Proof of Concept document shall be considered a necessary precedent to Notice to Proceed for the Work.

3.1.3 Trenching and Excavation

Perform required trenching and excavation in accordance with Section 31 00 00 EARTHWORK. Keep excavation bottoms dry during installation of drainage

system. Changes in direction of drain lines shall be made with 1/8 bends. Use wye fittings at intersections.

3.1.4 Filter Material

Place graded filter material, minimum 6 inches in depth, in the bottom of area shown on the Drawings for its full width and length compacted as specified prior to laying of foundation drain pipe. Each section shall rest firmly upon the filter material through the entire length, with recesses formed for bell joints. Except for recesses for bell joints, the bedding shall fully support the lower quadrant of the pipe.

3.1.5 Pipe Installation

PVC piping shall be installed in accordance with manufacturer's specifications and as specified herein. PVC piping with physical imperfections shall not be installed, and shall be removed from the project site.

Lay drainage piping to the lines and to =/- 0.05 feet of grade as shown on the Drawings. Bells of pipe sections shall face upgrade. Clean interior of pipe thoroughly before being laid. When drain lines are left open for connection to discharge lines, the open ends shall be temporarily closed and the location marked with wooden stakes. Any length that has had its grade or joints disturbed shall be removed and replaced at no additional cost to the District.

Position pipe and fittings so that identifying markings are readily visible to inspection when installed. Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent welded. Test drain lines with water to assure free flow before covering. Remove obstructions and retest until satisfactory. Place filter sand around drain pipes to depths and thickness shown on Drawings. Compact filter material with a hand operated vibrating plate to preclude settlement and to avoid damage to drain pipe. Within a horizontal distance of 2 feet of the drain pipes and over top of the filter sand, place Embankment fill in 6-inch lifts and compact with a hand led vibrating plate to a height of 2 feet above the top of the filter sand to preclude settlement and to avoid damage to the drain pipe.

3.1.6 Jointing

3.1.6.1 Cutting the Pipe

Cut the pipe square with saws or pipe cutters designed specifically for this material; protect pipe and fittings from serrated holding devices and abrasion.

3.1.6.2 Deburring Pipe

Remove burrs from inside and outside pipe edges.

3.1.6.3 Cleaning Joining Surfaces

Wipe off all dust, dirt, and moisture from surfaces to be cemented with a clean, dry rag or paper towel. Remove gloss and any oily film from the pipe

and couplers with clean steel wool, fine abrasive paper, chemical cleaner, primer, or as recommended by the manufacturer.

3.1.6.4 Application of Cement

Use a natural bristle or nylon brush of adequate size or an applicator supplied with the can of cement. Apply a moderate even coating of cement in the fitting socket completely covering the pipe joining surfaces only. Make sure that the coated distance on the pipe is equal to the depth of the fitting socket.

3.1.6.5 Assembly

Make the joint as quickly as possible after application of the cement and before the cement dries. Insert the pipe into the fitting socket turning the pipe slightly to ensure even distribution of cement. The pipe shall be inserted to the full depth of the socket. Remove excess solvent cement from the exterior of the joint with a clean, dry cloth.

3.1.6.6 Handling Pipe-Fitting Joint

Do not disturb the pipe-fitting joint until after the cement has set.

3.1.7 Cleanouts

Provide cleanouts in locations indicated. Cleanout locations shall be surveyed to provide horizontal location to nearest one foot, and elevation to nearest tenth of a foot. Contractor shall field mark and protect locations of cleanouts for the duration of the contract. Orient cleanouts in same direction for ease of maintenance.

3.2 BACKFILLING

After joints and connections have been inspected and approved, place the specified pervious backfill material adjacent to and 12 inches above the top of the pipe. Place the backfill preventing displacement of or injury to the pipe, and to prevent segregation of or contamination of filter materials. Compact backfill as specified in Section 31 00 00 EARTHWORK. Compaction of filter materials adjacent to piping shall be accomplished using hand led compactors only.

3.3 PROTECTION AND REPAIRS

Care shall be exercised during construction not to damage the pipe and fittings. Construction equipment shall not be allowed to pass over any pipe until a minimum of 3 feet of compacted fill is placed over the crown of the pipe. Exceptions to this are the toe drain beneath the slope protection system, whereby the Contractor shall determine and demonstrate the cover thickness and material placement and compaction equipment appropriate for that application. Any pipe section, fitting, or joint that becomes broken, cracked, crushed, cut, scratched, gouged, or otherwise rendered unsuitable, as determined by the District, shall be removed and replaced by the Contractor at no additional cost to the District.

## 3.4 QUALITY CONTROL INSPECTION AND TESTING

The Contractor is responsible for quality control, testing and documentation of quality for all aspects of the work. The Contractor shall allow the District access to the work areas at all times for inspection and quality assurance testing. The District will regularly inspect the pipe and fittings diameter, and filter materials for compliance with applicable ASTM standards, slot width and spacing, quality of workmanship of the slots, and composition of the filter materials. The DISTRICT will observe the installation of the pipe, joints and fittings for compliance with this specification. The Contractor shall sample and test gradation of filter materials at a frequency that provides at least one gradation per week per material type per installation crew.

-- End of Section --

# SECTION 33 71 02

# 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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO HB-17 | (2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges |

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 318M | (2014; ERTA 2015) Building Code Requirements for Structural Concrete & Commentary |
| ACI SP-66 | (2004) ACI Detailing Manual |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel |

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

| | |
|---|---|
| AEIC CS8 | (2013) Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A48/A48M | (2003; R 2012) Standard Specification for Gray Iron Castings |
| ASTM B1 | (2013) Standard Specification for Hard-Drawn Copper Wire |
| ASTM B231/B231M | (2012) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors |
| ASTM B3 | (2013) Standard Specification for Soft or Annealed Copper Wire |
| ASTM B400/B400M | (2008; E 2013) Standard Specification for Compact Round Concentric-Lay-Stranded Aluminum 1350 Conductor |

| | |
|---|---|
| ASTM B496 | (2016) Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors |
| ASTM B609/B609M | (2012; E 2015) Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical purposes |
| ASTM B8 | (2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM B800 | (2005; R 2011) Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers |
| ASTM B801 | (2016) Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation |
| ASTM C139 | (2014) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes |
| ASTM C309 | (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C32 | (2013) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale) |
| ASTM C478 | (2015a) Standard Specification for Precast Reinforced Concrete Manhole Sections |
| ASTM C478M | (2015a) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric) |
| ASTM C857 | (2014) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures |
| ASTM C990 | (2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM C990M | (2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric) |
| ASTM F2160 | (2010) Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD) |

| | |
|---|---|
| ASTM F512 | (2012) Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 386 | (2006; INT 1 2011) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V |
| IEEE 400.2 | (2013) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF) |
| IEEE 404 | (2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V |
| IEEE 48 | (2009) Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV |
| IEEE 495 | (2007) Guide for Testing Faulted Circuit Indicators |
| IEEE 81 | (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |
| IEEE C2 | (2017; Errata 1 2017) National Electrical Safety Code |
| IEEE C37.20.3 | (2013) Standard for Metal-Enclosed Interrupter Switchgear |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

| | |
|---|---|
| ICEA S-94-649 | (2013) Standard for Concentric Neutral Cables Rated 5 Through 46 KV |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C119.1 | (2011) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts |

| | |
|---|---|
| ANSI/NEMA WC 71/ICEA S-96-659 | (2014) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy |
| NEMA C119.4 | (2011) Electric Connectors - Connectors for Use Between Aluminum-to-Aluminum or Aluminum-to-Copper Conductors Designed for Normal Operation at or Below 93 Degrees C and Copper-to-Copper Conductors Designed for Normal Operation at or Below 100 Degrees C |
| NEMA RN 1 | (2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit |
| NEMA TC 2 | (2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit |
| NEMA TC 3 | (2016) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing |
| NEMA TC 6 & 8 | (2013) Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations |
| NEMA TC 7 | (2013) Standard for Smooth-Wall Coilable Electrical Polyethylene Conduit |
| NEMA TC 9 | (2004) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation |
| NEMA WC 70 | (2009) Power Cable Rated 2000 V or Less for the Distribution of Electrical Energy--S95-658 |
| NEMA WC 74/ICEA S-93-639 | (2012) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code |

SOCIETY OF CABLE TELECOMMUNICATIONS ENGINEERS (SCTE)

| | |
|---|---|
| ANSI/SCTE 77 | (2013) Specification for Underground Enclosure Integrity |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA-758 | (2012b) Customer-Owned Outside Plant Telecommunications Infrastructure Standard |

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| RUS Bull 1751F-644 | (2002) Underground Plant Construction |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-60005 | (Basic; Notice 2) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1072 | (2006; Reprint Jun 2013) Medium-Voltage Power Cables |
| UL 1242 | (2006; Reprint Mar 2014) Standard for Electrical Intermediate Metal Conduit -- Steel |
| UL 44 | (2014; Reprint Feb 2015) Thermoset-Insulated Wires and Cables |
| UL 467 | (2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment |
| UL 486A-486B | (2013; Reprint Jan 2016) Wire Connectors |
| UL 510 | (2005; Reprint Jul 2013) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape |
| UL 514A | (2013) Metallic Outlet Boxes |
| UL 514B | (2012; Reprint Nov 2014) Conduit, Tubing and Cable Fittings |
| UL 6 | (2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel |
| UL 651 | (2011; Reprint May 2014) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings |
| UL 83 | (2014) Thermoplastic-Insulated Wires and Cables |
| UL 854 | (2004; Reprint Nov 2014) Standard for Service-Entrance Cables |
| UL 94 | (2013; Reprint Mar 2016) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances |

## 1.2 SYSTEM DESCRIPTION

This section is intended to cover the low-voltage three-phase underground electrical distribution system on the load side of the utility metering point.

## 1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Conduit

Conductors and cables

~~Handhole~~ Pull box frames and covers

Composite/fiberglass ~~handholes~~pull boxes

Protective Devices and Coordination Study

Contractor Coordination and Sequencing

SD-06 Test Reports

a. Provide a conduit placement plan identifying the conduit locations and depths and as-built locations (VVH)for all conduits buried in the ground or cast in concrete.

SD-07 Certificates

Directional Boring Certificate of Conformance (if performed by EC)

## 1.5 QUALITY REQUIREMENTS

### 1.5.1 Directional Boring Certificate of Conformance

Provide certification of compliance with the registered Professional Engineer's design requirements for each directional bore, including: HDPE conduit size and type, bend radius, elevation changes, vertical and horizontal path deviations, conductor size and type and any conductor derating due to depth of conduit. Record location and depth of all directional-bore installed HDPE conduits using Global Positioning System (GPS) recording means with "resource grade" accuracy.

### 1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" 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 Construction Manager. Equipment, materials,

installation, and workmanship must be in accordance with the mandatory and advisory provisions of IEEE C2 and NFPA 70 unless more stringent Florida Power and Light (FPL) requirements are specified or indicated.

1.5.3 Standard Products

FPL ~~P~~provided materials and equipment ~~that are~~should be products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for 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 must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable, unless specified otherwise by FPL or the Construction Manager.

1.6 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS except for the FPL provided equipment and materials.

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

2.1.1 Rigid Metal Conduit

UL 6.

2.1.2 Intermediate Metal Conduit

UL 1242.

2.1.3 Plastic Conduit for Direct Burial and Riser Applications

UL 651 and NEMA TC 2, EPC-40 or EPC-80.

2.1.4 Plastic Duct for Concrete Encasement

Provide Type EB-20 or Type EB-35 per UL 651, ASTM F512, and NEMA TC 6 & 8 or Type EPC-40 per UL 651 and NEMA TC 2.

2.1.5 Duct Sealant

UL 94, Class HBF. Provide high-expansion urethane foam duct sealant that expands and hardens to form a closed, chemically and water resistant, rigid structure. Sealant must be compatible with common cable and wire jackets and capable of adhering to metals, plastics and concrete. Sealant must be capable of curing in temperature ranges of 35 degrees F to 95 degrees F. Cured sealant must withstand temperature ranges of -20 degrees F to 200 degrees F without loss of function.

2.1.6 Fittings

2.1.6.1 Metal Fittings

UL 514B.

2.1.6.2 PVC Conduit Fittings

UL 514B, UL 651 or NEMA TC 3.

2.1.6.3 PVC Duct Fittings

NEMA TC 9.

2.1.6.4 Outlet Boxes for Steel Conduit

Outlet boxes for use with rigid or flexible steel conduit must be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and must conform to UL 514A.

2.2 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES (CONTRACTOR)

Insulated conductors must be rated 600 volts and conform to the requirements of NFPA 70, including listing requirements, or in accordance with NEMA WC 70. Wires and cables manufactured more than 24 months prior to date of delivery to the site are not acceptable. Service entrance conductors must conform to UL 854, type USE.

2.2.1 Conductor Types

Cable and duct sizes indicated are for copper conductors and THHN/THWN unless otherwise noted. Conductors No. 10 AWG and smaller must be solid. Conductors No. 8 AWG and larger must be stranded. All conductors must be copper.

2.2.2 Conductor Material

Unless specified or indicated otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt, Type THWN/THHN conforming to UL 83. Copper conductors must be annealed copper complying with ASTM B3 and ASTM B8.

2.2.3 Jackets

Multiconductor cables must have an overall PVC outer jacket.

2.2.4 Direct Buried

Single-conductor and multi-conductor cables must be of a type identified for direct burial.

2.2.5 In Duct

Power ~~C~~cables must be single-conductor cable. ~~Cables in factory-installed, coilable-plastic-duct assemblies must conform to NEMA TC 7.~~Control cables may have multiple conductors as required.

2.2.6 Cable Marking

Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length.

Identify each cable by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag must contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

Conductors must be color coded. Provide conductor identification within each enclosure where a tap, splice, or termination is made. Conductor identification must be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, heat shrink type sleeves, or colored electrical tape. Control circuit terminations must be properly identified. Color must be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals must be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems must be as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

~~c. 120/240 volt, single phase: Black and red~~

~~d. On three-phase, four-wire delta system, high leg must be orange, as required by NFPA 70.~~

## 2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS (CONTRACTOR)

Must provide a uniform compression over the entire conductor contact surface. Use solderless terminal lugs on stranded conductors.

a. For use with copper conductors: UL 486A-486B.

b. For use with aluminum conductors: UL 486A-486B. For connecting aluminum to copper, connectors must be the circumferentially compressed, metallurgically bonded type.

## 2.4 LOW VOLTAGE SPLICES (CONTRACTOR)

Provide splices in conductors with a compression connector on the conductor and by insulating and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

### 2.4.1 Heat Shrinkable Splice

Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material applied in accordance with the manufacturer's written instructions.

### 2.4.2 Cold Shrink Rubber Splice

Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation must not require heat or flame, or any additional materials such as covering or adhesive. It must be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

## 2.5 TAPE (CONTRACTOR)

### 2.5.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

### 2.5.2 Buried Warning and Identification Tape

Provide detectable tape in accordance with Section 31 00 00 EARTHWORK.

## 2.6 PULL ROPE (CONTRACTOR)

Plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

## 2.7 GROUNDING AND BONDING

### 2.7.1 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than ~~3/4~~5/8 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.

### 2.7.2 Grounding Conductors

Stranded-bare copper conductors must conform to ASTM B8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors must conform to ASTM B1 for sizes No. 8 and smaller. Insulated conductors must be of the same material as phase conductors and green color-coded, except that conductors must be rated no more than 600 volts. Aluminum is not acceptable.

## 2.8 CAST-IN-PLACE CONCRETE (CONTRACTOR)

Provide concrete in accordance with Section 03 31 01.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS. In addition, provide concrete for encasement of underground ducts with 3000 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts must be 4000 psi minimum 28-day compressive strength unless specified otherwise.

## 2.9 UNDERGROUND STRUCTURES (FPL AND CONTRACTOR)

### 2.9.1 ~~Handhole~~ Pull Box Frames and Covers

Frames and covers of steel must be welded by qualified welders in accordance with standard commercial practice. Steel covers must be rolled-steel floor plate having an approved antislip surface. Hinges (if determined to be required by the District) must be of stainless steel with bronze hinge pin, 5 by 5 inches by approximately 3/16 inch, without screw holes, and must be for full surface application by fillet welding. Hinges must have nonremovable pins and five knuckles. The surfaces of plates under hinges must be true after the removal of raised antislip surface, by grinding or other approved method.

### 2.9.2 Composite/Fiberglass ~~Handholes~~Pull Boxes and Covers

ANSI/SCTE 77. Provide ~~handholes~~pull boxes and covers of polymer concrete, reinforced with heavy weave fiberglass with a design load (Tier rating) appropriate for or greater than the intended use. All covers are required to have the Tier level rating embossed on the surface and this rating must not exceed the design load of the box. Steel covers with supportive boxes will be required in travel areas for heavy vehicles.

## 2.10 CABLE TAGS

### 2.10.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. 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 pounds. The cable tags must have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags' orientation.

2.10.2 Protective Devices and Coordination Study (CONTRACTOR)

The Contractor provided Protective Devices and Coordination Study must be submitted with protective device equipment submittals. The Study must follow the guidance provided in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION. No time extension or similar contract modifications will be granted for work arising out of the requirements for this Study. Approval of protective devices proposed must be based on recomme3ndations of this study. The District must not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered or procured prior to approval of the study.

PART 3 EXECUTION LOW VOLTAGE SYSTEM

3.1 INSTALLATION LOW VOLTAGE

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. In addition to these requirements, install telecommunications in accordance with TIA-758 and RUS Bull 1751F-644.

3.2 CABLE INSPECTION LOW VOLTABE

Inspect each cable reel for correct storage positions, signs of physical damage, and broken end seals prior to installation. If end seal is broken, remove moisture from cable prior to installation in accordance with the cable manufacturer's recommendations.

3.3 UNDERGROUND CONDUITS SUPPLYING AND LEAVING BUILDINGS

Terminate underground feeders supplying building at a point 5 feet outside the building and projections thereof, except that conductors must be continuous to the terminating point indicated. Coordinate connections of the feeders to the service entrance equipment with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide PVC, Type EPC-40 conduit from the supply equipment to a point 5 feet outside the building and projections thereof. Protect ends of underground conduit with plastic plugs until connections are made.

3.4 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 must 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 must conform to ASTM C309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures must fit the frames without undue play. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets.

### 3.4.1 Field Painting

Cast-iron frames and covers not buried in concrete or masonry must be cleaned of mortar, rust, grease, dirt and other deleterious materials, and given a coat of bituminous paint.

## 3.5 UNDERGROUND CONDUIT AND DUCT SYSTEMS (CONTRACTOR MATERIAL And FPL material with CONTRACTOR labor)

### 3.5.1 Requirements

Run conduit in straight lines except where a change of direction is necessary. Provide numbers and sizes of ducts as indicated. ~~Provide a 4/0 AWG bare copper grounding conductor above medium-voltage distribution duct banks.~~ Bond bare copper grounding conductor to ground rings (loops) in all ~~manholes~~ pull boxes and to ground rings (loops) at all equipment slabs (pads). ~~Route grounding conductor into manholes with the duct bank (sleeving is not required). Ducts must 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~~,~~ or ~~a manhole,~~ a ~~handhole~~pull box~~, or between manholes or handholes~~. Provide ducts with end bells whenever duct lines terminate in structures.

Perform changes in ductbank direction as follows:

a. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable.

b. The minimum manufactured bend radius must be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter.

c. As an exception to the bend radius required above, provide field manufactured longsweep bends having a minimum radius of 25 feet for a change of direction of more than 5 degrees, either horizontally or vertically, using a combination of curved and straight sections. Maximum manufactured curved sections: 30 degrees.

### 3.5.2 Treatment

Ducts must be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers must be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer must be used whenever an existing duct is connected to a duct of different material or shape. Ducts must be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts must be thoroughly cleaned before being laid. Plastic ducts must be stored on a flat surface and protected from the direct rays of the sun.

### 3.5.3 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. For conduit sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

### 3.5.4 Galvanized Conduit Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations must be PVC coated and must extend from at least 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of 6 inches from penetration).

### 3.5.5 Multiple Conduits

Separate multiple conduits by a minimum distance of ~~3~~ 2 inches, except that light and power conduits must be separated from control, signal, and telephone conduits by a minimum distance of 12 inches. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly must 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.

### 3.5.6 Conduit Plugs and Pull Rope

New conduit indicated as being unused or empty must be provided with plugs on each end. Plugs must 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.

### 3.5.7 Conduit and Duct Without Concrete Encasement

Depths to top of the conduit must be not less than 24 inches below finished grade. Provide not less than 3 inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 1/4 inch sieve. The first 6 inch layer of backfill cover must be sand compacted as previously specified. The rest of the excavation must be backfilled and compacted in 3 to 6 inch layers. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

#### 3.5.7.1 Encasement Under Roads and Structures

Under roads, paved areas, install conduits in concrete encasement of rectangular cross-section providing a minimum of 3 inch concrete cover around ducts. Concrete encasement must extend at least 5 feet beyond the edges of paved areas and roads, and 12 feet beyond the rails on each side of railroad tracks. Depths to top of the concrete envelope must be not less than 24 inches below finished grade.

#### 3.5.7.2 Directional Boring (FPL MATERIAL WITH CONTRACTOR LABOR)

HDPE conduits must be installed below the frostline and as specified herein.

For distribution voltages greater than 1000 volts and less than 34,500 volts, depths to the top of the conduit must not be less than 48 inches in pavement-covered areas and not less than 120 inches in non-pavement-covered areas. For distribution voltages less than 1000 volts, depths to the top of the conduit must not be less than 48 inches in pavement- or non-pavement-covered areas. For branch circuit wiring less than 600 volts, depths to the top of the conduit must not be less than 24 inches in pavement- or non-pavement-covered areas.

3.5.8 Duct Encased in Concrete

| COVER | UNREINFORCED | REINFORCED* |
|---|---|---|
| > 18 in and < 48 in | Undeveloped areas. | Transition from good to poor soil conditions where differential settlement is anticipated. |
| > 24 in and < 48 in | Roads/paved areas for light to moderate traffic loads. | Other roads/paved areas (i.e. supporting trucks, cranes, ultra-heavy loads.) |

Construct underground duct lines of individual conduits encased in concrete. Depths to top of the concrete envelope must be not less than 18 inches below finished grade, except under roads and pavement, concrete envelope must be not less than 24 inches below finished grade. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank must be rectangular in cross-section and must provide at least ~~3~~ 2 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of ~~3~~ 2 inches. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring. Anchoring must be done by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.6 GROUNDING SYSTEMS

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 25 ohms.

3.6.1 GROUNDING ELECTRODES SYSTEMS

Provide cone pointed driven ground rods driven full depth plus 12 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 must 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, notify the Construction Manager immediately.

3.6.2 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 must be as recommended by the manufacturer. An embossing die code or other standard method must provide visible indication that a connector has been adequately compressed on the ground wire.

3.6.3 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. Use a No. 2/0 for the ground rings and other sizes as indicated on drawings.

3.6.4 Fence Grounding

Provide grounding for fences as indicated. 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 must be bonded to its gatepost by a 1/8 by 1 inch flexible braided copper strap and ground post clamps. Clamps must be of the anti-electrolysis type.

3.7 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70 and Section 31 00 00 EARTHWORK.

3.7.1 Reconditioning of Surfaces

3.7.1.1 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. Provide work in accordance with Section 32 92 19 SEEDING.

3.7.1.2 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.

3.8 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 31 01.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS.

3.8.1 Concrete Slabs (Pads) for Equipment

Unless otherwise indicated, the slab must 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. Slab must be placed on a 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 4 inches above finished grade with gradual slope for drainage. Edges above grade must have 1/2 inch chamfer. Slab must 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.

3.8.2 Sealing

When the installation is complete, seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.9 FIELD QUALITY CONTROL

3.9.1 Performance of Field 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.

3.9.1.1 Low Voltage Cables, 600-Volt

Perform tests after installation of cable, splices and terminations and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Verify tightness of accessible bolted electrical connections.

(4) Inspect compression-applied connectors for correct cable match and indentation.

(5) Visually inspect jacket and insulation condition.

(6) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 1000 volts dc for one minute.

(2) Perform continuity tests to insure correct cable connection.

3.9.1.2 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE 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 ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must 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. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.9.2 Follow-Up Verification

Upon completion of acceptance checks and tests, 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 District must be given 5 working days advance notice of the dates and times of checking and testing.

## 3.10 CONTRACTOR COORDINATION AND SEQUENCING REQUIREMENTS

### 3.10.1 Pickup of FPL Material

Contractor is responsible for pickup of all FPL provided material from a service center and time designated by FPL.

### 3.10.2 Delivery and Storage of FPL Material

Contractor will assume responsibility for the safe delivery and on-site storage of this FPL material until the Contractor’s installation is approved and accepted by FPL representative in writing.

### 3.10.3 Sequencing of Construction Activities

Contactor shall develop a schedule of available trenching locations where the FPL conduits and pull boxes can be installed without creating future conflict with other trenching activities in the same area. Contractor and FPL to determine the best timing for delivery and on-site storage of the FPL material.

-- End of Section --

# SECTION 35 01 70.13

# WIRE ROPE FOR GATE OPERATING 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.

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (2014) Safety and Health Requirements Manual |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS RR-C-271D | Chains and Attachments, Welded and Weldness |
| FS RR-S-550D | Sockets, Wire Rope |
| FS RR-W-410D | (Rev H) Wire Rope and Strand |

WIRE ROPE TECHNICAL BOARD (WRTB)

| | |
|---|---|
| WRTB | (2005) Wire Rope Users Manual |

### 1.2 SYSTEM DESCRIPTION

#### 1.2.1 Wire Rope Safety Plan

The work area, conditions of work area(s), and type of work required can create considerable potential for accidents. Submit a safety plan indicating how accidents will be prevented. Include in the safety plan details of how the wire rope will be handled and installed to minimize the risk to personnel. Perform work in accordance with EM 385-1-1. Include the safety provisions of this section in the safety plan required by Section 01 35 26 SAFETY REQUIREMENTS.

### 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications

Supervisor's Qualifications

SD-02 Shop Drawings

End Terminations

SD-03 Product Data

Lubrication

Pre-Stretching

SD-06 Test Reports

Tension Testing

Wire Strength and Ductility

Pre-Forming

Stress Relief "(Wrapping Test)"

End Terminations

SD-07 Certificates

Warranty

Type of Wire Rope

Tension Testing Equipment

## 1.4 SUPERVISOR'S QUALIFICATIONS

Submit the supervisor's experience in the installation of wire rope. The supervisor must have performed work similar to that required in this contract on at least three separate occasions. The supervisor must be on site at all times when wire rope is being delivered, stored, un-reeled, during testing, installation, and after installation testing. Submit the Contractor's Installation Supervisor's experience record before work at the site may begin.

## 1.5 DELIVERY, STORAGE, AND HANDLING

### 1.5.1 General

The work and storage areas are as indicated on Drawing. Wind the wire ropes on spools in the same direction as they were bent during manufacturing. Cover the coils or spools for protection from rain, snow, and/or road spatter during shipping.

### 1.5.2 Inspection on Delivery

Upon delivery to the work or storage area, inspect the wire ropes in the presence of the District. Inspect the wire rope for dings, kinks or other damage. Unreel the wire ropes from spool to spool to allow complete inspection of the wire ropes over their entire length. Perform the unreeling/reeling operation, and furnish extra spools or any other equipment required. Upon completion of the inspection, furnish the Contracting Officer with a written report of the results.

1.5.3 Storage

After delivery, store the wire ropes in well ventilated enclosures in the storage area and protect from the elements.

1.6 ENVIRONMENT PRECAUTIONS

Take special care to prevent any materials of any type falling into or contaminating waters surrounding the work site. Immediately notify the Contracting Officer if materials fall into or contaminate waters.

1.7 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 WIRE ROPE AND SOCKETS

Provide wire rope and sockets which are the standard product of a manufacturer regularly engaged in the manufacture of wire rope, and that essentially duplicate products having been in satisfactory use for at least 5 years prior to bid opening. Submit manufacturer's qualifications statement.

2.1.1 Quantity

Furnish wire ropes at both ends. Wind the wire rope on reels in lengths such that a sufficient length of wire rope is available for use, as splicing will not be allowed.

2.1.2 Type of Wire Rope

The wire rope must be of the following type:

2.1.2.1 Strand Configuration

6X37 Warrington Seale

2.1.2.2 Lay

Right, regular and Left, regular

2.1.2.3 Diameter

Rope shall be one 1-1/2 inch diameter minimum with a tolerance of minus and plus 5 percent. Increase rope diameter as required to meet minimum breaking strength specified under this Section.

2.1.2.4 Finish

Plain

2.1.2.5 Minimum Breaking Strength

For rated hoist capacity, tension in the wire ropes shall not exceed 20 percent of the breaking strength of the rope, and for stalled conditions it shall not exceed 70 percent of the breaking strength.

2.1.2.6 Material

AISI 302 stainless or AISI 304 stainless, having a nominal analysis of 18% chromium and 8% nickel.

2.1.2.7 Core Type

Independent wire rope core

2.1.2.8 Pre-Formed

Yes

2.1.3 Pre-Stretching

Submit Pre-Stretching Procedure. Pre-stretch the wire ropes before attaching their end terminations. This is done by subjecting them to three cycles at 40 percent of its nominal strength. Hold the 40 percent loads for 5 minutes with 5 percent loads for 5 minutes between cycles. A method of dynamic pre-stretching may be proposed.

2.1.4 Wire Strength and Ductility

Perform testing in accordance with FS RR-W-410D to verify wire strength and ductility. Submit test results.

2.1.5 Pre-forming

Provide pre-formed wire rope, and perform testing in accordance with FS RR-W-410D to verify pre-forming. Submit test results.

2.1.6 Stress Relief "(Wrapping Test)"

Stress relieve the wire rope, and perform testing in accordance with FS RR-W-410D to verify stress relief. Submit test results.

2.1.7 Weld Distribution

Wire joints in any strand must not be closer than 18 inches in any strand.

2.1.8 Strand Pitch Length

Not be less than 4-1/2 times the nominal rope diameter.

2.1.9 Core Strand Wires

The number of wires in the core strand must be equal to or greater than the number of wires in the other strands. Use the same material as the wires in the other strands, or use a material with a lower tensile strength.

### 2.1.10 Wire Rope and Fittings

Furnish two 1-inch wire rope dogging slings for each gate, complete with end fittings and pins. End termination for the dogging slings shall consist of forged steel grooved spelter sockets and pins rated for use with IWRC wire rope conforming to FS RR-S-550D, B. Rope shall conform to FS RR-W-410D Type 304 stainless, Class 3.

Provide forged bolt-type anchor shackles to attach the upper block to the eye-bolt and the lower block to the gate. The shackles shall conform to FS RR-C-271D.

All fittings shall be proof tested and rated to develop the full strength of the wire rope conforming to FS RR-C-271D and shall be made up in accordance with the Fitting Manufacturers recommendations.

All rope fittings not otherwise specified shall be of stainless steel.

### 2.1.11 End Terminations

Submit shop fabrication drawings, as specified. The wire rope end terminations must be an open spelter socket type with poured zinc or epoxy resin. Spelter sockets must be forged steel grooved.

### 2.1.12 Tension Testing

Submit rope tension test report. Perform a tension test to verify the wire rope meets the accepted industry standards for nominal strength. Test two rope samples to failure to be sure the expected performance level has been met. Perform the test using suitable tension testing equipment and by qualified personnel. Submit certification of rope tension testing device. Cut the rope samples to no less than 3 feet of length. The test will not be considered valid if the failure occurs less than 2 inches from either socket or holding mechanism. Relative speed between the machine heads must not exceed 1 inch per minute.

## 2.2 LUBRICATION

Submit manufacturer's literature for factory and field lubricant. The field and factory lubricants must be compatible. Lubricate the wire ropes at the manufacturing facility. Apply the lubricant with equipment capable of forcing the lubricant between the rope wires, including the center strand. The Contractor shall ensure that the lubrication points are accessible by District O&M staff. If the lubrication points are not accessible in routine access areas (i.e., a catwalk) the Contractor shall add hose extensions, accordingly.

# PART 3 EXECUTION

## 3.1 EXAMINATION

It is highly recommended that bidders visit the site before submitting bids. Drawings and verbal descriptions cannot fully describe the effort required to satisfactorily complete the contract work.

### 3.1.1 QA Inspections

Up to two representatives of the District will be present to witness the various manufacturing processes for the wire rope. At a minimum, a site visit will be made to witness the tension test, and the wire rope will be inspected upon delivery.

### 3.1.2 Verify Dimensions

After becoming familiar with the details of the work, verify dimensions in the field, and immediately advise the Contracting Officer of any discrepancies before performing any work.

## 3.2 ATTACHING SOCKETS

Attach the end terminations to the wire rope recommended by WRTB.

## 3.3 CLEAN DRUMS AND SHEAVES

Clean all drum and sheave grooves with a power wire brush, and inspect them for wear, abrasion, corrosion or other roughness and verify their dimensions are suitable for the new wire rope. Immediately advise the Contracting Officer of any problems.

## 3.4 LUBRICATION

Lubricate the wire ropes after they are installed, but before break-in/testing. Submit the proposed method in the work plan.

## 3.5 UN-REELING AND INSTALLING WIRE ROPE

Attach the wire rope(s) to spools or pulleys as indicated. Wind the wire rope under adequate tension and guide the each end of the rope(s) to its proper location. Wind the wire rope in the same direction it was bent during its manufacture. Ensure that no twists or loops occur. Do not install wire rope damaged during installation by kinking, and remove from the site. Submit the proposed method of un-reeling and installing in the work plan.

## 3.6 FIELD TENSIONING MULTI-LINE HOISTS

Adjust the wire rope tension of multi-line hoists to ensure that they share load equally. Submit the proposed field tensioning method in the work plan. For each multi-line hoist rope drum, final tension values for each rope must be no more than plus or minus 5 percent from the average of the individual rope tension values. For two multi-line hoists on a gate, the total wire rope load on each hoist is computed by summing the measured tension values for all wire ropes on a hoist. The total wire rope load on each hoist must be within a range less than or equal to 0.5 percent of the average of the two total wire rope loads. Measure and adjust wire rope tensions while keeping the gate properly positioned and aligned. After "break-in/testing" test the ropes to determine if they share load equally, and if not, re-tension.

## 3.7 BREAK-IN/TESTING

After installation is complete, run the gate-operating device through four complete cycles, fully open to fully closed.

## 3.8 ORDERLY WORK AREA/SITE CLEANUP

Maintain neat and orderly storage and work areas. The Contract will not be considered complete until all the tools, equipment and property have been removed from the site, and the storage and work areas have been restored. Remove all dirt, debris, litter etc. from project and dispose of in a proper manner.

-- End of Section --

# SECTION 35 20 14

# BULKHEADS AND STOPLOGS

## PART 1 GENERAL

Four sets of carbon steel (horizontal) bulkheads shall be provided as indicated on the structural drawings and in paragraph STOPLOG/BULKHEAD SCHEDULE. Two sets of aluminum (horizontal) stoplogs shall be provided as indicated on the mechanical drawings and in paragraph STOPLOG/BULKHEAD SCHEDULE.

### 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 A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A307 | (2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A325 | (2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A36/A36M | (2014) Standard Specification for Carbon Structural Steel |
| ASTM A490 | (2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength |
| ASTM D2240 | (2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness |
| ASTM D395 | (2016; E 2017) Standard Test Methods for Rubber Property - Compression Set |
| ASTM D412 | (2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension |
| ASTM D471 | (2016a) Standard Test Method for Rubber Property - Effect of Liquids |
| ASTM D572 | (2004; R 2010) Rubber Deterioration by Heat and Oxygen |

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Sequencing and Scheduling

Welding

Materials

Identification System

SD-05 Design Data

Design data and engineering calculations for stoplogs and bulkheads

SD-06 Test Reports

Tests, Inspections, and Verifications

SD-07 Leakage Test Reports

Leakage Test Reports

## 1.3 QUALIFICATION OF WELDERS AND WELDING OPERATORS

Qualification of welders and welding operators shall conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Delivery, handling and storage of materials and fabricated items shall conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

### 1.4.1 Rubber Seals

Store rubber seals in a place which permits free circulation of air, maintains a temperature of 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Rubber seals shall be kept free of oils, grease, and other materials which would deteriorate the rubber. Rubber seals shall not be distorted during handling.

### 1.4.2 Identification System

Submit an Identification System which shows the disposition of specific lots of approved materials and fabricated items in the work, before completion of the contract.

## 1.5 PERFORMANCE REQUIREMENTS

### 1.5.1 Stoplogs and Bulkheads

Stoplogs and bulkheads shall be suitable to withstand the maximum seating head with a deflection less than 1/360 of the span, under the maximum design head.

Maximum allowable leakage of stoplogs shall not exceed 0.10 gallons per minute per foot of wetted perimeter.

No water shall be allowed to intrude into the interior of the log.

Stoplogs and bulkheads shall be of sufficient weight to be submerged under their own weight and shall be able to be installed during free flow at maximum head conditions.

### 1.5.2 Lifting Device

Build the lifting beam in such a manner as to automatically latch on the stoplogs when lowered into the guide frame.

Build the lifting beam in such a manner as to automatically latch on the bulkheads when lowered into the guide frame.

## 1.6 QUALITY CONTROL

Equipment shall be the latest design of a manufacturer engaged in the production of equipment of this type.

Frames, logs, bulkheads, and beams shall be by one manufacturer.

# PART 2 PRODUCTS

## 2.1 MINIMUM QUALIFICATIONS AND EXPERIENCE

A. The Manufacturer must possess, in order to be eligible for award of this work, either of the following certifications: ISO 9000 (2000) or AISC certification standard for Steel Building Structures. All work shall be done in a fixed shop, enclosed or covered. A copy of proof of this certification must accompany the quote sheet. If not supplied with the quote sheet, the quote shall be deemed non-responsive.

B. The bulkhead and stoplog systems shall be the product of a Manufacturer regularly engaged in the design and fabrication of such systems. The Manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past ten years. In addition the Manufacturer shall have supplied a minimum of two (2) bulkheads and stoplogs comparable to those required for this project within the last ten years. Proof of experience shall be submitted with the bid listing representative bulkheads and stoplogs designed and manufactured over the last ten years. Listing shall include size of bulkhead and stoplogs, operating head, materials, year of manufacture, and contact name and phone number of gate Owner.

C. Manufacturer's Design Responsibility - The bulkhead and stoplog Manufacturer shall be responsible for the design of a complete and

operational system to meet the performance requirements indicated on the Drawings and Specified herein:

1. The details included in the Drawings are to establish the Basis of Design for the system to be provided. The Basis of Design represents the minimum requirements that shall be provided. Deviation from these details shall only be considered by the District if the Manufacturer's design dictates such change is necessary to comply with the design requirements of the system or standard recognized industry practice, codes, or standards. Sufficient supporting documentation, including calculations, shall be provided for review and approval by the District.

2. If the systems proposed which require modifications to the Basis of Design, then Contractor shall include in the lump sum bid all modifications, including structural, electrical, and mechanical modifications, and accessories as required to provide a complete and operational system.

3. Calculations and design drawings shall be signed and sealed by a Professional Engineer in the State of Florida and submitted along with other Design Data and Engineering Calculations for stoplogs and bulkheads.

## 2.2 MATERIALS

Materials orders, materials lists and materials shipping bills shall conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

### 2.2.1 Metals

Structural steel, structural aluminum, and other metal materials sections and standard articles shall be as shown and as specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

#### 2.2.1.1 Structural Steel

Structural steel shall conform to ASTM A36/A36M.

#### 2.2.1.2 Structural Aluminum

Structural aluminum shall conform to Alloy 6061, Temper T6.

### 2.2.2 Rubber Seals

#### 2.2.2.1 General Requirements

Rubber seals shall be compounded of natural rubber, synthetic polyisoprene, or a blend of both, and shall contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers. Physical characteristics of the seals shall meet the following requirements:

| PHYSICAL TEST | TEST VALUE | TEST METHOD SPECIFICATION |
|---|---|---|
| Tensile Strength | 2,500 psi (min.) | ASTM D412 |
| Elongation at Break | 450 percent (min.) | ASTM D412 |
| 300 percent Modulus | 900 psi (min.) | ASTM D412 |
| Durometer Hardness (Shore Type A) | 60 to 70 | ASTM D2240 |
| *Water Absorption | 5 percent by weight (max.) | ASTM D471 |
| Compression Set | 30 percent (max.) | ASTM D395 |
| Tensile Strength (after aging 48 hrs) | 80 percent tensile strength (min.) | ASTM D572 |

The "Water Absorption" test shall be performed with distilled water. The washed specimen shall be blotted dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees plus/minus 2 degrees C for 22 plus/minus 1/4 hour. The specimen shall be removed, allowed to cool to room temperature in air, and weighed. The weight shall be recorded to the nearest 1 mg as W1 (W1 is defined in ASTM D471). The immersion temperature shall be 70 degrees plus/minus 1 degree C and the duration of immersion shall be 166 hours.

## 2.3 MANUFACTURED UNITS

Bolts, nuts, washers, screws and other manufactured units shall conform to the requirements specified and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

### 2.3.1 Bolts, Nuts and Washers

High-strength bolts, nuts, and washers shall conform to ASTM A325, Type 1, hot-dip galvanized or ASTM A490, Type 1. Bolts, nuts, studs, stud bolts and bolting materials other than high-strength shall conform to ASTM A307, Grade A, hot-dip galvanized. Bolts 1/2 inch and larger shall have hexagon heads. The finished shank of bolts shall be long enough to provide full bearing. Washers for use with bolts shall conform to the requirements specified in the applicable specification for bolts.

### 2.3.2 Screws

Screws shall be of the type indicated.

### 2.3.3 Clips and Clip Bolts for Aluminum or Steel Panels

Clips and clip bolts for aluminum or steel panels shall be approved standard manufactured stock items.

## 2.4 LIFTING DEVICE

The lifting device shall be provided to remove and install the stoplog or bulkhead plank as specified herein. The lifting device shall be equipped with a suitable eye bolt for portable crane operation. The device shall be oriented in its position by the stoplog or bulkhead plank guides and shall be capable of securing and releasing the stoplogs or bulkheads after placement. Lifting pins shall be Type 316 stainless steel. Lifting beam

shall be carbon steel. Hooks and other hardware shall be Type 304 stainless steel.

## 2.5 LIFTING LUGS

Lifting lugs for bulkheads shall be manufactured of ASTM A36 steel. Lifting lugs for stoplogs shall be manufactured of aluminum Alloy 6061, Temper T6. Two lifting lugs shall be provided for each stoplog and bulkhead. Lifting lugs shall be capable of withstanding the lifting load necessary to remove the stoplog plank under the design head and shall be tested during the trial operation.

## 2.6 FABRICATION

### 2.6.1 Detail Drawings

Detail drawings of bulkheads and stoplogs and appurtenant shop fabricated items, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, shall conform to the requirements specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

#### 2.6.1.1 Fabrication Drawings

Show on the fabrication drawings complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

#### 2.6.1.2 Shop Assembly Drawings

Show on the shop assembly drawings details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

#### 2.6.1.3 Delivery Drawings

Show on the delivery drawings descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

#### 2.6.1.4 Field Installation Drawings

Show on the field installation drawings a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; and methods for installing appurtenant items.

### 2.6.2 Structural Fabrication

Structural fabrication shall conform to the requirements specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

### 2.6.3 Welding

Submit sequencing and scheduling schedules of welding procedures for structural steel bulkheads and welding processes for aluminum stoplogs.

Welding shall conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.6.4 Bolted Connections

Bolted connections shall conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.6.5 Machine Work

Machine work shall conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.6.6 Miscellaneous Provisions

Miscellaneous provisions for fabrication shall conform to the requirements specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Zinc coating of hardware items shall conform to ASTM A153/A153M.

2.6.7 Fabrications

2.6.7.1 Stoplogs and Bulkheads

Bulkheads shall be fabricated of structural steel conforming to ASTM A36/A36M. Stoplogs shall be fabricated of extruded aluminum conforming to Alloy 6061, Temper T6. Furnish all materials and equipment as required for fabrication.

2.6.7.2 Stoplog and Bulkhead Guides

Stoplog and bulkhead guides shall be fabricated of structural steel conforming to ASTM A36/A36M.

2.6.7.3 Miscellaneous Embedded Metals

Corner protection angles, frames, base plates, and other embedded metal items required for complete installation shall conform to the details shown.

2.6.8 Seal Assemblies

Seal assemblies shall consist of rubber seals, stainless steel retainer and spacer bars, and fasteners. Rubber seals shall be continuous over the full length. Seals shall be accurately fitted and drilled for proper installation. Bolt holes shall be drilled in the rubber seals by using prepared templates or the retainer bars as templates. Splices in seals shall be fully molded, develop a minimum tensile strength of 50 percent of the unspliced seal, and occur only at locations shown. All vulcanizing of splices shall be done in the shop. The vulcanized splices between molded corners and straight lengths shall be located as close to the corners as practicable. Splices shall be on a 45 degree bevel related to the "thickness" of the seal. The surfaces of finished splices shall be smooth and free of irregularities. Stainless steel retainer bars shall be field-spliced only where shown and machine-finished after splicing.

## 2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

### 2.7.1 General

Tests, inspections, and verifications for materials shall conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Submit certified test reports for material tests, with all materials delivered to the site.

2.7.2 Wet Testing: The Contractor shall perform a field leakage test of each bulkhead and stoplog to the design heads (seating and unseating) as indicated on the Drawings and as Specified. Otherwise, the test shall be performed under a water head determined by the District, if specified head is not available. This shall be accomplished by filling the structure with water on the respective side to be tested. Leakage shall be measured and both the water differential head and leakage recorded. Any problems discovered shall be corrected with the bulkhead and stoplog in its installed position. Include minimum duration of 2 hours of the wet testing.

2.7.3 Leakage: The leakage across the passage closed by the bulkhead or stoplog shall not exceed the allowable leakage (0.1 gpm per foot of sealing perimeter) under maximum head differential. The leakage of all bulkheads and stoplogs shall be tested by the Contractor per the Wet Testing method for Substantial Completion. Submit Leakage Test Reports for review and approval following completion of this activity.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Installation shall conform to the requirements specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

### 3.1.1 Embedded Metals

Corner protection angles, frames, base plates, and other embedded metal items required for complete installation shall be accurately installed to the alignment and grade required to ensure accurate fitting and matching of components. Embedded metals shall be given a primer coat of the required paint on all surfaces prior to installation in concrete forms. Anchors for embedded metals shall be installed as shown. Items requiring two concrete pours for installation shall be attached to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour.

### 3.1.2 Seal Assemblies

Rubber seal assemblies shall be installed after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Rubber seals shall be fastened securely to metal retainers. Before operating the gates, a suitable lubricant shall be applied to the rubber seal rubbing plates to protect the rubber.

### 3.1.3 Painting

Exposed parts of stoplogs, bulkheads, and appurtenances except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in

concrete, rubber seals, and other specified surfaces shall be painted as specified in Section 09 06 90 PROTECTIVE COATINGS, System S-2.

3.2 PROTECTION OF FINISHED WORK

Protection of finished work shall conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

3.3 ACCEPTANCE TRIAL OPERATION

After completion of installation, the District will examine the stoplog and bulkhead installation for final acceptance. The individual components of the stoplog and bulkhead installation will be examined first to determine whether or not the workmanship conforms to the specification requirements. The Contractor will be required to place the stoplogs and bulkheads in the guides a sufficient number of times to demonstrate that the stoplogs and bulkheads fit properly ~~and~~, seat uniformly meet leak testing requirements. Required repairs or replacements to correct defects, shall be made at no cost to the District. The trial operation shall be repeated after defects are corrected.

3.4 STOPLOG SCHEDULE

Contractor shall verify dimensions listed in the below table based on design conditions specified in this section.

| **Stoplog/Bulkhead Schedule** | | | | | | |
|---|---|---|---|---|---|---|
| **Structure Number** | **Width of Opening (Inches)** | **Height of Each Log (Inches)** | **Number of Logs** | **Design Pressure, Seating, Feet** | **Design Pressure, Unseating, Feet** | **Remarks** |
| S-479-S1 | 72, nominal | 12 (minimum) | 6 (maximum) | 5 | N/A | Provide Aluminum Stoplogs |
| S-479-S2 | 48, nominal | 12 (minimum) | 4 (maximum) | 5 | N/A | Provide Aluminum Stoplogs |
| S-471-B1 | 336, nominal | 60 (minimum) | 6 | 28.2 | N/A | Provide Structural Steel Bulkheads |
| S-471-B2 | 336, nominal | 60 (minimum) | 6 | 28.2 | N/A | Provide Structural Steel Bulkheads |
| S-475-B1 | 336, nominal | 60 (minimum) | 6 | 28.2 | N/A | Provide Structural Steel Bulkheads |
| S-475-B2 | 336, nominal | 60 (minimum) | 6 | 28.2 | N/A | Provide Structural Steel Bulkheads |

-- End of Section --

# SECTION 35 20 16.53

# ROLLER GATES

## PART 1 GENERAL

### 1.1 SCOPE

A. Scope of Work: The work related to roller gates shall include the following tasks: Design, fabrication, inspection, testing, delivery to the Site, installation, field checkout, startup, operational testing and commissioning. This work is to be done all in accordance with the Contract documents.

B. Coordination: The gate equipment specified represents an integrated system. It shall be the responsibility of the selected gate supplier to coordinate the design and fabrication of all equipment including the gate, embedded parts, gate hoist, electric actuator, gate assembly, position indicators, and accessories as required to achieve compatibility, proper installation and subsequent operation.

C. This Section includes fabricated single stem stainless steel roller gates and accessories. Roller gates with yoke mounted gate operators shall be furnished for all gate assemblies associated with structures S-471 and S-473.

This Section also includes requirements for a fabricated drum-hoist operated stainless steel roller gate and accessories. A drum-hoist roller gate shall be furnished for the gate assembly associated with structure S-475.

Furnish the number and type of gates and operators as specified and as indicated on the Drawings. Reference drawing M28601 for gate schedule.

The Gate Manufacturer is responsible for all components of the gates, including but limited to the gate disc, embeds, gate assembly, operators (includes actuator and hand wheel, and cable and drum hoist, as indicated on the drawings), gate frame, and position indicators associated with the gate assembly.

The Manufacturer is responsible for the design of each gate and all of its components and appurtenances regardless of the information provided on the drawing.

### 1.2 APPLICABLE STANDARDS AND PUBLICATIONS

A. Standards or Codes: The edition of the standards of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. See the various paragraphs for the specified standard. In the case of a conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A148/A148M | (2014) Standard Specification for Steel Castings, High Strength, for Structural Purposes |
| ASTM A167 | (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A240/A240M | (2016) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| ASTM A27/A27M | (2017) Standard Specification for Steel Castings, Carbon, for General Application |
| ASTM A276/A276M | (2017) Standard Specification for Stainless Steel Bars and Shapes |
| ASTM A314 | (2015) Standard Specification for Stainless Steel Billets and Bars for Forging |
| ASTM A380/A380M | (2017) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A564/A564M | (2013) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes |
| ASTM A743/A743M | (2017) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application |
| ASTM B22 | (2017) Standard Specifications for Bronze Castings for Bridges and Turntables |
| ASTM D2000 | (2018) Standard Classification System for Rubber Products in Automotive Applications |
| ASTM D2240 | (2015 e1) Standard Test Method for Rubber Property - Durometer Hardness |
| ASTM D395 | (2016; E 2017) Standard Test Methods for Rubber Property - Compression Set |
| ASTM D412 | (2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension |

| | |
|---|---|
| ASTM D413 | (1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate |
| ASTM D471 | (2016a) Standard Test Method for Rubber Property - Effect of Liquids |
| ASTM D572 | (2004; R 2010) Rubber Deterioration by Heat and Oxygen |
| ASTM F436/F436M | (2016) Standard Specifications for Hardened Steel Washers Inch and Metric Dimensions |
| ASTM F593/F593M | (2017) Standard Specifications for Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F594/F594M | (2009, R 2015) Standard Specifications for Stainless Steel Nuts |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1 | (2015; errata 1 2015; Errata 2 2016) Structural Welding Code Steel |
| AWS D1.5 | (2015) Bridge Welding Code |
| AWS D1.6 | (2017) Structural Welding Code - Stainless Steel |

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

Manual of Steel Construction

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI B1.1 | (2013; R 2008) Unified Inch Screw Threads |
| ANSI B46.1 | (2009) Surface Texture, Surface Roughness, Waviness and Lay |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| ETL 1110-2-584 | Design of Hydraulic Steel Structures |

## 1.3 SYSTEM DESCRIPTION

A. Performance and design requirements:

1. Roller gates will be used to control and regulate flows in the canal system.

2. Gates shall be capable of exercising precise control of flows. When fully closed, leakage shall not exceed 0.1 gallons per minute (gpm) per linear foot of seal length for the specified head. For gates designed to seal in either direction (bi-directional gates), the specified

maximum leakage shall apply to flow in either direction. Maximum water surface operating levels are indicated on the Drawings.

3. Opening and closing of the gate will be under unbalanced head conditions.

4. Gates shall be operable from the control panel located as directed by the District.

5. For S-475, when not in use, the gate will be stored in the gate slots just below the hoist deck, suspended by the gate hoist wire ropes. Dogging slings will be used to support the gate when it is to be disconnected from the hoist, so the hoist can be removed for major maintenance. See SECTION 35 01 70.13 WIRE ROPE FOR GATE OPERATING DEVICES for additional requirements.

6. To ensure self-closing characteristics, adequate ballast shall be added to the gate as required to make it self-lowering under all conditions of operation.

7. Operating loads shall be based on the weight of the gate, breakaway or sliding friction, roller friction, buoyancy, and other hydrostatic or hydrodynamic forces as applicable.

8. The S-475 gate shall be designed to close under its own weight.

B. Gate components: Gate disc, seals, rollers, guide rails, and sill plate.

C. Operating requirements:

1. Gate shall be designed to close by gravity against the design head listed in Gate Data.

2. Gate shall be capable of operating at partial gate opening.

3. Gate associated with S-475 will be raised and lowered by the hoist mechanism specified in SECTION 35 22 55 VERTICAL LIFT GATE OPERATING SYSTEM.

4. Gate associated with S-471 and S-473 will be raised and lowered by single stem actuated motor as specified in Section 40 05 57.23 ELECTRIC ACTUATOR.

5. Gate operating speed shall be six (6) inches per minute, plus or minus ten percent (10%), for raising and lowering.

D. Design Loading On Gate Structures:

1. General:

   a. Gate equipment shall be suitable for safely performing intended functions as described in these specifications.

b. Each gate component shall be designed to comply with the specified structural requirements when subjected to any of the loading conditions listed in this Section.

c. Calculations may be limited to the critical loading case or cases, if it is evident or can be demonstrated that only these cases are critical. The gate Manufacturer shall provide a technical demonstration to justify its selection if the critical case(s) and conditions are not evident, or if requested to do so by the District.

d. The magnitude of loading effects shall be calculated as specified; where not specified, the method of calculation shall be submitted for approval by the District.

2. Design Loads:

a. The design head shall be defined as the difference between the maximum water level or the top of the gate (whichever is greater) and the bottom of the gate.

b. Hydrostatic loads shall be calculated with a specific weight of 62.5 lb/ft3 for water.

3. Normal Loading Conditions: Each of the following conditions shall be considered for normal loading:

a. Gate Closed. Effects of the following loads shall be combined:

i. Water load corresponding to the design head acting on the gate

ii. Dead weight of the gate and hoist connection parts (block and tackle) bearing on the gate, supported on the sill plate by a reaction normal to the supporting plane, neglecting all friction forces

iii. Velocity up to and exceeding 25 feet per second.

b. Gate Being Raised or Lowered, at Any Point of Gate Travel. Effects of the following loads shall be combined:

i. Water load corresponding to the design head acting on the gate

ii. Dead weight of the gate

iii. Rated hoist pull or required control force acting on the gate

4. Overload Conditions. Overload conditions for gates shall be obtained by combining each of the normal loading conditions with the effect of one overload force component. Combinations of two (2) or more simultaneous overload effects are not required. The following overload combinations shall be considered:

a. Water load corresponding to the probable maximum flood (PMF) level of Elevation 46.2 NAVD88 combined with normal raising.

b. Overload operating forces, including maximum hoist pull (stalled condition), combined with normal water loading condition and including forces generated by waves.

## 1.4 GATE DATA

Furnish the number and type of gates, gate dimensions, design head, elevations and operator type as indicated on the Drawings. Reference drawing M28601 for gate schedule.

a. Dimensions for gate are shown as (clear opening width) × (height of gate disc). Width listed does not include those portions of the gate that fall within the roller slots. Gate sizes are approximate; the Contractor shall verify all dimensions prior to fabrication.

b. Top of sill plate where gate sits when fully closed

c. Elevations given are based on NAVD88 (North American Vertical Datum of 1988).

## 1.5 SUBMITTALS

SD-01 Preconstruction Submittals

Storage and handling detailed instructions

Installation instructions

Fracture Control Plan

SD-02 Shop Drawings

Signed and Sealed Shop Drawings

SD-03 Product Data

Materials

Parts list

SD-05 Design Data

Structural design calculations

SD-06 Test Reports

Shop and Field Test Results

SD-07 Certificates

Material specifications and mill test certificates

Welding qualifications

SD-08 Manufacturer's Instructions

Storage and handling detailed instructions

Installation Instructions

Shop and Field Test Procedures

SD-10 Operation and Maintenance Data

Operating and maintenance instructions

SD-11 Closeout Submittals

AS-BUILT DRAWINGS

1.6 SUBMITTAL REQUIREMENTS

A. Submittals shall be accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

B. Signed and Sealed Shop Drawings, prepared under the supervision of a Professional Engineer registered in the State of Florida, shall be submitted for review prior to beginning fabrication.

C. Shop drawings shall be detailed fabrication drawings of the gate, embedded parts and accessories. Drawings shall include bill of materials, member sizes, weld sizes, tolerances, finishes and nondestructive tests to check the integrity of welds.

D. Structural design calculations for the gate disc and accessories, including lifting lugs, rollers, bearings, shafts, guide rails, pins, seals, etc., with due consideration of normal as well as overload conditions; weight and center-of-gravity calculations; and load-bearing weld designs

E. Parts list, including quantities, weights and materials specifications

F. Storage and handling detailed instructions shall be submitted for storage and handling of the equipment at the Site prior to installation. The instructions shall include identification of parts requiring special outdoor, indoor, or temperature or humidity-controlled storage for both long and short-term storage.

G. Installation Instructions. Detailed step-by-step instructions for the installation of the equipment, together with reduced size copies of applicable drawings, shall be submitted for review before proceeding with the installation of the equipment.

H. Fracture Control Plan (see paragraph SOURCE QUALITY CONTROL of this specification)

I. Shop and Field Test Procedures

J. Shop and Field Test Results

K. Material specifications and mill test certificates for all materials

L. Welding qualifications in accordance with Section 4, "Qualifications," of AWS D1.6

M. As-built drawings, including all field modifications

N. Detailed operating and maintenance instructions, which shall include reduced-size copies of applicable drawings, applicable parts lists, spare parts lists, and catalogs covering all equipment furnished and which may be needed or useful in operation, maintenance, repairs, and dismantling or assembling, shall be submitted.

1.7 DELIVERY, STORAGE AND HANDLING

Deliver, handle, store and protect equipment as recommended by the Manufacturer.

Store rubber seals in a place which permits free circulation of air, maintains a temperature of 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Keep rubber seals free of oils, grease, and other materials which would deteriorate the rubber. Rubber seals shall not be distorted during handling.

1.8 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

1.9 ACCEPTABLE MANUFACTURERS

A. Roller Gates:

1. Golden Harvest

2. Rodney Hunt

3. HydroGate

4. Or approved equal.

PART 2 PRODUCTS

2.1 MINIMUM QUALIFICATIONS AND EXPERIENCE

The Manufacturer must meet the minimum qualifications and experience requirements herein.

A. The Manufacturer must possess, in order to be eligible for award of this work, either of the following certifications: ISO 9000 (2000) or AISC certification standard for Steel Building Structures. All work shall be done in a fixed shop, enclosed or covered. A copy of proof of this certification must accompany the quote sheet. If not supplied with the quote sheet, the quote shall be deemed non-responsive.

B. The gate systems shall be the product of a Manufacturer regularly engaged in the design and fabrication of roller gates. The Manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past ten years. In addition

the Manufacturer shall have supplied a minimum of two (2) roller gates of sizes comparable to those required for this project within the last ten years. Proof of experience shall be submitted with the bid listing representative roller gates designed and manufactured over the last ten years. Listing shall include size of roller gate, operating head, material of gate, year of manufacture, and contact name and phone number of gate Owner.

C. Manufacturer personnel proposed to work on the design and fabrication of the gates shall include a Project Manager with a minimum of five (5) years of experience with gate projects, a Design Engineer with a minimum of ten years of experience designing roller gates of comparable size, and a Quality Control Leader with a minimum of ten years of applicable experience.

D. Current licenses, certifications held, and resumes of the proposed personnel shall be submitted with the bid. Proposed personnel shall not be changed without the written approval of the District.

E. Welders and Welding Operators shall be qualified by an independent laboratory using test procedures covered in AWS D1.6. Welders shall have been tested within the past twelve (12) months and their qualifications shall be considered as remaining in effect unless the welder is not engaged in a given process of welding for a period exceeding six (6) months. The Manufacturer shall provide the District with the names of welders to be employed on the work, certification of the position, date of the last qualification test and the name of the qualifying laboratory.

F. Manufacturer's Design Responsibility - The gate Manufacturer shall be responsible for the design of a complete and operational roller gate systems, including operators, to meet the performance requirements indicated on the Drawings and Specified herein:

1. The details included in the Drawings are to establish the Basis of Design for the gate system to be provided. The Basis of Design represents the minimum requirements that shall be provided. Deviation from these details shall only be considered by the District if the Manufacturer's design dictates such change is necessary to comply with the design requirements of the system or standard recognized industry practice, codes, or standards. Sufficient supporting documentation, including calculations, shall be provided for review and approval by the District.

2. If the gate systems proposed which require modifications to the Basis of Design, then Contractor shall include in the lump sum bid all modifications, including structural, electrical, and mechanical modifications, and accessories as required to provide a complete and operational system.

3. Once design of the complete gate assembly has been set, the Manufacturer shall provide a hydrodynamic analysis using Computational Fluid Dynamics (CFD) software for all service gates and evaluate potential oscillatory behavior, as well as, determine where the gates should be stored to allow a sufficient distance above the opening to ensure the bottom of the gate is not located in an unstable region. In addition to CFD modeling, the Manufacturer shall perform a physical model study for the service gates to determine the dimension to set the upstream vortex breakers shown on the Drawings and confirm that the

gates are adequate to withstand any vibrations that may be encountered from potential oscillatory behavior and/or vortexes. The model study shall be performed by a hydraulic laboratory if the Manufacturer does not have such capabilities.

2.2 GATE DISC

A. General: The gate disc shall consist of a smooth skin plate with horizontal and vertical structural channel members, continuously welded throughout to form a box-like structure. Minimum weld size shall be 1/4 in., unless otherwise approved by the District. Splicing of the skin plate, if required, shall only occur over a vertical or horizontal structural channel member. The maximum gate section height shall be no greater than ten feet (10'). Gate heights greater than that are to be fabricated in sections not to exceed ten feet (10') in height each.

B. Allowable Stresses:

1. Structural Steel:

a. The allowable stresses for structural members under normal loading conditions shall not be higher than following percentages of the yield stress of the respective material used:

| | |
|---|---|
| Tension (on net section at holes) | 40% |
| Bending (tension and compression on extreme fibers of unsymmetrical members) | 55% |
| Bending (tension and compression on extreme fibers of symmetrical members) | 55% |
| Shear (on gross section of beam and plate girder webs) | 35% |
| Bearing on contact area of machine surfaces | 70% |

b. Equivalent stress resulting from combining bi-axial or tri-axial stresses may be 25% higher than the allowable mono-axial stress, but for all loading conditions shall not exceed 80% of the yield strength.

c. Structural calculations based on Load Resistance Factor Design (LRFD) shall be in accordance with ETL 1110-2-584.

2. Mechanical Components:

a. Working stresses and other design criteria for mechanical components, including shafts, pins and bearings, shall be based on a consideration of functional requirements, dynamic loading, impact effects and stress concentration effects.

b. Stresses computed for normal load conditions (or rated capacity) shall not exceed 20% of the ultimate strength of the materials involved.

c. Working stresses for overload may be increased to 80%. Working stresses for overload caused by stalled conditions (or by motor

pullout torque) may be increased to 90% of the minimum yield strength or elastic limit of the materials used.

d. The allowable contact stress for the rail and wheel shall not exceed 1.6 times the lower ultimate strength between the two.

C. Disc deflection shall not exceed 1/800 of nominal gate width.

D. Average coefficient of friction between polymer bearings and stainless steel shall range from 0.10 to 0.17. The gate roller bearings shall not require external lubrication.

E. Average bearing pressure for polymer sleeve bushing on stainless steel pins shall not exceed the Manufacturer's recommended value.

F. Axle mounting holes in the disc shall be line-bored after fabrication to be parallel to seal support surface within a parallelism tolerance of ±0.005 in.

G. The gate shall be provided with two (2) lifting eyes and two (2) eyes for dogging or hanging the gate in a raised position.

H. The gate and embedded parts shall be of all-welded, stainless steel construction. All welding shall be done in the shop.

I. Fully dressed weight of each and all gates shall be welded on the top using 4 inch-tall, plain capital block letters/numbers reading "S-471 XX,XXX pounds", "S-473 XX,XXX pounds", and "S-475 XX,XXX pounds" to determine weight, weigh gate, including all attachments and hardware (rollers, seals, block & tackle), after fabrication and round weight up to nearest 100-pound increment. (For Structures S-471 and S-473, the gates shall be numbered consecutively 1 through 6.)

J. The bottom edge of the gate skin plate shall be ground smooth. This work shall be performed only after the welding on the gate is complete.

K. Field splices (or field connections) shall not be used, except as required for compliance with size or weight limits for transportation, and only after being specifically approved by the District.

L. If permanent field splices of the gate are required, they shall be welded; fitted bolts shall be used for precise alignment of the gate sections and embedded parts before field welding.

M. Location and arrangement of field splices shall be such that they do not affect the integrity, rigidity, function or alignment of the structure. Field splices shall be located as far away from highly stressed areas as possible and shall not be used in the main structural members.

N. No field or shop-weld splicing shall be used on members heat-treated in the shop.

O. Stress Relieving: All parts where stress relieving is required shall be stress relieved by heat treatment. Details of the stress relieving process shall be submitted for the District's review and acceptance before proceeding with the welding.

P. Bolted Connections:

1. Provide bolts with one nut and one washer, unless otherwise indicated.

2. Provide bevel washers at bolted connections to channel flanges, where applicable (i.e. where the channel legs are tapered).

Q. Drain Holes: Drain holes or other openings of suitable size, quantity and location shall be provided to ensure effective drainage of all water accumulated due to submergence or weather conditions.

2.3 SEALS

A. The gate shall be provided with a sealing system consisting of neoprene rubber seals mounted on the gate and sealing surfaces embedded in the concrete structure. Seals shall be mounted along the top, bottom and both sides of the gate to prevent leakage.

B. Seals shall be continuous, providing a tight, closed sealing line without gaps around the gate when the gate is closed.

C. Neoprene rubber seals shall be molded, not extruded. The material shall be compounded of neoprene rubber and shall contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents and plasticizers. Physical characteristics shall meet the following requirements:

| **Physical Test** | **Test Value** | **Test Method Specification** |
|---|---|---|
| Tensile Strength | 2500 psi (min.) | ASTM D412 - Die C |
| Elongation at Break | 400% (min.) | ASTM D412 |
| 300% Modulus | 900 psi (min.) | ASTM D412 |
| Durometer Hardness (Shore Type A) | 60 to 70 | ASTM D2240 |
| Water Absorption | 10% by weight (max.) | ASTM D471<br>48 hours @ 70C |
| Compression Set | 30% (max.) | ASTM D395- Method B,<br>22 hours @ 212C |

D. Fabrication of Rubber Seals

1. Rubber seals shall have a fluorocarbon film vulcanized and bonded to the sealing surface of the bulb. The film shall be 0.060 inches thick Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and shall have the following physical properties:

| | |
|---|---|
| Tensile strength | 2,000 psi (min.) |
| Elongation | 250 percent (min.) |

2. The outside surface of the bonded film shall be flush with the surface of the rubber seal and shall be free of adhering or bonded rubber. Strips and corner seals shall be molded in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, the fluorocarbon film shall be masked during

bonding to prevent a bond for a length sufficient to hold the film securely during testing.

E. Seal attachment hardware shall be leak-tight and designed to permit easy, onsite adjustment and replacement of seals.

F. Sealing Surfaces:

1. Sealing surfaces for the seals shall be straight and smooth, free of any imperfections and ground or machined if necessary.

2. Splices shall be avoided on seal surfaces, if possible. If splices cannot be avoided because of transportation limitations, they shall be finished by field welding, grinding and polishing. Field splices on corners between different seal plates shall also be finished in the same way.

3. Irregularities in exposed surfaces of embedded metal in contact with rubber seals shall not vary more than ±0.03 in. from the positions shown.

4. Sealing surfaces shall have maximum roughness of 125 micro-inch rms.

G. Bottom seals shall be plain flat seals without fluoro-carbon or metal cladding, as shown on the Drawings.

H. Side and Top Seals:

1. Side and top seals shall be solid bulb, rubber J-type seals or double-bulb seal, with fluoro-carbon, as shown on the Drawings.

2. Unless otherwise shown on the Drawings, seals shall have an adjustable, positive initial pre-load (or preset), achieved by stem deflection, when the gate is closed. Mounting shall be such that water pressure increases seal compression and the seal has adequate freedom of movement for seal deflection.

3. Each seal shall be mounted on a continuous angle secured with thru-bolts to the skin plate. The angle leg that bolts to the skin plate shall have slotted holes to permit adjustment of the seal preload. The seal shall be clamped between the other leg of the angle and a continuous backer bar with thru-bolts in standard holes. This leg shall have the sharp edge machined to a 1/8-inch radius.

4. To prevent leakage around the thru-bolts in the skin plate and gate seal angle, sealing washers with bonded rubber backing (as manufactured by Apex Fasteners, 1-800-642-1333, or approved equal) shall be used under the nuts on the skin plate side. In addition, there shall be a neoprene gasket between the gate seal angle and skin plate, with undersize holes in the gasket for the thru-bolts to pass through.

5. Gate seal angles or plates shall be used as templates for drilling holes in the rubber seals. The holes shall be drilled with a hollow drill bit designed for this purpose.

6. Side seals shall extend to, and seal against, the sill plate. If the sill plate is not wide enough to provide a sealing surface for the side

seals, then it shall be expanded for this purpose at the corners. Cope both side seals to allow the bottom seal to pass through, and then splice the bottom seal to each side seal. Alternatively, install a molded corner to join bottom seal to each side seal.

I. Seals shall be furnished in sections as long as is feasible. Each section shall have an excess length of six (6) inch minimum for field splices and for trimming the seal ends in the field. All splices, other than those specified herein as field splices, shall be connected in the shop. Shop splicing of seals or molded corner pieces of the same profile shall be by vulcanizing. Where a corner block is required between two seals, the corner block shall be cemented to one of the seals in the shop.

J. J-type or double bulb seals corners shall be formed by continuous, molded sections.

1. Joints between molded corners and top or side seals shall be square butt type, located twelve (12) inches minimum from corner.

2. Molded corner shall be bonded to top and side seal and assembled to gate disc in the Manufacturer's shop.

3. Mitered joints shall not be used.

## 2.4 ROLLERS, GUIDE RAILS, AND GATE ASSEMBLY

### 2.4.1 Rollers

1. Rollers shall be spaced along each side of the gate disc to support equal portions of the hydrostatic load. The size, number and distribution of rollers shall be based on a hydrostatic pressure analysis of the design head condition, such that the concentrated load at any roller does not exceed 14.5 kips for 12-inch diameter rollers or 16.5 kips for 15-inch diameter rollers.

2. Roller treads shall be machine finished as shown on the Drawings. Rollers shall include a removable axle or shaft.

3. Rollers shall be provided with polymer bearings and spacers, as shown on the Drawings. Bearings and spacers shall be designed for continuous submerged service and shall be capable of operating in the wet or dry. Bearings shall be press fitted to the roller hub and finish machined to obtain a radial clearance of .035 inch. Bearings shall have a minimum wall thickness of 3/8 inch after machining.

4. Axles shall be stationary and stepped down at the wheel end, creating an eccentricity to enable shifting of the wheel rotation center a minimum of 1/8-inch on either side from the neutral position. The locking system for the axle position shall ensure the set position of adjustment with a precision of ± 0.0005 inch.

5. Roller assemblies, complete with axles, shall be removable from gate.

### 2.4.2 Guide Rails

1. Custom fabricated rails, as indicated on the drawings, shall be used to guide rollers on gate disc as the gate is raised and lowered.

2. Rails shall extend the full height of the structure so gate can be raised completely out of the structure.

2.5 S-471 AND S-473 SINGLE STEM, MOTOR OPERATED ROLLER GATE ASSEMBLY

For structures S-471 and S-473 roller gate assembly shall be provided as specified herein, and as indicated on the drawings, to meet the loading conditions required for complete operation of a single stem operated roller gate assembly. Unless otherwise indicated, the requirements specified within this section shall apply to the S-471 and S-473 Single Stem, Motor Operated Roller Gate Assembly with additional requirements described within paragraph S-471 AND S-473 SINGLE STEM, MOTOR OPERATED ROLLER GATE ASSEMBLY.

2.5.1 Yoke

1. Design:

   a. The gate assembly shall be provided with a wrought stainless steel yoke designed to withstand the thrust of an actuator when an 80 ft-lb torque is applied to the input shaft, with a minimum safety factor of 4.0 with regard to ultimate tensile, compressive and shear strength, and a minimum safety factor of 2.0 with regard to tensile, compressive and shear yield strength.

   b. The yoke shall be designed to allow removal of the roller gate from the gate assembly.

2.5.2 Pedestal

1. For pedestal mounted actuators, the Contractor shall coordinate the mounting of the pedestal with the structural supports indicated on the Drawings.

2. The pedestals shall be cast iron and coated in accordance with Section 09 06 90 PROTECTIVE COATINGS or fabricated from stainless steel.

2.5.3 Stem and Stem Couplings

1. Material: The stem shall be stainless steel of the specified grade.

2. Design:

   a. The operating stem shall be rising and shall be designed to withstand both tension and compression loads. For manual actuators (or electric motor actuators in manual mode) the tension and compression loads shall be those caused by the application of an 80-lb effort on the crank or a 100-ft-lb torque on a wrench nut. Where electric-motor-driven actuators are used, the tension and compression loads shall be those caused by 1.5 times the output thrust of the unit in the stalled motor condition.

   b. The tension design load shall not exceed one-fifth (1/5) of the ultimate tensile strength of the stem material. The compression design load shall be less than the critical buckling load as determined by the Euler Column formula, with C = 2. The Euler Column formula is $P = C?^2 EA (r/l)^2$, where P = axial load on stem,

C defines end restraint conditions, E = modulus of elasticity, l = length or span between supports, r = radius of gyration, and A = area of stem, minor diameter for threaded portion of stem.

3. Threads:

   a. Stem threads shall be machine-cut, American Standard, General purpose Acme type with a surface finish of 32 micro-inch or better. Rolled threads or stub Acme threads are not acceptable. The number of threads per inch and pitch shall be selected by the Manufacturer to work most efficiently with the lift mechanism used and the gate speed specified.

   b. The top of the stem shall be provided with a stop nut to be field adjusted according to the Manufacturer's instructions at the time of gate installation to prevent over-closing the gate. The stop nut shall be fabricated from a single piece matching the stem material, tapped to match the stem, and drilled and tapped for a minimum of two 3/8-in. set screws.

   c. Coupling: Where stems are provided in more than one piece, the sections shall be joined by solid couplings. The couplings shall be threaded and keyed, threaded and bolted, or bolted only when one of the pieces is made of tubing and shall be of greater strength than the stem.

4. Inverted Gates: For inverted-gate applications where the gate is lowered to open, a stop nut or other positive means shall be provided to prevent the loss of the gate disc from the guides.

5. Stem Guides: Stem guides shall be provided as required to meet the stem design requirements. The stem guide brackets may be mounted on the gate guides, the yoke or the wall of the structure. Stem guides shall be factory aligned in gate frame applications. The stem guide shall be bushed with a maximum diametric clearance of 1/8-in. The length/radius of gyration ratio (l/r) of the stem shall not exceed 200.

6. Stem Boot: Furnish a PVC telescoping style stem protection boot, as manufactured by Mako Hose & Rubber Co. (no substitutions permitted), for the entire length of the exposed stem from the top of the gate to the underside of the yoke or pedestal, as applicable.

2.5.4 Stem Connector

1. General: A stem connector shall be welded to the gate disc as a means of connecting the operating stem. The bottom portion of the stem shall be affixed to the stem connector with a minimum of two (2) thru-bolts.

2. Design: The connection shall be designed to withstand the stated design load with a minimum safety factor of 4.0 with regard to ultimate tensile, compressive and shear strength, and a minimum safety factor of 2.0 with regard to tensile, compressive and shear yield strength. The design load for the stem connection shall be (1) for manual actuators, the output thrust developed when an 80-lb effort is applied to the crank, and (2) for electric actuators, 1.5 times the output thrust developed in the motor-locked rotor torque condition.

3. The use of a threaded stem block for the stem connector is not acceptable.

2.5.5 Assembly Bolts, Studs, Nuts and Anchor Bolts

1. General: Anchor bolts shall be Type 316 stainless steel, fully threaded, with a minimum diameter of 1/2-in. Anchor bolts shall be of the epoxy type. Bolt loads for adhesive anchors shall not exceed the anchor bolt Manufacturer's recommendations.

2. Design: Assembly bolts, studs, nuts and anchor bolts shall be of such size and spacing as required to resist the design forces with a minimum safety factor of 4.0 with regard to ultimate tensile, compressive and shear strength, and a minimum safety factor of 2.0 with regard to tensile, compressive and shear yield strength.

3. Scope of supply: The Manufacturer shall furnish all anchor bolts and fasteners for the installation of the actuator assembly, including, but not limited to, the following:

   a. Stem guides

4. Responsibility: If the anchor bolt design is by the Manufacturer, then a signed and sealed calculations by an engineer registered in the State of Florida shall be submitted for District review.

2.5.6 Gate Actuator

Furnish gate actuator as indicated in drawing M28601. The electric actuator shall be mounted to the pedestal or yoke as applicable and as indicated on the Drawings.

1. Electric actuators shall also meet the requirements of Section 40 05 57.23 ELECTRIC ACTUATOR.

2. Portable Electric Actuator: In manual mode, the actuator shall be of the bevel gear type suitable for operation with a Waterman EM-25 portable electric actuator. The input shaft of the operator shall be 42 inches above the operating platform.

2.6 SILL PLATE

A. Bottom sill shall consist of a perfectly flat, rigid, reinforced steel plate of stainless steel construction, as shown on the Drawings. Bottom sill shall be set in blockouts and aligned by means of studs, field-welded to welding pads embedded in first-stage concrete, or other District-approved method.

B. Blockouts shall be filled with Class II non-shrink grout after final alignment of embedded parts.

2.7 MATERIALS

A. All material shall be ASTM A240/A240M or ASTM A276/A276M, Type304/304L, dual certified stainless steel with a minimum yield strength of 30,000 psi, unless otherwise shown or specified.

B. Gate Disc Skin Plates: Stainless steel, ASTM A240/A240M, Type 304/304L

C. Gate Disc Frame Members: Stainless steel, ASTM A276/A276M, Type 304/304L

D. Seals: See paragraph SEALS.

E. Gate Seal Angles and Backing Bars for Seals: Stainless steel, ASTM A167 or ASTM A276/A276M, Type 304/304L

F. Sealing Surfaces For Seals: Stainless steel ASTM A167 or ASTM A276/A276M, Type 304

G. Roller Assemblies:

1. Rollers: Cast stainless steel conforming to ASTM A743/A743M, Grade CF8 (Type 304), HB156

2. Bearings and Spacers: Polymer sleeve type, Thordon SXL Grade, as manufactured by Thordon Bearings, Inc. (no substitutions permitted)

3. Axle: Stainless steel ASTM A564/A564M, Type 630

H. Guide Rails: Stainless steel conforming to ASTM A276/A276M, Type 309Cb, HB190

I. Roller Slot Liners, Prefabricated (as applicable): Stainless steel, ASTM A276/A276M, Type 304L

J. Fasteners (Studs, Anchors, and Assembly Bolts): Stainless steel ASTM A276/A276M, Type 316. Bolted connections shall be assembled with marine grade, anti-seize lubricant (Loctite or approved equal).

K. Asbestos: Equipment and materials (e.g. gaskets, packings, brake pads, etc.) shall not contain any asbestos products.

L. Actuator Pedestal and Gear Housing: stainless steel per ASTM A276/A276M, Type 304

M. Gears: Steel per AISI 1117, AISI 4140 or AISI 8620

N. Thrust Nuts: Stainless steel per ASTM A276/A276M, Type 303, Type 304 or Type 316, grade CF8 or CF8M; or bronze per ASTM B584

O. Stem Couplings: Stainless steel per ASTM A276/A276M, Type 303, Type 304 or Type 316; or bronze per ASTM B584 (CA 863, CA 865 or CA 873)

P. Gate Actuator Lift Nut: Bronze per ASTM B584 (CA 863, CA 865) or ASTM B505/B505M (UNS C95800)

Q. Stem Guide Bushings: Cast or extruded UHMW-PE per ASTM D4020; stainless steel per ASTM A276/A276M, Type 303, Type 304 or Type 316; or bronze per ASTM B584 (CA 932 or CA 873), ASTM B98/B98M (CA 651 or CA 655) or ASTM B39 (CA 510)

R. Stems: Stainless steel per ASTM A276/A276M, Type 303, Type 304 or Type 316

S. Stem Boot: PVC

T. Stem Cover: Stainless steel or aluminum

2.8 SOURCE QUALITY CONTROL

A. General: All materials or parts used in the equipment shall be tested, unless otherwise directed, in conformity with applicable methods prescribed by the applicable ASTM standards, or such other organization as may be specifically required, and in accordance with the best commercial methods. When requested, tests shall be made in the presence of District representatives. Stocked material may be used provided evidence is furnished to the District showing that such material meets the specified requirements, in which case tests on stocked material may be waived.

B. All Fracture Critical Members (FCMs) shall be clearly identified on the drawings. These shall include, but not be limited to, the hoist lift connections or brackets on the top of the gate, lift cables and dewatering stop logs (if applicable). All FCMs shall meet the source/quality control requirements of ETL 1110-2-584, Design of Hydraulic Steel Structures. See paragraph SOURCE QUALITY CONTROL for the minimum requirements.

C. Test Reports: Certified material test reports shall be furnished unless waived by the District. The test reports shall identify the component for which the material is to be used and shall contain all information necessary to verify compliance with the Specifications.

D. Shop Assembly and Tests:

1. Finished gate including seals, guiding devices, and all other applicable accessories shall be completely shop-assembled. All field splices, if any, shall be shop assembled.

2. All seals shall be fitted to their supports during the shop-assembly and proper allowances shall be made for shrinkage after aging. Seal sections that are furnished in excess lengths for field-splicing shall each be mounted successively.

3. While assembled, gate shall be checked for dimensions, tolerances and accuracy of alignment.

4. All shop assemblies and tests will be witnessed by a District representative, unless specifically waived in writing. Copies of all shop test/inspection records shall be furnished to the District. No equipment shall be shipped from Manufacturer's shops until it has been inspected or inspection has been waived in writing by the District on an item-by-item basis.

5. Each sealing frame, including sill beam and side members, shall be completely shop-assembled. This may be done in either the vertical or horizontal position.

6. All other members of embedded parts shall be shop assembled in partial lengths, successively joining their matching connections so that each field connection shall be checked for assembly at least once.

E. Workmanship:

1. All work shall be performed and completed in a thorough, workmanlike manner and shall follow the best modern practices in the design and manufacture of gates. All work shall be done by personnel skilled in the related professions and trades. All parts shall be made accurately to standard gages so as to facilitate replacement and repairs. All bolts, nuts, screws, rivets, threads, pipe, gages, gears, and measurements or dimensions shown on the Drawings shall conform to US standards. All special gauges and templates necessary for field erection shall become the property of the District.

2. Like parts and spare parts shall be interchangeable wherever possible. Machining of fits on renewable parts shall be accurate and to specified dimensions so that replacements made to the size shown on the Shop Drawings may be readily installed.

3. Prior to fabrication, all oil grease, dirt, rust, mill scale or other foreign material shall be removed as a part of metal preparation.

4. The design and fabrication of the gate shall provide for adequate adjustment (by the use of shim plates, oversized holes, or other suitable means) so that there are minimal interfacing difficulties during erection.

F. Welding:

1. All welds shall be continuous and watertight. All welding shall be performed using the electric-arc method, and by a process that excludes the atmosphere from the molten metal, and where practicable, by automated machines. Machined surfaces of parts affected by welding shall be machined to final dimensions and surface finishes after welding. Machined surfaces of parts requiring stress relief shall be machined to final dimensions after the parts have been stress relieved. Localized stress relieving will not be permitted for shop welded parts.

2. All welding on stainless steel members shall be done in accordance with AWS D1.6.

3. Clearly distinguish between shop and field welds on Shop Drawings. Length of welds shown on the Drawings shall be the effective length.

4. For stainless steel welding, use stainless steel filler material identical to the base metal.

5. Weld joints in contact with other surfaces (e.g. skin plate) shall be ground flush.

6. Splicing of framing members will not be permitted. Splicing of the skin plate will be allowed provided continuous full penetrations welds are used and splices occur at vertical framing members. Splices shall be clearly identified on Shop Drawings.

7. Remove all traces of weld slag, splatter, heat tint and contamination from stainless steel parts in accordance with ASTM A380/A380M.

8. Preparation of Base Material: Members to be joined by welding shall be cut to shape and size by mechanical means such as shearing, machining, grinding, or by gas or arc cutting, to suit the conditions. The design of welded joints and the selection of weld filler metal shall allow thorough penetration and good fusion of the weld with the base metal. The edges of surfaces (up to the thickness of the metal) to be welded shall be sound metal, free of visible defects, such as laminations or defects caused by cutting operations, and free from rust, oil, grease, and other foreign matter.

9. Technique of Welding: The technique of welding, the appearance and quality of the welds, and the methods used in correcting defective work shall conform to the AWS D1.1 & AWS D1.6 as applicable. Special care shall be taken to avoid undercuts along the seams or warping of the structure. If undercuts appear along the welds, they shall be filled using a small diameter electrode of the same composition as the original electrode after slag, if any, is removed.

10. Weld Finish: Welds shall in general be treated so that they display a finished appearance. Structural welds shall be ground and blended to avoid stress raisers. All welds which require nondestructive examinations shall be dressed by chipping and grinding as required for good interpretation by the selected weld.

G. Nondestructive Testing:

1. General: Unless otherwise indicated, all nondestructive tests shall be in accordance with the applicable sections of ASTM Volume 03.03. The Shop Drawings submitted for review shall define the areas, extent and type of nondestructive examination to be employed.

2. Examination of Welds:

   a. All butt welds shall be given complete nondestructive examination by ultrasonic methods, supplemented by radiographic examination using the best suitable option for a given weld. Supplemental radiographic examinations shall include examination of areas where interpretations by other methods is unclear, or wherever the integrity of the weld is doubtful.

   b. All other welds shall be examined by dye penetrant method or visual inspection (as directed by the District) throughout their entire length. The District shall have the right to request random spot-check examination of welds, including radiographic examination, as part of the equipment inspection.

   c. Examination of welds shall be in accordance with the technique and acceptance standards of AWS D1.6 for stainless steel welding and AWS D1.1 for structural steel welding, if applicable.

H. Fracture Critical Members (FCMs): For FCMs, the following minimum requirements shall be met to verify compliance with ETL 1110-2-584:

1. For welded structures, the fabrication and inspection requirements must follow a Fracture Control Plan (FCP), to be developed by the Manufacturer and submitted for District review, for control of the following parameters that influence fatigue and fracture:

a. Material toughness (base metals and consumables)

b. Hydrogen control in consumables

c. Heat input and cooling rates

d. Limits of discontinuities

e. Welding processes/procedures

f. Repairs of welded connections

g. Qualifications of welders, fabricators, inspectors, etc.

2. Ultrasonic examination (UT) shall be performed on the hoist lift bracket welds.

I. Machine Work:

1. General: Sufficient machining stock shall be allowed on all parts to be machined to insure true finished surfaces of solid material. Finished contact or bearing surfaces shall be true and exact to secure full contact. Journal and sliding surfaces shall be polished, and all surfaces shall be finished with sufficient smoothness and accuracy to insure proper operation when assembled. No machining shall be done on working surfaces of self-lubricating bushings or washers.

2. Finished Surfaces: In addition to the machined surfaces indicated on the Drawings, all surfaces that require machining for their intended function, and those surfaces that are normally machined in good shop practice, shall be machined.

3. Unfinished Surfaces: All work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the Drawings and shall be chipped or ground free of all projections and rough spots.

J. Tolerances:

1. All tolerances shall be selected with due consideration to the nature and function of the parts and to the corresponding accuracy required to secure proper operation, but shall not exceed the tolerances specified below.

2. Skin Plate: Bottom and top edge of each skin plate shall be parallel within ± 0.010 in. per 5 ft height. Length of diagonals connecting skin plate corners shall be within ± 0.005 in. for any 5 ft of skin plate perimeter or within + 0.050 in. whichever is smaller. Bottom of each skin plate and the top of each skin plate on sectionalized gate shall be straight within ± 0.050 in. straight over any 10 ft length, and ± 0.010 in. over any 5 ft of length.

3. Wheels: The rolling surfaces of all the wheels shall be in the same plane within + 0.010 in. The rolling surfaces of all wheels on one side of a gate shall be in line within + 0.005 in. The plane of rotation of all wheels shall be within 0.050 in. over each 5 ft. length. The distance between wheels on opposite sides of a gate shall be within 0.100 in. The rolling surface of each wheel shall be round within + 0.0005 in. and shall have no sudden steps greater than 0.001 in.

4. Rails for Wheel Gates: Rails for roller gate shall be within ± 0.03125 in. of the design plane along their length and ± 0.005 in. across their width. Rails shall be checked for straightness by means of a ten foot (minimum length) straight edge and feeler gages, and shall be straight within ± 0.01 in. over any 10-ft length or ± 0.002 in. over any 5-ft length. Sudden steps on rail surfaces shall be not more than 0.001 in. high. Rails across the opening (upstream and downstream rails) shall be parallel to each other within ± 0.050 in. The distance in the flow direction between the downstream and the upstream rails shall be within 0.125 in. in addition to the wheel dimension.

5. Plumbness: Gate, when hung vertically during shop testing, shall be plumb within 1/4-in. with respect to width as well as thickness of the panel.

6. Side Seal Plates: Each side sealing surface shall be within ± 0.030 in. of the design plane along its length and ± 0.010 in. across its width.

7. Side and top seal plates shall be in the same plane within ± 0.030 in.

8. Sill beams shall be square with the centerline of the vertical bearing plates within ± 0.050 in. They shall be level within ± 0.050 in. and shall have a maximum camber of 0.050 in. for the entire length. The distance of the sill beam centerline from the skin plate centerline, when gate is in fully closed position, shall be less than 1/4-in

9. Guides: All guiding surfaces shall be straight within ± 0.050 in. over any 10-ft length. All guides shall be parallel with their opposite guide across the opening within ± 0.125 in.

K. Testing of Rubber Seals

1. The fluorocarbon film of rubber seals shall be tested for adhesion bond in accordance with ASTM D413 using either the machine method or the deadweight method. A 1 inch long piece of seal shall be cut from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. There shall be no separation between the fluorocarbon film and the rubber when subjected to the following loads:

| THICKNESS OF FLUOROCARBON FILM | MACHINE METHOD AT 2 INCHES PER MINUTE | DEADWEIGHT METHOD |
|---|---|---|
| 0.030 in. | 30 lbs per inch width | 30 lbs per inch width |
| 0.060 in. | 30 lbs per inch width | 30 lbs per inch width |

PART 3 EXECUTION

3.1 INSTALLATION

A. General: The gate shall be field assembled, erected, and tested by the Contractor in the presence of equipment Manufacturer's Supervising Erector. All equipment shall be assembled and installed in accordance with the applicable drawings; written instructions of the equipment Manufacturer, as approved by the District; and applicable codes, standards, and specifications. The Manufacturer's written instructions shall be used as a general guide and are subject to augmentation or modification by the Supervising Erector to suit the field conditions during installation. The tests shall include, but not be limited to, those specified herein.

B. Erection Supplies: All labor, tools, supplies, bracing, spiders, shims (including special shim to suit a particular item of equipment), temporary fixtures, alignment tools, clamps, and supports not furnished with the equipment and all other items or materials necessary to assemble, erect, and install the equipment or making the repairs in a thorough workmanlike manner shall be provided. The proper grades and centerline to which equipment is to be set shall be established. Items to be grouted shall be checked for alignment, clearances, and fit before grouting.

C. Preliminary Checks: Before field assembly and erection, the gate equipment shall be examined for damage during shipment. In particular, it shall be checked for rain or moisture damage to panels, inadequate painting and accumulations of dirt and rubbish.

D. Checks During Erection: In the course of equipment erection, repeated careful checks of alignments and levels, concentricity, and trueness shall be made and recorded. Mating surfaces shall be cleaned, and adjustments, checks and minor repairs of the components shall be made during installation. In final placement of the equipment, some components may require being set in place and removed for adjustment and then replaced. These types of checks, repairs, adjustments, etc. shall be included as routine procedure in the installation. All equipment shall be installed at proper elevation and position within the specified tolerances. All equipment shall be correctly aligned by approved methods and tolerances to insure proper functioning of the completed work.

E. Testing of Gate in Dry: Before operational tests, a thorough visual inspection shall be made of the gate and their embedded parts to check their completion, including correction of damage during shipment, field touch-up of painting, removal of foreign matter, and cleanliness of rolling and sealing surfaces. The gate shall then be operated in the dry in its slot through at least five (5) complete cycles to demonstrate that it will operate properly and smoothly without any binding or excessive friction drag. Adjustments necessary to achieve the above shall be made where required. The testing shall include a check of seals and rollers contact with the embedded parts by the use of feeler gages, function of dogging devices.

F. Wet Testing: ~~The operation of the gate shall be tested again when water is present.~~ The Contractor shall perform a field leakage test of each roller gate to the design heads (seating and unseating) as indicated on the Drawings and as Specified. ~~This shall be accomplished by utilizing the bulkheads and/or stop logs and filling the structure with water on the~~

~~respective side to be tested).~~ Otherwise, ~~T~~the test shall be performed under a water head determined by the District, if specified head is not available. This shall be accomplished by utilizing the bulkheads and/or stop logs and filling the structure with water on the respective side to be tested. Leakage shall be measured and both the water differential head and leakage recorded. Any problems discovered shall be corrected with the gate in its closed position. Include minimum duration of 2 hours of the wet testing.

G. Leakage: The leakage across the passage closed by the gate shall not exceed the allowable leakage (0.1 gpm per foot of sealing perimeter) under maximum head differential (in both directions if a bi-directional gate is specified). ~~This~~ The leakage of all gates shall be tested by the Contractor per the Wet Testing method for Substantial Completion and prior to water being available in the reservoir.

3.2 FIELD SUPPORT

A factory certified service technician from the Manufacturer shall be provided to instruct the Contractor prior to the installation of the first gate of each type. The service technician shall be available for two (2) 8-hr work days at the Project Site. A separate service trip, consisting of two (2) 8-hr work days, shall be provided to certify the completed installation and to set limit switches and torque switches on electric motor actuators when provided as part of the gate assembly.

3.3 WORK SCHEDULE

The Contractor shall submit to the District for its approval, a schedule for completing the all the works involved, including the fabrication, installation and field testing of the gate equipment.

3.4 DISPOSAL

The Contractor shall neatly clean up all work upon completion as directed by the District. The Site shall be left in a neat and orderly condition. Any salvaged or unused material, brought in by the Contractor, shall be removed from the Site.

3.5 SCHEDULE

The CONTRACTOR shall deliver the indicated items within the number of days or as otherwise indicated in the following schedule:

| **Item** | **Delivery Time** |
|---|---|
| Quality Program Manual | 120 days after Notice To Proceed (NTP) |
| Work Schedule Including Fabrication Schedule | 180 days after NTP |
| Statement of Conformance | At the time of equipment shipment |
| Progress Report and Issue of Purchase Orders for Equipment Procurement | Monthly (formal), Bi-weekly (informal) |
| Shop Drawings, Data, and Bills of Material | In accordance with Section 01 33 00 SUBMITTAL PROCEDURES |
| Shop Inspection Plan | 180 Days After NTP |

| Item | Delivery Time |
|---|---|
| As Fabricated Drawings | 45 days after completion of shop fabrication and field assembly |
| Handling and Storage Instructions | 180 days after NTP |
| Preliminary Operating and Maintenance Instructions | 30 days prior to the delivery |
| Final Operating and Maintenance Instruction | 30 days after field testing of the installed equipment |
| Shop Inspection Records and Test Reports | 10 days after completion of inspection or check-out |
| Welding Inspection and Radiographs | 30 days after completion |
| Equipment Guarantees | At completion of installation |
| Certified Material Test Reports | 15 days after receipt by the Contractor |
| Details of Stress Relieving Process | 30 days prior to commence of welding |
| Notice(s) of Shop Check-Outs or Inspections | 15 days prior to test or inspections |

-- End of Section --

# SECTION 35 20 16.54

# SLIDE GATES

## PART 1 GENERAL

### 1.1 SCOPE

A. Summary of Work: This Section includes fabricated stainless steel slide gates and accessories.

B. Furnish the number and type of gates and operators as specified herein and as indicated on the Drawings.

C. Coordination: The gate equipment specified represents an integrated system. It shall be the responsibility of the selected gate supplier to coordinate the design and fabrication of all equipment including the gate, embedded parts, gate hoist, electric actuator, gate assembly, position indicators, and accessories as required to achieve compatibility, proper installation and subsequent operation.

### 1.2 APPLICABLE STANDARDS AND PUBLICATIONS

A. Standards or Codes: The edition of the standards of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. See the various paragraphs for the specified standard. In the case of a conflict between the requirements of this Section and those of the listed document, the requirements of this Section shall prevail.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI 1117 | Carbon Steel (UNS G1117) |
| AISI 4140 | Alloy Steel (UNS G1400) |
| AISI 8620 | Alloy Steel (UNS G8620) |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ASME B1.5 | (1997) Acme Screw Threads |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A126 | (2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM A240/A240M | (2016) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |

| | |
|---|---|
| ASTM A249/A249M | (2018) Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat Exchanger, and Condenser Tubes |
| ASTM A269/A269M | (2015) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service |
| ASTM A276/A276M | (2017) Standard Specification for Stainless Steel Bars and Shapes |
| ASTM A312/A312M | (2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A356/A356M | (2016) Standard Specification for Steel Castings, Carbon, Low Alloy, and Stainless Steel, Heavy-Walled for Steam Turbines |
| ASTM A36/A36M | (2014) Standard Specification for Carbon Structural Steel |
| ASTM A376/A376M | (2017) Standard Specification for Seamless Austenitic Steel Pipe for High-Temperature Service |
| ASTM A380/A380M | (2017) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems |
| ASTM A48/A48M | (2016) Standard Specification for Gray Iron Castings |
| ASTM A536 | (2014) Standard Specification for Ductile Iron Castings A582 - Standard Specification for Free-Machining Stainless Steel Bars |
| ASTM A743/A374M | (2017) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application |
| ASTM B505/B505M | (2018) Standard Specification for Copper Base Alloy Continuous Castings |
| ASTM B179 | (2018) Standard Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes |
| ASTM B39 | (1979; R 2008) Standard Specification for Nickel |
| ASTM B584 | (2014) Standard Specification for Copper Alloy Sand Castings for General Applications |
| ASTM B98/B98M | (2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes |

| | |
|---|---|
| ASTM D1149 | (2007; R 2012) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber |
| ASTM D2000 | (2018)Standard Classification System for Rubber Products in Automotive Applications |
| ASTM D2240 | (2015 e1) Standard Test Method for Rubber Property - Durometer Hardness |
| ASTM D395 | (2016; E 2017) Standard Test Methods for Rubber Property - Compression Set |
| ASTM D4020 | (2011) Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials |
| ASTM D412 | (2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension |
| ASTM D471 | (2016a) Standard Test Method for Rubber Property - Effect of Liquids |
| ASTM F593/F593M | (2017) Standard Specifications for Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F594/F594M | (2009, R 2015) Standard Specifications for Stainless Steel Nuts |

American Welding Society (AWS)

| | |
|---|---|
| AWS D1.6 | (2017) Structural Welding Code - Stainless Steel |

American Water Works Association (AWWA)

| | |
|---|---|
| AWWA C540 | Standard for Power-Actuating Devices for Valves and Slide Gates |
| AWWA C561 | Standard for Fabricated Stainless Steel Slide Gates |

Copper Development Association (CDA)

Copper Alloy Numbers

## 1.3 SUBMITTALS

Submittals shall be accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-01 Preconstruction Submittals

Storage and handling detailed instructions

Installation instructions

SD-02 Shop Drawings

Signed and Sealed Shop Drawings

Detailed custom drawings

SD-03 Product Data

Catalog data and illustrations

Spare parts list

Protective coating system

Weights of gate assemblies

SD-05 Design Data

Calculations

Engineering calculations

SD-06 Test Reports

Test reports

Leakage testing procedure

SD-07 Certificates

Certificates

Affidavits of compliance

SD-08 Manufacturer's Instructions

Assembly, disassembly and repair instructions and procedures

Installation manuals

SD-10 Operation and Maintenance Data

Operation and maintenance manuals

SD-11 Closeout Submittals

AS-BUILT DRAWINGS

1.4 SUBMITTAL REQUIREMENTS

A. Submit as specified in Section 01 33 00 SUBMITTAL PROCEDURES.

B. The Contractor shall submit complete Signed and Sealed Shop Drawings and certificates, test reports and affidavits of compliance, in accordance with the requirements in Section 01 33 00 SUBMITTAL PROCEDURES and as specified herein. When any material is specified to comply with applicable standards,

codes or laws, such compliance must be clearly stated in the Manufacturer's submittal.

C. Include, but not limited to, the following:

1. Catalog data and illustrations showing principal parts and materials

2. Detailed custom drawings of the gate assembly shall be provided, with dimensional and mounting information and a complete listing of the materials of construction. General arrangement drawings and cut sheets are not considered acceptable drawings

3. Weights of gate assemblies

4. Calculations shall be provided to confirm compliance with the safety factors listed in AWWA C561 for all parts of the frame, anchorage and slide, including the portion of the slide that engages the frame.

5. Spare parts list

6. Assembly, disassembly and repair instructions and procedures

7. Protective coating system for non-stainless steel components

8. Leakage testing procedure

9. Installation instructions

10. Installation manuals, operation and maintenance manuals

11. Engineering calculations, prepared by a Professional Engineer licensed in the State of Florida, demonstrating compliance with the mechanical and structural criteria specified.

12. Contractor shall provide as-built drawings.

## 1.5 QUALITY ASSURANCE

Manufacturers shall be experienced in the design and manufacture of stainless steel slide gate equipment and accessories for a minimum period of five (5) years.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Submit storage and handling detailed instructions.

A. Shipment Preparation: Slide gates shall be complete when shipped. Prepare equipment and materials for shipment in a manner to facilitate unloading and handling, and to protect against damage or unnecessary exposure in transit and storage. Shipping preparations shall include:

1. Crates or other suitable packaging materials

2. Covers and other means to prevent corrosion, moisture damage, mechanical injury and accumulation of dirt in motors, electrical equipment and machinery

3. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel

4. Grease packing or oil lubrication in all bearings and similar items

B. Marking:

1. Each gate shall be marked by body marking, or a corrosion-resistant nameplate, or both, that clearly indicates the Manufacturer's name or trademark, gate size, maximum working pressure rating and date of manufacture.

2. Tag or mark each item of equipment or material as identified in the delivery schedule or on Submittals and include complete packing lists and bills of material with each shipment. Each piece of every item need not be marked separately provided that all pieces of each item are packed or bundled together, and the packages or bundles are properly tagged and marked.

3. Mark partial deliveries of component parts of equipment to identify the equipment, to permit easy accumulation of parts, and to facilitate assembly.

## 1.7 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

A. Slide Gates:

1. Golden Harvest

2. Rodney Hunt

3. HydroGate
4. District approved equal

## 2.2 DEFINITIONS

A. Gate Function:

1. Slide gate: A gate used to control flow in an open top channel; the gate slide is raised to allow water to flow under the slide. It has a three-sided seal system, with seals positioned along the sides and across the invert of the opening.

2. Sluice gate: A slide gate that is raised to uncover a submerged orifice opening, allowing water to flow under the slide. The four-sided seal system provides continuous sealing in any position of the slide, allowing water flow only in the open part of the gate.

3. Weir gate: A downward-opening gate; the gate slide is moved down to allow water to flow over the top of the slide. The bottom and side

seals provide continuous sealing in any position of the slide, allowing water flow only in the open part of the gate.

3. Velocity up to and exceeding 25 feet per second and including forces generated by waves.

B. Gate Assembly:

1. Self-contained: The actuator is mounted on a yoke bolted or welded to side extensions of the gate frame. The bottom invert seal shall be integral with (welded to) the gate frame.

2. Non-self-contained: Same as self-contained except the actuator is mounted on a pedestal that is supported independently of the gate frame.

C. Mounting Configuration:

1. Flange back: The gate frame is mounted to a concrete head wall with anchor bolts. The gate shall be mounted such that the normal flow direction subjects the gate to seating head, unless otherwise indicated in the Drawings.

2. Channel mount: The gate frame is embedded in the channel wall such that the sides and bottom (sill) of the frame are embedded in, and flush with, the channel walls and bottom, respectively.

D. Design Head:

1. Seating: Maximum differential head across the gate (headwater stage minus tailwater stage) in the normal flow direction indicated in the Drawings.

2. Unseating: Maximum differential head across the gate opposite the normal flow direction indicated in the Drawings.

3. Velocity up to and exceeding 25 feet per second and including forces generated by waves.

E. Acme Threads:

1. General: The Acme thread form is a trapezoidal screw thread profile used for lead screws (power screws). Acme threads referenced in this specification shall be machine-cut; rolled threads are not acceptable.

2. Type: The type of Acme threads referenced in this specification is General purpose, as defined in the ASME B1.5 standard. Angle of thread of general purpose Acme thread is 29°. The thread height is half of the thread pitch (0.5 × P). Stub Acme threads are not acceptable.

3. Class: Acme threads referenced in this specification shall be tolerance class 2G, unless otherwise indicated in the Drawings.

## 2.3 DESIGN REQUIREMENTS

A. Slide gates, sluice gates and weir gates shall comply with the latest version of AWWA C561, as modified herein.

B. Site specific design requirements - number of gates, opening dimensions, gate function, gate assembly, mounting configuration, size, seating and unseating heads, bottom seal and top of yoke elevations, and actuator type - as in drawing M28601 for gate schedule.

C. Gates shall be suitable for operation after periods of inactivity of a year or more.

2.4 MATERIALS

The requirements of AISI, ASTM, AWS, AWWA, CDA or other standards referenced in this text shall govern the physical and chemical characteristics of the slide gate components.

A. Frame, Guides, Yoke, Slide, Stem Guides and Miscellaneous Fabrications: Austenitic stainless steel, Type 304 and 304L ASTM A276/A276M. "L" grades or dual certified grades shall be used for all welded components.

B. Actuator Pedestal and Gear Housing: stainless steel per ASTM A276/A276M, Type 304

C. Gears: Steel per AISI 1117, AISI 4140 or AISI 8620

D. Thrust Nuts: Stainless steel per ASTM A276/A276M, Type 303, Type 304 or Type 316, grade CF8 or CF8M; or bronze per ASTM B584

E. Stem Couplings: Stainless steel per ASTM A276/A276M, Type 303, Type 304 or Type 316; or bronze per ASTM B584 (CA 863, CA 865 or CA 873)

F. Gate Actuator Lift Nut: Bronze per ASTM B584 (CA 863, CA 865) or ASTM B505/B505M (UNS C95800)

G. Seats: Cast or extruded ultra-high-molecular-weight polyethylene (UHMW-PE) per ASTM D4020

H. Seals: When used, seal material shall be nonmetallic resilient material, such as neoprene, EPDM (ethylene propylene diene monomer), polyethylene or UHMW-PE per ASTM D4020. Reclaimed rubber, as described in ASTM D2000, shall not be used.

I. Stem Guide Bushings: Cast or extruded UHMW-PE per ASTM D4020; stainless steel per ASTM A276/A276M, Type 303, Type 304 or Type 316; or bronze per ASTM B584 (CA 932 or CA 873), ASTM B98/B98M (CA 651 or CA 655) or ASTM B39 (CA 510)

J. Stems: Stainless steel per ASTM A276/A276M, Type 303, Type 304 or Type 316

K. Anchor Bolts and Fasteners: Stainless steel per ASTM F593/F593M or ASTM F594/F594M, alloy group 1 or group 2; or ASTM A276/A276M, Type 316

L. Flush-Bottom Seal: Resilient seals for flush-bottom type gates shall be extruded or molded neoprene or EPDM. Reclaimed, as described in ASTM D2000, shall not be used.

M. Flush-Bottom Seal Retainer: Stainless steel per ASTM A276/A276M, Type 303, Type 304 or Type 316

N. Stem Boot: PVC

O. Stem Cover: Stainless steel or aluminum

2.5 FRAME

A. General: The frame configuration - for example, flange back or channel mount - shall be as specified. The frame shall be self-contained, with yoke mounted gate actuator, or non-self-contained, with pedestal mounted gate actuator, as indicated. Flanged frame sections in self-contained gates shall extend the length of the frame. The use of angles as extensions from the guides to the yoke is not acceptable. Lifting lugs shall be provided on all frame styles.

B. Material: The frame shall be made of wrought stainless steel of the specified commercial grade or from commercially available structural shapes to form a rigid one-piece frame. The minimum material thickness of all members except seal retainers shall be 1/4-in.

C. Design: The structural members shall be designed to provide the required structural support for the gate actuator and the loads produced from the gate operation under the design head conditions indicated with a minimum safety factor of 4.0 with regard to ultimate tensile, compressive and shear strength, and a minimum safety factor of 2.0 with regard to tensile, compressive and shear yield strength.

D. Gate Stops: The frame shall be furnished with gate stops to limit the opening of the gate. The gate stops shall be bolted to the frames to allow removal. Stops shall be located to allow the bottom of the gate to clear the top seal opening plus six inches (6").

2.6 SLIDE

A. General: The slide shall consist of flat structural plate reinforced with stiffeners to withstand the design head conditions. The stiffeners shall be welded to the slide plate. The slide shall be designed to drain when opened above the water level and not trap soil or other debris.

B. Material: The slide shall be made of wrought stainless steel of the specified commercial grade or from commercially available structural shapes. The minimum thickness of all members shall be 1/4-in.

C. Design: The slide shall be designed for a minimum safety factor of 4.0 with regard to ultimate tensile, compressive and shear strength, and a minimum safety factor of 2.0 with regard to tensile, compressive and shear yield strength. The slide shall have surfaces to engage the guides for the full length of the slide when fully closed. Slide deflection shall not exceed 1/720 of gate width at maximum design head or 1/16-in., whichever is less.

## 2.7 SEATS AND SEALS

A. General: The gate may have an integral seat/seal system or a seal separate from the seat. The seat/seal system shall be arranged to ensure that there is no metal-to-metal contact between the slide and the frame.

B. Seat Contact: Seat contact pressure shall not exceed 600 psi at the design head. For this calculation, the bottom seat and top seat, if any, shall not be considered as load bearing.

C. Leakage Requirements: The seating/sealing surfaces shall contact their mating surfaces so as to meet the following leakage requirements at the design head conditions:

1. Seating head leakage rate: 0.05 gallons per minute (GPM) per linear foot of seat/seal

2. Unseating head leakage rate: 0.10 GPM per linear foot of seat/seal

D. Invert Seal:

1. General: The invert seal on upward-opening gates shall use a compressible rubber seal located in the invert of the frame (sill) and incorporated into a structural member or formed plate. The invert seal shall be mechanically fastened with stainless steel bolts; invert seals attached solely by the use of adhesives are not acceptable. The bottom sill arrangement shall be coordinated with the frame configuration and type of frame mounting.

2. Material tests: Rubber compounds shall be capable of withstanding an ozone-resistance test when tested in accordance with ASTM D1149. The tests shall be conducted on unstressed samples for 70 hrs at 104°F (40°C) without visible cracking in the surface samples after the tests. Rubber compounds shall have less than 2 percent volume increase when tested in accordance with ASTM D471, after being immersed in distilled water at 73.4°F ± 2°F (23°C ± 1°C) for 70 hrs.

E. Top Seal (Sluice Gates only): Furnish a horizontal framing member at top of gate opening. Frame member shall be attached, either by welded or bolted connection, to the gate frame for mounting of a top seal. The top seal shall be retained with backing plates and fasteners as required.

## 2.8 GUIDES

Guides shall run the full length of the frame and prevent metal to metal contact between the slide and the frame.

A. Material: The guides shall be wrought stainless steel of the specified commercial grade or commercially available structural shapes. The minimum material thickness, except for seal retainers, shall be 1/4 in.

B. Design:

1. The guides shall be integral with the frame or bolted to the frame. The guides, including their bolting, if any, shall be designed to resist the design head indicated with a minimum safety factor of 4.0

with regard to ultimate tensile, compressive and shear strength, and a minimum safety factor of 2.0 with regard to tensile, compressive and shear yield strength.

2. The guides shall support at least one half of the slide height when the slide is in the fully open position. Guides of self-contained gates shall be designed to adequately support the yoke and resist operating loads with a safety factor of 4.0 on the ultimate or 2.0 on the yield with regard to tensile, compressive and shear strengths of the material.

2.9 YOKE

A. Design:

1. Self-contained gates shall be provided with a wrought stainless steel yoke designed to withstand the thrust of an actuator when an 80 ft-lb torque is applied to the input shaft, with a minimum safety factor of 4.0 with regard to ultimate tensile, compressive and shear strength, and a minimum safety factor of 2.0 with regard to tensile, compressive and shear yield strength.

2. In addition to the above criteria for manual operation, yokes for electric actuators shall be designed for a safety factor of 1.5 with regard to yield strength at the locked-rotor torque of the actuator. Yoke deflection shall not exceed 1/360 of the gate width, or a maximum of 1/4 in., whichever is less, at maximum operating load.

B. The yoke shall be designed to allow removal of the slide from the gate assembly.

2.10 PEDESTAL

A. For pedestal mounted actuators, the Contractor shall coordinate the mounting of the pedestal with the structural supports indicated on the Drawings.

B. The pedestals shall be cast iron and coated in accordance with Section 09 06 90 PROTECTIVE COATINGS or fabricated from stainless steel.

2.11 STEM AND STEM COUPLINGS

A. Material: The stem shall be stainless steel of the specified grade.

B. Design:

1. The operating stem shall be rising and shall be designed to withstand both tension and compression loads. For manual actuators (or electric motor actuators in manual mode) the tension and compression loads shall be those caused by the application of an 80-lb effort on the crank or a 100-ft-lb torque on a wrench nut. Where electric-motor-driven actuators are used, the tension and compression loads shall be those caused by 1.5 times the output thrust of the unit in the stalled motor condition.

2. The tension design load shall not exceed one-fifth (1/5) of the ultimate tensile strength of the stem material. The compression design

load shall be less than the critical buckling load as determined by the Euler Column formula, with C = 2. The Euler Column formula is $P = (PI)^2 EA (r/l)^2$, where P = axial load on stem, C defines end restraint conditions, E = modulus of elasticity, l = length or span between supports, r = radius of gyration, and A = area of stem, minor diameter for threaded portion of stem. The minimum stem diameter for the gates on S471 and S473 shall be 2-1/2 inches before threading and 2 inches before threading for the other gates.

C. Threads:

1. Stem threads shall be machine-cut, American Standard, General purpose Acme type with a surface finish of 32 micro-inch or better. Rolled threads or stub Acme threads are not acceptable. The number of threads per inch and pitch shall be selected by the Manufacturer to work most efficiently with the lift mechanism used and the gate speed specified.

2. The top of the stem shall be provided with a stop nut to be field adjusted according to the Manufacturer's instructions at the time of gate installation to prevent over-closing the gate. The stop nut shall be fabricated from a single piece matching the stem material, tapped to match the stem, and drilled and tapped for a minimum of two 3/8-in. set screws.

3. Coupling: Where stems are provided in more than one piece, the sections shall be joined by solid couplings. The couplings shall be threaded and keyed, threaded and bolted, or bolted only when one of the pieces is made of tubing and shall be of greater strength than the stem.

D. Inverted Gates: For inverted-gate applications where the gate is lowered to open, a stop nut or other positive means shall be provided to prevent the loss of the slide from the guides.

E. Stem Guides: Stem guides shall be provided as required to meet the stem design requirements. The stem guide brackets may be mounted on the gate guides, the yoke or the wall of the structure. Stem guides shall be factory aligned in self-contained gate frame applications. Wall-mounted stem guides for non-self-contained gate frame applications shall provide lateral adjustment between the wall and the guide bracket and between the guide bracket and the guide for field alignment. The stem guide shall be bushed with a maximum diametric clearance of 1/8-in. The length/radius of gyration ratio (l/r) of the stem shall not exceed 200.

F. Stem Boot: Furnish a PVC telescoping style stem protection boot, as manufactured by Mako Hose & Rubber Co. (no substitutions permitted), for the entire length of the exposed stem from the top of the gate to the underside of the yoke or pedestal, as applicable.

## 2.12 STEM CONNECTOR

A. General: A stem connector shall be welded to the slide as a means of connecting the operating stem. The bottom portion of the stem shall be affixed to the stem connector with a minimum of two (2) thru-bolts.

B. Design: The connection shall be designed to withstand the stated design load with a minimum safety factor of 4.0 with regard to ultimate tensile,

compressive and shear strength, and a minimum safety factor of 2.0 with regard to tensile, compressive and shear yield strength. The design load for the stem connection shall be (1) for manual actuators, the output thrust developed when an 80-lb effort is applied to the crank, and (2) for electric actuators, 1.5 times the output thrust developed in the motor-locked rotor torque condition.

C. The use of a threaded stem block for the stem connector is not acceptable.

2.13 ASSEMBLY BOLTS, STUDS, NUTS AND ANCHOR BOLTS

A. General: Anchor bolts shall be Type 316 stainless steel, fully threaded, with a minimum diameter of 1/2-in. Anchor bolts shall be of the epoxy type. Bolt loads for adhesive anchors shall not exceed the anchor bolt Manufacturer's recommendations.

B. Design: Assembly bolts, studs, nuts and anchor bolts shall be of such size and spacing as required to resist the design forces with a minimum safety factor of 4.0 with regard to ultimate tensile, compressive and shear strength, and a minimum safety factor of 2.0 with regard to tensile, compressive and shear yield strength.

C. Scope of supply: The Manufacturer shall furnish all anchor bolts and fasteners for the installation of the gate, frame, and actuator assembly, including, but not limited to, the following:

1. Gate frames

2. Stem guides

D. Responsibility: If the anchor bolt design is by the Manufacturer, then a signed and sealed calculations by an engineer registered in the State of Florida shall be submitted for District review.

2.14 GATE ACTUATOR

Furnish gate actuator as indicated on the Drawings. The electric or manual actuator shall be mounted to the pedestal or yoke as applicable and as indicated on the drawings.

A. Electric actuators shall also meet the requirements of Section 40 05 57.23 ELECTRIC ACTUATOR.

B. Portable Electric Actuator: In manual mode, the actuator shall be of the bevel gear type suitable for operation with a Waterman EM-25 portable electric actuator. The input shaft of the operator shall be 42 inches above the operating platform.

C. Performance:

1. The gate travel shall be a minimum of six inches (6") per minute, plus or minus ten percent (10%) with an input speed of 250 rpm.

2. The actuator shall be sized to permit slide operation with an effort of not more than a 40-lb pull on the hand crank or an 80-ft-lb torque on the input shaft after the slide is unseated, based on the design head

conditions. Maximum pull or torque to start the slide in motion must not exceed 1.5 times this amount. Components of the actuator shall be designed to withstand these input efforts or torques with a minimum safety factor of 5.0 with regard to ultimate tensile, compressive and shear strength.

D. General Design:

1. The actuator shall have a bronze lift nut threaded to fit the operating stem. Lift nuts shall be of high-strength bronze having a minimum tensile strength of 65,000 psi and a minimum hardness of 94 BHN (Brinell Hardness Number). Threads shall be Acme type and shall have a PV (pressure velocity) factor not exceeding 30,000 with lubrication as specified by the Manufacturer. Pressure velocity factor equals surface feet per minute times contact pressure (SFPM × psi). Maximum pressure on the projected area of thread contact shall not exceed 2,000 psi at normal maximum operating load.

2. Ball or roller bearings shall be provided above and below the flange on the lift nut to take up the thrust developed during gate operation. Bearings (and gears) shall be enclosed in a cast-iron or ductile-iron housing with oil seals and O-rings or mechanical seals to seal the unit. The housing shall be grease-lubricated and permanently sealed.

3. The actuator shall be supplied with a base plate; machined and drilled for mounting to the lift housing; and ready for bolting to the gate yoke.

4. The drive gears shall be machined accurately, with cut teeth to provide smooth, proper operation of the lifting mechanism. Input shafts shall be stainless steel and supported by tapered roller or other roller type bearings designed for the radial and thrust loads generated during operation. All geared actuators shall be suitable for operation by use of a portable motor apparatus.

E. Hand Crank: The crank shall be removable and fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 15 in.

F. Opening Direction: The direction of crank rotation to open the gate shall be indicated on the actuator. Single-speed actuators shall open counterclockwise. Two-speed actuators shall open counterclockwise for the low mechanical-advantage gear ratio (high-speed pinion shaft).

G. Stem Cover: Furnish a rigid protective cover for the stem section above the operator.

1. The cover shall be of sufficient diameter and length to permit full travel of the threaded stem without obstruction.

2. The top of the stem cover shall be closed and vented. The bottom end of the stem cover shall be vented, drained, and mounted in a housing or adapter plate for easy field-mounting installation.

PART 3 EXECUTION

3.1 MANUFACTURE

A. Fabrication and Finish:

1. Workmanship: The gate, slide and frame shall be fabricated to within 1/8-in squareness, flatness and dimensional tolerance with respect to the gate opening. Bolt holes shall be accurately located, and drilled or punched, and free of burrs and defects. Machined parts shall be accurately machined with interchangeable parts.

2. Castings: Castings shall be clean, sound and without defects that could impair their function.

3. Welding: Stainless steel shall be welded in accordance with AWS D1.6.

B. Protective Coatings and Surface Treatment:

1. Items to be protectively coated: Carbon and alloy steel surfaces exposed to weather shall be factory painted with protective coating System S-3 as specified in Section 09 06 90 PROTECTIVE COATINGS, or District approved equal.

2. Uncoated material: Stainless steel and aluminum surfaces do not require protective coating.

3. Stainless steel cleaning: Stainless steel parts shall be cleaned, free of grease and dirt, and descaled in accordance with ASTM A380/A380M. All heat tint and slag from the welding process shall be acid passivated or mechanically passivated through bead blasting in accordance with ASTM A380/A380M. Grinding or buffing is not acceptable in lieu of passivation.

3.2 INSTALLATION

A. Comply with provisions of AWWA C561 and as specified.

B. The slide gate frames shall be installed in a true vertical plane, square and plumb, with no twist, convergence or divergence between the vertical legs of the guide frame.

1. The Contractor shall provide for a one-inch (1") thick grout pad between the gate frame and the concrete mounting surface.

2. After the gate frame is plumbed and aligned, the CONTRACTOR shall fill the void between the frame and the mounting surface with non-shrink grout, in accordance with the grout Manufacturer's recommendations.

C. Lubricate all bearings and gears before placing gates in operation.

D. Provide Manufacturer's field services as specified in DIVISION 1.

E. Perform equipment tests during and after start-up to determine if equipment is performing as specified.

## 3.3 FIELD SUPPORT

A factory certified service technician from the Manufacturer shall be provided to instruct the Contractor prior to the installation of the first gate of each type. The service technician shall be available for two (2) 8-hr work days at the Project Site. A separate service trip, consisting of two (2) 8-hr work days, shall be provided to certify the completed installation and to set limit switches and torque switches on electric motor actuators when provided as part of the gate assembly.

## 3.4 LEAKAGE TEST

A. ~~The Contractor shall perform a field leakage test of each slide gate to the design heads, seating and unseating, as indicated on the Drawings. This shall be accomplished by utilizing the bulkheads and/or stop logs and filling the structure with water on the respective side to be tested. Leakage in excess of the allowable shall be corrected by the Contractor at his expense.~~ Testing of Gate in Dry: Before operational tests, a thorough visual inspection shall be made of the gate and their embedded parts to check their completion, including correction of damage during shipment, field touch-up of painting, removal of foreign matter, and cleanliness of sealing surfaces. The gate shall then be operated in the dry in its slot through at least five (5) complete cycles to demonstrate that it will operate properly and smoothly without any binding or excessive friction drag. Adjustments necessary to achieve the above shall be made where required. The testing shall include a check of seals with the embedded parts by the use of feeler gages.

B. Wet Testing: The Contractor shall perform a field leakage test of each gate to the design heads (seating and unseating) as indicated on the Drawings and as Specified. Otherwise, the test shall be performed under a water head determined by the District, if specified head is not available. This shall be accomplished by utilizing the bulkheads and/or stop logs and filling the structure with water on the respective side to be tested. Leakage shall be measured and both the water differential head and leakage recorded. Any problems discovered shall be corrected with the gate in its closed position. Include minimum duration of 2 hours of the wet testing.~~Leakage test duration shall be at least 30 minutes.~~

C. Leakage: The leakage across the passage closed by the gate shall not exceed the allowable leakage (0.1 gpm per foot of sealing perimeter) under maximum head differential (in both directions if a bi-directional gate is specified). The leakage of all gates shall be tested by the Contractor per the Wet Testing method for Substantial Completion and prior to water being available in the reservoir.

-- End of Section --

# SECTION 35 20 20

# ELECTRICAL EQUIPMENT FOR GATE HOIST

## 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) |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 112 | (2004) Standard Test Procedure for Polyphase Induction Motors and Generators |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C80.1 | (2005) American National Standard for Electrical Rigid Steel Conduit (ERSC) |
| NEMA FB 1 | (2014) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable |
| NEMA MG 1 | (2016; SUPP 2016) Motors and Generators |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-50553 | (2015; Rev B) Fitting for Conduit, Metal, Rigid (Thick-Wall and Thin-Wall (EMT) Type) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 44 | (2014; Reprint Feb 2015) Thermoset-Insulated Wires and Cables |

### 1.2 SYSTEM DESCRIPTION

All equipment furnished under these specifications will be subjected to severe moisture conditions, shall operate over a temperature range of 40 to 104 degrees F, and shall be designed to render it resistant to corrosion. The general requirements to be followed are specified below; any additional special treatment or requirement considered necessary for any individual item is specified under the respective item.

1.2.1 Fastenings and Fittings

Where practicable, all screws, bolts, nuts, pins, studs, springs, washers, and such other miscellaneous fastenings and fittings shall be of an approved corrosion-resisting material or shall be treated in an approved manner to render them resistant to corrosion.

1.2.2 Corrosion-Resisting Materials

Corrosion-resisting steel, copper, brass, bronze, copper-nickel, and nickel-copper alloys are acceptable corrosion-resisting materials. However, contact between dissimilar metals should be avoided as much as practicable, except where one of the dissimilar metals is steel or in the case of wiring and connections.

1.2.3 Corrosion-Resisting Treatments

Hot-dip galvanizing shall be in accordance with ASTM A123/A123M or ASTM A153/A153M as applicable. Other corrosion-resisting treatments may be used if approved by the District.

1.2.4 Frames, Enclosing Cases, and Housings

All surfaces of the enclosing cases or housings of brakes, limit switches, and other similar equipment, if other than plastic or stainless steel construction, shall be cleaned of rust, grease, mill scale, and dirt and then treated with an approved iron and zinc phosphate solution followed by rinsing with a chromic acid solution, bonderizing, or equivalent process. Immediately after rinsing and drying, the inside and outside surfaces shall be given one coat of a zinc molybdate primer and cured as required. For items of cast construction, the iron and zinc phosphate treatment may be omitted.

1.2.5 Finish Painting

Shop Finishing (for all components not Stainless Steel or Galvanized):

a. Protective Coatings:

(1) Costing systems include surface preparation, prime coat, finish coate, inspection, cleaning, and touch-up of surfaces and equipment

(2) Concealed surfaces are not required to have finish coats, but prime coat should be applied and touched up prior to concealment

(3) All structural steel and the mechanical assembly shall be painted gray

b. Coating Systems: (Section 09 06 90 Protective Coating

(1) Structural steel frames and support steel: System S-2

(2) Reduction gear housing, couplings, pillow blocks, motor and brake: System S-2

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Limit Switch

Hoist Motor

Control Panel

Brake Enclosing Case

SD-03 Product Data

Hoist Motor

Brake

Limit Switch

Control Panel

Wiring and Conduit

Conductors

Terminal Leads

Motor nameplates

SD-06 Test Reports

Tests

PART 2 PRODUCTS

2.1 HOIST MOTOR

Submit 6 copies of motor characteristics, curves or tabulated data (tested or calculated), indicating the speed, power factor, efficiency, current and kilowatt input, all plotted or tabulated against torque or percent of rated motor load.

a. Submit 6 copies of calculations to determine the required horsepower rating of each motor.

b. Submit 6 copies of detailed descriptive specifications of the motor, with necessary cuts, photographs, and drawings to clearly indicate the construction of the machine. Place special emphasis on describing and illustrating features of "Insulated Windings," "Winding Heaters," "Bearings and Lubrication," and "Terminal Leads."

2.1.1 Motor Type

See Section 35 22 55 VERTICAL GATE OPERATING SYSTEM for motor type and motor rating requirements.

2.1.2 Motor Torque

2.1.2.1 Motor Limits

The torque limits for each individual winding shall be as follows:

a. Upper Limit: The upper limit of the torque between locked-rotor and breakdown shall be not more than 280 percent of the rated full-load torque of the motor.

b. Lower Limit: The lower limit of the torque between locked-rotor and breakdown shall be as high as possible consistent with good design but not less than 150 percent of the rated full-load torque of the motor.

c. When the characteristics of a motor or the winding of a motor results in a speed torque curve without a definite value of breakdown torque, the limitations on the minimum value of torque shall apply between locked-rotor and 75 percent of synchronous speed.

2.1.3 Frames and Shafts

Size and dimensions of frames shall conform to NEMA MG 1 and shaft extension shall be as required. Eye bolts shall be provided on all motors. Each motor shall be provided with a drain-breather which shall be so located to prevent accumulation of water inside the motor. Frames shall have corrosion prevention in accordance with the requirements of paragraph CORROSION-RESISTING TREATMENTS. Exposed portions of shafts shall be treated with manufacturer's standard primer and two coats of moisture proof varnish in accordance with the manufacturer's recommendation.

2.1.4 Windings and Insulation

| CLASS | LIMITING TEMPERATURE (in degrees Celsius) |
|---|---|
| B | 130 |
| F | 155 |
| H | 180 |

Insulation shall be Class F with special moisture, fungus, and oil proof treatment. Motors shall be designed and constructed to withstand the environmental conditions specified. The following specifications describe the minimum requirements for acceptable insulation and are not intended to restrict or prohibit the use of materials or methods which will give equal or better performance.

#### 2.1.4.1 Insulated Windings

Insulated windings, unless otherwise approved, shall be completely assembled in the motor core before impregnating with the insulating compound. Insulating compound shall be 100 percent solid. Impregnation of the windings with the insulating compound shall be by vacuum impregnation method followed by baking. The procedure shall be repeated as often as necessary to fill in and seal over the interstices of the winding, but in no case shall the number of dips and bakes be less than two dips and bakes when the vacuum method of impregnation is used.

#### 2.1.4.2 Magnet Wire

The magnet wire shall have an insulation or combination of insulations with an insulation thickness not less than that required for the environment specified and the temperature rating as required by the hot-spot temperature of the motor.

### 2.1.5 Winding Heaters

See Section 35 22 55 VERTICAL GATE OPERATING SYSTEM for winding heater requirements.

### 2.1.6 Bearings and Lubrication

The motors shall be provided with antifriction bearings, and the design of the housing and method of assembly shall permit ready removal of the end brackets and prevent escape of lubricant and entrance of foreign materials. Bearings shall be fitted with bronze or other approved bushings to prevent any binding of moving parts. Approved antifriction bearings of corrosion resisting construction may be used. Bearings shall be of an approved prelubricated type requiring no addition or change of lubrication for a period of at least 5 years. Pressure lubrication fittings may be used provided the housings are properly vented to prevent damage to the seals. When the brake housing or other equipment is to be assembled adjacent to or bolted to the motor end bell, suitable filler and drain pipe extensions, with the ends properly fitted and easily accessible, shall be provided. For those applications where the brake wheel is mounted on a shaft extension on the front end of the motor, the bearing housing, or a suitable flange, shall be furnished to provide a suitable surface and connecting means to allow the fastening of the brake enclosure to the bearing housing (see paragraph BRAKE ENCLOSING CASE).

### 2.1.7 Terminal Leads

Terminals leads shall extend outside the frame; shall have insulation equivalent to that of the motor winding; shall be terminated in a two-piece, watertight terminal box secured rigidly to the motor frame; and shall be suitably identified. Leads shall be positioned and sealed where they pass through the frame with a water-resistant seal of a synthetic rubber material or a synthetic rubber gasket. Terminal box shall have threaded conduit entrances on a minimum of four sides.

### 2.1.8 Machine Work

Machine work shall be accurate, of high quality, and in conformity with approved standard practice. Threads shall be in accordance with ASME B1.1.

Thread fittings shall be Class 2. Threads on all body-bound bolts shall be chased a sufficient length so that when the nut is tightened there will be approximately one and one-half full threads under the nut. All bolts and cap screws shall be provided with lock washers.

2.1.9 Designation and Markings

Motor nameplates of a suitable corrosion-resisting material shall be attached to the frame of each motor and shall indicate clearly the motor NEMA temperature and insulation class, continuous amperage rating, voltage rating, operating frequency, rated RPM, horsepower rating, nominal efficiency, NEMA locked rotor code letter and serial number. In addition, the nameplate shall show a lead connection diagram. Identification or serial numbers shall be die stamped on the frame.

2.2 BRAKE

Submit 6 copies of detailed descriptive data covering the brake, with necessary cuts, photographs, and drawings to indicate clearly the construction of the brake and the materials used. Releasing device specifications and characteristics, including input current minimum voltage required for brake release.

2.2.1 Brake Type

The brakes shall be of the shoe type, spring set, with AC magnet operated release and shall be completely enclosed in a watertight and dusttight enclosing case arranged for floor mounting.

2.2.2 Brake Rating

See Section 35 22 55 VERTICAL GATE OPERATING SYSTEM for brake rating requirements.

2.2.3 Adjustment

Means shall be provided for varying torque required for holding. Additionally, the brake shall have means of adjusting the position of the shoes to compensate for wear, unless the design is such that compensation for shoe wear is automatic.

2.2.4 Release

2.2.4.1 Releasing Magnets and Rectifier

The releasing magnets shall be of the DC or AC shunt type and of standard stock design, suitable for operation on 208-volt, 60-Hz, AC electrical power. Direct current shall be supplied by means of a self-contained rectifier unit of proper rating. The complete unit shall be suitable for connection to the control circuit or the power circuit of the motor with which the brake is used so that the brake will set or release when the motor is deenergized or energized, respectively. The brake releasing magnet shall be rated in accordance with the brake rating requirements of paragraph MOTOR RATING, and shall be sufficient to release and hold the brake in the released position with 85 percent of rated voltage impressed on the incoming terminals.

2.2.4.2 Hand Release

Hand release shall be provided. It shall be operable only when the enclosing case cover is removed and shall be self-resetting.

2.2.5 Terminal Leads

Connecting leads from the releasing magnet shall be extended outside the enclosing case and shall be terminated on a terminal block located in a watertight terminal box, which shall be rigidly bolted or equally secured to and on the outside of the lower or fixed half of the enclosing case. The terminal box shall provide for conduit entrances on four sides. All conduit entrances to the brake terminal box shall be threaded. The leads inside the brake enclosing case shall be suitably protected. Enclosing case space heater leads shall be terminated in the same manner in separate terminal boxes.

2.2.6 Brake Enclosing Case

Submit 6 copies of dimensioned outline drawings showing specific relationships and clearances between equipment and their component parts. The outdoor NEMA Type 4-watertight enclosing case shall be in accordance with the manufacturer's standard practice for the conditions indicated. In order that the brake mechanism will be accessible from above, when the upper half or cover of the enclosing case is removed, the enclosing case shall be constructed to give equal accessibility to all portions of the brake. The joint between the two halves shall be made with a synthetic rubber gasket, not less than 1/4 inch in width, and held in place by embedding in a groove or by other equally effective means. For those applications where the brake wheel is mounted on a shaft extension on the front end of the motor, the enclosing case shall be arranged to permit bolting to the bearing housing of the motor, the joint being made watertight with a gasket. For those applications where the brake wheel is mounted on a shaft of the operating machine or on a flange and shaft extension on the front end of the motor, suitable watertight seals shall be provided on each part of the housing. The shaft seals shall be arranged for pressure lubrication and shall be adjustable for alignment relative to the shaft. An automatic drain breather, located in a protected location, shall be provided in the lower part of the enclosing case. If the drain breather cannot be located in a protected location, the tapped hole shall be plugged and the drain furnished separately for installation in the field. Enclosing case space heaters conforming to the applicable part of paragraph HEATERS-GENERAL, shall be provided. The enclosing case shall be treated to render the steel resistant to corrosion as required by paragraph CORROSION-RESISTING TREATMENTS.

2.2.7 Mechanical Construction

Except for brake wheels, shoes, and electrical parts, no cast iron shall be used in brake construction. All pins, fittings, and other miscellaneous small metal parts shall be of approved corrosion-resisting metal or shall be treated to render them corrosion-resistant as required by paragraph CORROSION-RESISTING TREATMENTS. Bearings shall be fitted with bronze or other approved bushings to prevent any binding of moving parts. Approved antifriction bearings of corrosion-resisting construction may be used. Approved means for lubrication shall be provided for all bearings, unless bearings are of an approved self- or prelubricated type. The machine work

shall conform to the requirements for the motor with which the brake is used.

2.2.8 Designation and Markings

A nameplate of suitable corrosion-resisting material shall be provided and attached to a part of the brake which ordinarily will not be renewed during its service life. The nameplate shall conform to standard practice and clearly indicate the manufacturer's name, identification symbols, serial number, and salient design features such as type, frame, torque, rating, voltage, phase, and frequency. If adjustment is required, pertinent information for making the adjustments is necessary.

2.3 CONTROL SYSTEM

The scheme of operation of the control gate hoist motor control system shall be as described and indicated in the contract drawings. The control system shall include the limit switch, master control panel, and such other items as may be required to accomplish the operating features specified. Each item shall be installed and tested as specified and shall be complete and ready for operation in accordance with the scheme of operation.

2.4 WIRING AND CONDUIT

2.4.1 Conductors

Conductors shall be of annealed copper wire. Copper conductors shall be insulated with polyethylene. Conductors shall be Class B or Class C stranding, except for hinge wire which shall be Class D or K stranding. Unless otherwise specified, all wire and cable for power and control shall be single conductor. Insulation thickness shall be that required for a rated circuit voltage of 0 to 600 volts. Insulation shall be a cross-linked thermosetting polyethylene insulation type. Over the insulated conductor there shall be applied a moisture resisting thermoplastic jacket. The method of accomplishment shall be in accordance with the current practice of the industry. Wire for power and motor circuits shall have a current carrying capacity corresponding to the ampere rating of the circuit's air circuit breaker and not less than No. 10 AWG and the full-load current of the motor or the circuit. Wire for control circuits shall not be smaller than No. 12 AWG.

2.4.2 Control Wire

All control wire shall be type SIS switchboard wire meeting the requirements of UL 44.

2.4.3 Conduit

Rigid steel conduit shall conform to ANSI C80.1 and shall, in addition, be zinc-coated (galvanized) both inside and outside by the hot-dip method.

2.4.4 Fittings

Conduit fittings shall conform to the requirements of NEMA FB 1 and CID A-A-50553.

### 2.4.5 Assembly

The hoist motor, motor brake, limit switch, and master control panel shall be installed as shown on contract drawings.

a. All wiring shall be installed in rigid hot-dip galvanized metal conduit with threaded-type fittings (Condulets) and zinc-coated watertight outlet and pull boxes. The conduit shall be securely mounted and fastened to the hoist framework and shall be installed in a neat and workmanlike manner. Change of direction of a conduit run shall be made by means of threaded-type fittings (Condulets) or factory fabricated bends, and the conduit shall be installed to fit close to the hoist framework. Conduit unions shall be used whenever it is necessary to join conduits that are to be turned right and left. No running threads will be permitted. Ends of conduits shall be carefully reamed. All threaded connections shall be made up with electrically conductive colloidal copper rust-inhibiting compound or other suitable compound. Separate conduit systems shall be provided for power and control circuits. The entire conduit system shall be grounded and shall be installed so that any moisture will be drained away from terminal boxes and equipment. All conduit connections to equipment enclosures shall be of the watertight threaded type. Suitable "drain-breather" devices shall be provided at all low points of the conduit system to prevent an accumulation of water. All conductors shall be terminated in an approved manner. Indented terminals shall be used on No. 12 AWG and larger conductors and shall be terminated on screw or stud terminals. Toothed lock washers shall be used on all screw terminals and locking nuts or lock washers shall be used on all stud terminals.

## 2.5 HEATERS - GENERAL

Enclosure heaters shall be strip type constructed with a chrome-nickel heating element embedded in a refractory insulating material and encased in an approved watertight, corrosion-resisting, nonoxidizing metal sheath. The rate of heat dissipation shall be uniform throughout the effective length. Watt density shall not exceed 20 watts per square inch for chrome-nickel type.

### 2.5.1 Heater Ratings

Heaters shall be of such rating that, when energized, the temperature of the windings or enclosure will be held approximately 10C above ambient. They shall be designed for 120 volts AC and for continuous operation under the conditions of installation. The rate of heat dissipation shall be uniform throughout their effective length.

### 2.5.2 Insulation

Insulation for the heating cable (winding wrap around type) heaters shall be suitable for a conductor temperature of 180C.

### 2.5.3 Heater Terminals

The terminals of the heater, including the leads, shall be watertight. The leads shall be terminated and sealed in a watertight terminal box located as selected by the motor manufacturer. The method of sealing shall be as specified for the motor winding leads.

## 2.6 TESTS

Each item of equipment furnished, one of each rating and type and selected at random by the Contracting Officer, shall be given a complete test. The remaining items of equipment shall be given a routine test. All complete tests required herein shall be witnessed by the District, unless waived in writing, and no equipment shall be shipped until it has been approved for shipment by the District. Notify the District sufficiently in advance of the date of the tests, so that arrangements can be made for the District to be present at the tests. The test equipment and the test methods used shall conform to the applicable requirements of ANSI, IEEE, and NEMA standards and shall be subject to the approval of the Contracting Officer. Submit 6 certified copies of the reports of all complete and routine tests, including complete test data. Certified copies of the results of a complete test for duplicate equipment will be accepted in lieu of the requirement of the complete test specified. Reports shall include analysis and interpretation of test results and shall be properly identified with the test systems and materials. Provide test reports for "complete tests" on the motor, and brake. Certified copies of "Complete Tests" on duplicate equipment may be accepted with the approval of the District. No substitute will be accepted for the routine test. The cost of performing all tests shall be borne by the Contractor and shall be included in the price bid. Operational tests shall be made on equipment after it is installed. Performance curves indicating the results of the motor tests shall be furnished as follows:

a. Excitation Tests. Volts or percent of rated voltage as abscissa vs. amperes and watts as ordinates.

b. Impedance Tests. Volts or percent of rated voltage as abscissa vs. amperes and watts as ordinates.

c. Performance Test. Torque or percent of rated horsepower output as abscissa vs. efficiency, power factor, amperes watts, and rpm or percent slip as ordinates.

d. Speed-Torque Test. Torque in foot-pounds as abscissa vs. speed in rpm or percent of synchronous speed as ordinates.

e. Temperature Test. Time in minutes as abscissa vs. temperature rise in degrees C as ordinate.

f. Insulation Resistance Test. Test result values shall be plotted on semilogarithmic graphs, the insulation resistance values as logarithmic ordinates, and the temperature values as uniform abscissa.

g. Routine test reports shall include analysis and interpretation of test results and shall be properly identified with the test systems and materials. No substitute will be accepted for the routine test. Provide test reports for "routine tests" on the motor, brake, controller, limit switch, interrupter, and wiring.

h. Submit 6 copies of description of "Interrupter" drive including copies of dimensioned outline drawing of the interrupter. Show on the Drawings specific relationships and clearances between equipment and their component parts.

2.6.1 Motor Tests

All tests shall be performed in accordance with the requirements of IEEE 112 for three-phase induction motors.

2.6.1.1 Complete Motor Tests

The complete tests shall include the following:

a. Excitation test.

b. Impedance test.

c. Performance and speed-torque test (Prony brake or other approved method).

d. Temperature test.

e. Insulation resistance tests. Measurements shall be taken following temperature test with readings taken at approximately 10C intervals. Temperature shall be determined by the resistance method.

f. Dielectric test.

g. Cold and hot resistance measurement.

h. Effectiveness of enclosure.

i. Motor winding heater test.

(1) Successful operation.

(2) Dielectric.

2.6.1.2 Routine Motor Tests

The routine tests shall include the following:

a. Excitation test: (One point - no load, volts, amperes, and watts.)

b. Impedance test: (One point - half-voltage amperes and watts.)

c. General operation.

d. Insulation resistance - temperature test (one point).

e. Resistance measurements.

f. Dielectric.

g. Motor winding heater test.

(1) Successful operation.

(2) Dielectric.

h. Interrupter.

2.6.2 Brake Tests

2.6.2.1 Complete Brake Tests

The complete tests shall include the following:

a. Check operation of brake release at the specified rated brake torque for rated and 85 percent terminal voltage.

b. Heat run on release magnet at the specified rated brake torque and voltage.

c. Insulation resistance of release magnet including leads and terminal block.

d. Resistance measurements of release.

e. Dielectric test of release magnet including leads and terminal block.

f. Brake space heater test.

(1) Successful operation.

(2) Dielectric.

2.6.2.2 Routine Brake Tests

The routine tests of the brake shall be the same as specified in paragraph COMPLETE BRAKE TESTS, except that the heat run tests shall be omitted.

2.6.3 Limit-Switch Tests

Each drive shall be tested in the manufacturers shop by suitable means, simulating service conditions, to ascertain that it will transmit the correct information for the control sequence specified. In addition, the routine tests shall include the following:

a. Adjustment, fit, and material.

b. Accuracy of trip and reset.

c. Successful operation.

d. Dielectric.

e. Insulation resistance.

2.6.4 Wiring Tests

All wiring shall be given a dielectric test following installation by applying, for 5 minutes, a voltage test of 1,500 volts to each circuit and ground and between each conductor and all other conductors in the same conduit.

PART 3 EXECUTION

1. SCHEME OF OPERATION

a. General. The control system for the gate shall be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor shall be controlled by:

(1) A push button station located on the gate hoist with momentary contacts designated "RAISE," "LOWER" and "STOP."

c. Operating Features

(1) Actuation of the "RAISE" and "LOWER" contacts shall provide seal-in operation.

(2) A limit switch geared or directly connect to the hoist machine, shall control the incremental and stopping operations initiated manually from the control panel as described under sequence of operation.

(3) Actuation of the "STOP" contact during any operation shall stop the hoist motor and set the brake.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the first intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 0.5 foot and stop.

(2) When the gate is at or above the first intermediate position and is below the second intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 1 foot and stop.

(3) When the gate is at or above the second intermediate position, actuation of the "RAISE" contact will cause the gate to raise continuously to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and the second intermediate position, actuation of the "LOWER" contact will cause the gate to lower continuously to the second intermediate position and stop.

(2) When the gate is at or below the second intermediate position and above the first intermediate position, each actuation of the "LOWER" contact will cause the gate to lower approximately 1 foot and stop.

(3) When the gate is at or below the first intermediate position and is above the closed position, each actuation of the "LOWER" contact will cause the gate to lower approximately 0.5 foot and stop.

c. Over Travel. If during normal operation, the gate motor should fail to stop when the gate reaches the raised or closed positions, the over travel limit switch contacts shall stop the hoist motor after over travel by de-energizing the "main" or "line" contactor of the control panel. To operate gate after an over travel, the appropriate backout switch contact shall be held closed to permit operation of the gate only in the direction away from the over travel position after operation of either the "RAISE" or "LOWER" contact on the master control panel.

-- End of Section --

# SECTION 35 22 55

# VERTICAL LIFT GATE OPERATING SYSTEMS

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Summary of Work: The Work related to the rope drum hoist shall consist of the following tasks: detailed design, submittal of drawings and data, fabrication, shop testing, delivery to the site, installation, field checkout, startup, testing and placement into operation, including electrical equipment. The finished Work shall be complete, with all appurtenances, and all in accordance with these Specifications and as shown on the Plans.

B. Electrical equipment shall include control equipment, electrical control cabinet, wiring and all the required accessories.

C. The hoist shall be capable of raising and lowering the roller gate described in Section 35 20 16.53 ROLLER GATES under the design head condition.

D. Acceptable Suppliers: The suppliers of the design and fabrication of the rope drum hoist shall have been in the business of designing and fabricating similar equipment for at least fifteen (15) years and with at least five (5) working installations in the ten (10) years. The supplier shall be subject to approval by the District.

### 1.2 REFERENCES

Standards or Codes: The edition of the standards of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. See the various paragraphs for the specified standard. In the case of a conflict between the requirements of this SECTION and those of the listed document, the requirements of this SECTION shall prevail.

Aluminum Association (AA)

Standards and Data - Aluminum Standards and Data

American Institute of Steel Construction (AISC)

Manual of Steel Construction, Load and Resistance Factor Design

American Gear Manufacturers Association (AGMA)

| | |
|---|---|
| AGMA 9 | Gear Handbook |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI B1.1 | (2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form) |

| | |
|---|---|
| ANSI B30.7 | (2011)Base Mounted Drum Hoists |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A240/A240M | (2017) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| ASTM A27/A27M | (2017) Standard Specification for Steel Castings, Carbon, for General Application |
| ASTM A325 | (2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A36/A36M | (2014) Standard Specification for Carbon Structural Steel |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A227/A227M | (2017) Standard Specification for Steel Wire, Cold-Drawn for Mechanical Springs |
| ASTM A229/A229M | (2017) Standard Specification for Steel Wire, Quenched and Tempered for Mechanical Springs |
| ASTM A501/A501M | (2014) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing |
| ASTM A6/A6M | (2017a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A992/A992M | (2011) Standard Specification for Structural Steel Shapes |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B211 | (2012) Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire |
| ASTM E114 | (2015) Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Contact Testing |
| ASTM E709 | (2015) Standard Guide for Magnetic Particle Examination |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1 | (2015; Errata 1 2015; Errata 2 2016) Structural Welding Code for Steel |
| AWS D1.2 | (2014;Errata 1 2014;Errata 2 2008) Structural Welding Code for Aluminum |

FEDERAL SPECIFICATIONS (FS)

| | |
|---|---|
| FS RR-C-271D | Chains and Attachments, Welded and Weldless |
| FS RR-S-550D | Sockets, Wire Rope |
| FS RR-W-410D | Wire Rope and Strand |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE STD 112 | Polyphase Induction Motor and Generators |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | Motors and Generators |
| NEMA MG 2 | Safety Standard and Guide for Selection, Installation, and Use of Electrical Motors and Generators |

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI 1095 | Carbon Steel (UNS G10950) |
| AISI 8620 | Alloy Steel (UNS G86200) |

## 1.3 SYSTEM DESCRIPTION

A. General Requirements:

1. Hoist shall be complete and fully functional system with drums, drive shafts, couplings, worm gear reducers, sheaves, drive motor, brake, sheaves, wire rope fittings, welded rigid steel base frame, anchor bolts, electrical equipment, hoist cover, gate position indicator, slack cable limit switches, and accessories.

2. Each hoist shall be furnished as a complete unit capable of being installed and removed without breakdown into individual components (i.e. skid-mounted with anchor bolts to connect to the operating platform).

3. Drum and cable hoists must be designed and detailed for each specific installation. Sizes of structural members and components must be sized appropriately for the conditions provided in the design criteria.

4. Operation of the gates will be subject to automatic control based on headwater elevations as described in the Electrical Section.

5. Each gate shall operate at a speed of six (6) inches per minute plus or minus 10% with travel as shown on drawings.

B. Design Criteria:

1. Design Loading:

a. General:

i. Rated hoist capacity shall be calculated as specified under paragraph Operating Loading Conditions below.

ii. Walkways and stairs shall be designed for a normal loading of 100 lb/ft2 on the projected area of the entire walkway or stair.

iii. Railing shall be designed for a 200-pound concentrated load at any point on the top rail and 50 pounds/foot along the top rail.

b. Lifting Pins and Connections: Lifting pins and lifting lugs shall be designed for the rated hoist pull of the hoist.

c. Loading on Dogging Devices:

i. Loading on a dogging device shall be 150% of the load corresponding to the heaviest weight to be dogged. This load shall be considered evenly distributed between the dogging members.

2. Allowable Stresses:

a. Stresses in Steel Structures:

i. The design and allowable stresses for structural steel members shall be as per the AISC - Manual of Steel Construction, Allowable Load and Resistance Factor Stress Design.

b. Mechanical Components:

i. General: Working stresses, bearing pressures, and other design criteria for mechanical components including shafts, pins and gears shall be based on consideration of functional requirements, dynamic loadings, impact, and stress concentration effects. Stresses computed for rated hoist capacity shall not exceed 20% of the ultimate strength of the materials involved. Working stresses for stalled conditions (or by motor pull-out torque) may be increased to 90% of the minimum yield strength or elastic limit of the materials used.

ii. Wire Rope: For rated hoist capacity, tension in the wire ropes shall not exceed 20% of the breaking strength of the rope, and for stalled conditions it shall not exceed 70% of the breaking strength.

iii. Gears: Gears shall be designed to meet the requirements of applicable AGMA Standards. At rated loads and speeds, durability and strength rating of the gears shall be based on service factor of 1.15.

iv. Bearings and Bushings:

a) Average bearing pressures shall be calculated by dividing the bearing load by the effective projected area of the bearing.

b) For bronze bushings under normal loading condition, the average bearing pressure shall not exceed 10% of the yield point; the product of bearing pressure in pounds per square inch (psi) and circumferential velocity in ft/sec shall not exceed 1400.

c) For stalled conditions the limits may be multiplied by 2.25.

d) For permanent Self-Lubricating Bushings on corrosion-resistant steel pins ("Lubrite" or equal), average bearing pressure under the normal loading condition shall not be higher than 90% of the recommended value by bushing manufacturer, but in no case shall it be higher than 4200 pounds per square inch (psi).

e) The allowable average bearing pressure shall not exceed 7000 lb/in2 for loading caused by stalled conditions for self-lubricating bearing.

v. Anti-Friction Bearings: Anti-friction bearings shall be suitable for the respective application, shall have both inner and outer races, and shall conform to current standards of the Anti Friction Bearing Manufacturer's Association (AFBMA). Anti-friction bearings shall be selected to have an L-10 life of 50,000 hr under rated loaded conditions.

3. Operating Loading Conditions:

a. Force Components:

i. For calculating the operating loading conditions, either the maximum or minimum value shall be applied to each one of the force components, so that the most conservative results will be obtained.

ii. Weight: The nominal gate weight component shall also include the weight of the ballast (if any) and of any other gate-mounted equipment. The maximum weight component shall be the nominal weight increased by the weight of the connecting components between gate and hoist, and trapped water, as applicable.

iii. Buoyancy: The nominal buoyancy shall be calculated using the volume of the gate including ballast and any other gate-mounted equipment.

iv. Hydrostatic Effects: Nominal magnitude of hydrostatic effects shall be calculated using the design geometry of the part or detail under such effect and the applicable hydrostatic pressures.

v. Friction Forces: Maximum friction forces shall be calculated using design forces and maximum friction coefficients. Minimum friction forces shall be calculated using design forces and minimum friction coefficients.

b. Seals:

i. Normal force shall be calculated by summing the hydrostatic water load acting on the seal and the seal pre-compression force. Hydrostatic water load shall be calculated by considering the thrusts acting behind the seal and in front of the seal up to the centerline of seal contact and calculating the normal force caused by these thrusts directly or by their moments.

ii. Pre-compression forces as given by the seal manufacturer shall be used or if such data is not available, pre-compression forces shall be determined by tests performed by the manufacturer.

iii. Friction Coefficients for Seals

| | **Maximum** | **Minimum** |
|---|---|---|
| Rubber on steel | 1.0 | 0.3 |
| Rubber on corrosion-resistant steel | 0.8 | 0.2 |
| Fluoro-carbon on corrosion-resistant steel | 0.15 | 0.05 |
| Bronze on corrosion-resistant steel | 0.5 | 0.15 |

c. Roller Bearings: Friction coefficients of maximum 0.010 and minimum 0.00 shall be used. These friction coefficients shall be applied to the bearing bore.

d. Bottom Seal Compression Force shall be calculated by dividing the nominal weight of the gate minus nominal frictional forces and buoyancy, when the gate is nearly closed, by the length of the bottom seal. Bottom seal compression force shall not be less than 250 pounds per foot (lb/ft).

4. Combination of Force Components: Force components shall be combined according to the table "Force Combination Cases" below to establish the required operating forces.

5. Safety of Closure:

a. Safety of closure by gravity shall be demonstrated for all operating conditions including under dewatered condition.

b. Force combination Case I shall be used with an additional allowance equal to 15% of all negative force components. The sum of all force components, including additional allowance, shall be positive to demonstrate safety of closure.

6. Required Operating Forces:

a. All required operating forces shall be applied to the hoist connection points.

b. Required operating forces for the gate shall be calculated by gate operation under unbalanced head conditions. The required operating force shall be noted on the Shop Drawings submitted for review. Minimum unbalanced head condition shall be 25.2 feet; Engineer to

determine unbalanced head condition as specified in Section 35 20 16.53 ROLLER GATES

c. Required Pull Force: Force combination Case II (See Table below) shall be used to calculate required normal rated hoist pull, which shall be at least 120% of the sum of all force components.

d. Required Lowering Control Force: Force Combination Case III shall be used. Hoist rated lowering control capacity shall be at least 120% of the sum of all components.

| **Table: Force Combination Cases** | | | |
|---|---|---|---|
| | **Force Combination Cases** | | |
| | **I** | **II*** | **III** |
| Application Force Components | Safety of Closure | Normal Pull | Lowering Control |
| Weight | +0.95 Nom. | +1.05 Max. | +1.05 Max. |
| Buoyancy | -1.05 Max. | -0.95 Nom. | -0.95 Nom. |
| Hydrodynamic uplift | -1.1 Nom. | | |
| Hydrodynamic downpull | | +1.1 Nom. | +1.1 Nom. |
| Sliding friction | -1.3 Max. | +1.0 Max. | -0.8 Min. |
| Seal friction | -1.3 Max. | +1.0 Max. | -0.8 Min. |
| Guiding device friction | -1.5 Max. | +1.0 Max. | nil |
| Bottom seal compression | -1.0 Nom. | nil | nil |
| Additional allowances | -1.0 Nom. | +1.0 Nom. | nil |

7. Hoist

a. General: Design criteria used for hoist design shall ensure that the hoist can perform all operations as specified and can be safely operated under any loading condition in the environment for which it is intended.

b. Rated Hoist Capacity: Rated hoist capacity shall be considered evenly distributed between both drums of a hoist and on each rope of each drum.

c. Hoist Stalled Condition: Overload due to stalled hoist shall correspond to the breakdown torque (maximum torque) of the hoist motor. Gate shall be considered blocked and the pull forces evenly divided between both sides of the hoist. Minimum friction coefficients and maximum efficiencies shall be assumed in the system.

d. Efficiency and Friction: Efficiency of the hoist and their parts shall be calculated with the following assumptions:

i. Efficiency of drum equal to or less than 0.95.

ii. Friction coefficient between shafts and bearings: self-lubricating bronze bearings: 0.15, bronze: 0.30, roller bearings: 0.01.

iii. Meshing efficiency of straight gears (excluding bearing losses): 0.985 or less.

iv. Where friction acts to produce favorable calculation results, such as for stalled hoist loading, only 50% of friction coefficients and losses shall be considered.

8. Controls:

a. All equipment for local control of the hoist shall be supplied.

b. Local gate control cabinets shall provide an electrical interface for remote controls including remote position indication. These features shall be furnished for each individual hoist.

9. Life Expectancy: Mechanical computations based on life expectancy shall consider an equivalent service of 50,000 hours referred to nominal (rated or design) load; 10,000 starts shall be the basis of design for those parts whose design is governed by the number of starting and stopping operations.

1.4 GENERAL REQUIREMENTS

A. Standard Products:

1. All equipment, materials, and accessories to be furnished under this Section shall be the standard products of a manufacturer regularly engaged in the production of such items.

2. All equipment shall be suitable for long term exterior use in the hot, humid South Florida environment.

3. Design of equipment and materials shall be based on manufacturer's design calculations and experience but shall not be less than the values specified. Further, the selection, arrangement, and assembly of all circuitry and components thereof shall be accomplished by or under the direct supervision of a firm thoroughly experienced in providing such services.

4. All components of gate operating machinery shall be the products of reputable manufacturers with a reliable service network to promptly furnish any and all necessary spare, replacement, and worn-out parts upon request of the District.

5. Manufacturer's standard unit sizes are acceptable.

1.5 SUBMITTALS

SD-02 Shop Drawings

General arrangement drawings

Detailed shop drawings

Arrangement of the local control cabinet (LCC)

SD-03 Product Data

Catalog information

SD-05 Design Data

Design Calculations

Design and location of anchor bolts, bolt size, load on each bolt

Full line electrical diagram

Description of electrical controls

SD-06 Test Reports

Gate operator

Motor tests

Brake tests

Shop and Field Test Procedures

Shop and Field Test Results

SD-08 Manufacturer's Instructions

Storage and Handling Instructions

Installation Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual

SD-11 Closeout Submittals

As built drawings

1.6 SUBMITTAL REQUIREMENTS

A. General arrangement drawings showing the gate outline, hoist, support frames, and auxiliary equipment, indicating overall dimensions, tolerances and clearances with respect to the civil structures. These drawings shall include the list of various hoist components and the required operating capacity of the hoist.

B. Detailed shop drawings of hoist and hoist support structure, showing the details of rope drums, gearings, shafts, sheaves, brakes, base frame, including base plates & anchoring, position indicator, welding details including type of nondestructive tests proposed.

C. Design Calculations: Design calculations including structural analysis of hoist frame, dogging devices, anchors, bearing plates, walkway and other major items such as drum, sheaves, brakes, rope, gear reduction, considering normal as well as stalled conditions; required hoisting force calculations; motor horsepower calculations.

D. Catalog information on all electrical and mechanical standard purchased items, with selected model clearly marked and referenced to the relevant drawing number. In addition, the following information shall also be submitted.

1. Hoist Motor: Motor characteristics, curves or tabulated data (tested or calculated), indicating the speed, power factor, efficiency, current and kilowatt input, all plotted or tabulated against torque or percent of rated motor load.

2. Brake: Detailed descriptive data covering the brake, with necessary catalogue cuts, photographs, and drawings to indicate clearly brake construction and materials used; Releasing device specifications and characteristics, including input current and minimum voltage required for brake release.

3. Rotary Limit Switch: Detailed descriptive data covering its construction, range, rating, accuracy, and calibration for gate travel.

4. Slack cable limit switch.

E. Test Reports: The Contractor shall provide test reports for the gate operator, motor, and brake.

1. Gate operator shall be tested through the full range of gate travel and make adjustments made as required. Testing shall be accomplished in both a dewatered and flooded condition.

2. Motor tests shall be performed in accordance with the requirements of IEEE STD 112. Routine Tests shall include the following:

    a. Impedance

    b. Performance and general operation

    c. Insulation resistance (one point)

    d. Motor winding heater test:

        i. Successful operations

        ii. Dielectric

3. Brake tests shall include the following:

    a. Check operation of brake release at the specified rated brake torque for rated and 85% terminal voltage

    b. Insulation resistance of release magnet including leads and terminal block

c. Resistance measurement of release

d. Brake space heater test

i. Successful operation

ii. Dielectric

F. Operation and Maintenance Manual:

1. Detailed operating and maintenance instructions, which shall include reduced-size copies of applicable drawings, applicable parts lists, spare parts lists. Submittal shall also include catalogs covering all equipment furnished and which may be needed or useful in operation, maintenance, repairs, dismantling or assembling, and for repair and identification of parts for ordering replacements.

2. Operating and maintenance manual shall outline step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features.

3. Maintenance manual shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

G. Arrangement of the local control cabinet (LCC) including control panel layout and nameplate schedules, and point to point interconnections of control equipment.

H. Full line electrical diagram showing the power connection, control transformers, and other instruments.

I. Description of electrical controls.

J. As built drawings included all field modifications.

K. Shop and Field Test Procedures

L. Shop and Field Test Results

M. Storage and Handling Instructions: Detailed instructions shall be submitted for storage and handling of the equipment at the site prior to installation. The instructions shall include identification of parts requiring special outdoor, indoor, or temperature or humidity controlled storage for both long and short term storage; space requirement; procedure for unloading, placing, stacking, and blocking of equipment; and maintenance procedures for both long and short term storage. Short and Long terms shall be defined in calendar months.

N. Installation Instructions: Detailed step by step instructions for the installation of the equipment together with reduced size copies of applicable drawings shall be submitted for review before proceeding with the installation of the equipment. The instructions shall include information on slinging and handling major pieces of equipment, erection tolerances,

alignment of embedded parts, and any special precautions to be taken during installation.

O. Design and location of anchor bolts, bolt size, load on each bolt

1.7 SHIPMENT

A. Shipment Preparation: Prepare equipment and materials for shipment in a manner to facilitate unloading and handling, and to protect against damage or unnecessary exposure in transit and storage. Include:

1. Crates or other suitable packaging materials.

2. Covers and other means to prevent corrosion, moisture damage, mechanical injury and accumulation of dirt in motors, electrical equipment and machinery.

3. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel.

4. Grease packing or oil lubrication in all bearings and similar items.

B. Marking: Tag or mark each item of equipment or material as identified in the delivery schedule or on Submittals and include complete packing lists and bills of material with each shipment. Each piece of every item need not be marked separately provided that all pieces of each item are packed or bundled together, and the packages or bundles are properly tagged and marked. Mark partial deliveries of component parts of equipment to identify the equipment, to permit easy accumulation of parts, and to facilitate assembly.

1.8 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS

PART 2 PRODUCTS

2.1 GENERAL

A. General layout of an electric motor operated wire rope hoist shall be as shown on the Bid Drawings.

B. Each hoist shall be designed to perform its intended function in accordance with the requirements of the Contract Documents.

2.2 HOIST MOTOR

A. Motor Type: The hoist motor shall conform to the latest applicable standards of the ANSI, IEEE, and NEMA MG 1. Motor shall be designed for full voltage starting, reversing, and continuous full-load operation, 3 phase, 208 V, 60 Hz. Motor shall be NEMA Design B squirrel-cage induction type with a nominal speed of 1750 RPM, rated with a service factor of 1.15. The motor shall have Class F or better insulation with temperature rise in accordance with NEMA standards at 40 C ambient. Motor housing shall be totally enclosed fan cooled (TEFC) type. Motor terminal box shall be sized

to accommodate the splicing of the motor conductors. Lifting eyes (eye-bolts) shall be furnished for handling the motor.

B. Winding Heaters: Motor shall be equipped with winding heaters connected such that they are de-energized when the motor is energized. Winding heaters shall be 120 volt, with leads terminated in two-piece watertight motor terminal compartment secured to the motor frame. The terminal compartment shall have threaded conduit entrance. Motor shall be equipped with motor winding thermostats connected to the motor controls to de-energize the motor when overheated

2.3 BRAKE

A. Brake Rating: Hoist shall be provided with spring set, 120/208-VAC or DC electrical release shoe type brakes with a rated capacity of not less than 150% of the rated full load torque of the hoist motor. The torque rating shall be based on open construction, 1-hour duty. Brakes shall be arranged to set when the motor power supply is cut off or fails to release when the hoist motor is operated. The releasing magnets shall be thrust or torque motor operated of the AC shunt type and of standard stock design, suitable for operation on 120/140-V, 60-hz power at 85% of rated voltage. Manual release shall be provided to permit handcranking or portable power-drive operation. Brake enclosure shall be of weatherproof construction, with the upper half of the case removable for convenient access to the enclosed mechanism. Enclosure shall be equipped with a 115-V AC electric heater, controlled by the same contactor as specified for the motor heater. Means shall be provided for varying the holding torque and adjusting the position of the shoes to compensate for wear. Brake drum wearing surfaces, linkage bearings, and other miscellaneous small metal parts shall be corrosion-resistant. Insulation of electrical coils shall be moisture proof. Except for brake wheels, shoes, and electrical parts, no cast iron shall be used in brake construction.

B. Brake Enclosing Case: The outdoor NEMA Type 4-watertight enclosing case shall be in accordance with the manufacturer's standard practice for the conditions indicated. See Section 35 20 20 ELECTRICAL EQUIPMENT FOR GATE HOISTS for additional brake enclosing case requirements.

C. An AC Disc Brake shall be provided to hold the gate in the stationary open position when the motor is not in operation and in the case of power failure.

2.4 SPEED REDUCERS

A. Type: Speed reducers shall be designed, rated, and manufactured in accordance with AGMA standards. Speed reducers shall be of the double input/double output worm gear type with worm under arrangement for output shaft. Speed reducer unit shall be self-locking so as to prevent the over-speeding of load in lowering direction. Housing shall be rigid close-grained high tensile (minimum class 30) gray iron type (ASTM A319), to provide corrosion resistance and sound dampening characteristics. The motor shall be mounted on the speed reducer in such a manner as to permit easy removal.

B. Design Parameters: Motor horsepower and RPM shall be such that the motor and gear reducer combination supplies adequate torque for gate

raising, and that the resulting gate operating speed is as specified in paragraph 1.3.A.5.

C. Gearing: Worm gear shall be made from a centrifugally cast bronze alloy material meeting requirement of AGMA 9 or better. The running efficiency for a double reduction worm gear is assumed to be 35%. For the loaded start condition, 7% efficiency should be assumed. The worm gear reducer shall drive the two-transmission shafts which, in turn, are coupled to the cable drums. The gearboxes and associated power transmission components shall be designed, rated and manufactured in accordance to AGMA Standards.

D. Bearings: Bearings shall be antifriction, tapered roller type on all shafts and equipped with grease retaining rings and seals to allow bearings to be permanently lubricated. The overhung member on the input shaft and the output shaft shall be designed for 5,000 hours L-10 minimum bearing life (25,000 average hours).

E. Seals: Provide spring loaded lip oil seals on the input and output shaft.

F. Shafts: Speed reducer shall have double extended input and output shafts. Worm shaft shall be heat treated alloy AISI 8620 steel. All shafts shall be stress proof steel.

G. Keyway: Keyway shall be a standard keyway in accordance with the manufacturer's recommendations and designed to develop the full strength of the shaft. The minimum keyway size shall be 5/8 inches wide by 5/8 inches high, by 3 inches long. Key material shall have minimum compressive yield strength of 53,000 pounds per square inch.

## 2.5 DRIVE AND DRUM SHAFTS

Each shaft shall be solid and drilled and tapped on each end with a 1/2 inch diameter by 1 inch deep right hand thread, for rotary limit switches. The minimum specified shaft diameter shall be 2-1/2 inches based on AISI 1095 hot-rolled steel. A solid steel alloy drum shaft shall be provided and supported by rigid pillow blocks mounted on structural members of the hoist frame.

## 2.6 LIMIT SWITCH

A. Normal Operation: Limit switches shall contain all the contacts required for making and breaking control and interlocking circuits necessary for the proper control and operation in the manner specified or required.

B. Construction: The limit switches shall be of compact and rugged construction, totally enclosed in outdoor NEMA Type 4 watertight case, and include stainless steel mounting hardware. The cover shall be provided with cap screws or other approved means for readily breaking the cover free for removal unless the gasket is so designed that it will not stick. All parts shall be of corrosion-resisting metal or treated in an approved manner to render it resistant to corrosion. The switch shall permit final adjustment in the field. Tapped bosses shall be provided for making all conduit connections to the switch.

C. Switches: The Contractor shall provide snap acting contacts rated 10 amperes at 115 volts, minimum. The Contractor shall also provide suitable

terminals for connecting external conductors. The tripping mechanism shall be designed for fail-safe operation and shall reset the contacts when moving in the reverse direction.

D. Rotary Limit Switch: Provide worm and gear reduction rotary limit switch as described on the Standard Mechanical Detail Reference Drawings M17731 and the following specifications:

1. Provide a rotary limit switch to signal full open and full close gate positions

2. One normally open and one normally closed limit switch shall operate when the unit reaches full open and full close set points

3. The rotary limit switch enclosure shall be weather proof and rated NEMA 4

4. Mount enclosure on drum support member

5. Mount switch (GE CR115E421112) or approved equal at the end of the unit's cable drum shaft

6. Provide a 1/2 inch diameter stainless steel shaft extension threaded into the end of the drum shaft and a rubber jawed flexible coupling to the switch

7. Set points shall be field adjustable

8. The switch adjustments shall be at near mid travel when the rotary limit switch is properly calibrated

E. Slack Cable Limit Switch: Provide rotary lever type position switch as described on the Mechanical Detail Reference Drawing M177301 and the following specifications:

1. The switch shall be heavy duty, industrial grade, rotary lever type position switch with adjustable cast zinc lever arm, and length as required

2. Mount the switch on the support member of the hoist frame for activation by the release of the spring/cylinder under slack cable conditions

3. The tripping mechanism shall be designed for fail-safe operation and shall reset the contacts when moving in the reverse direction

4. Snap acting contacts shall be rated 10 amperes at 115 volts, minimum

5. All parts shall be corrosion-resistant

6. Enclosure shall be NEMA type 4 watertight case with stainless steel mounting hardware and tapped bosses for conduit connection

7. Spring shall be manufactured from oil-tempered ASTM A229/A229M hard-drawn ASTM A227/A227M rid steel wire with closed and ground ends

8. The spring shall be selected by the manufacturer based on the loading conditions

D. Accuracy of Trip and Reset

The design of the switch elements and operating mechanism of the limit switch shall provide for uniform and accurate setting. Switch shall be single turn with 1,000 counts per turn and a minimum of 16 set points. The switch shall accurately transmit position within + 3 inches and shall reset gate for drift exceeding 6 inches.

## 2.7 DRUM

Hoist drums shall be made of cast steel (ASTM A27/A27M Grade 70-40) or welded steel (ASTM A36/A36M) of sufficient strength to sustain the combined crushing and bending loads of the rope pull. The cable drum shall be sized in accordance with industry standards to reduce stresses on the wire rope for a longer service life. Drum and cable hoists shall be used to lift vertical lift roller gates of width greater than ten (10) feet. The cable drum shall be cast iron, cast steel, or a fabricated steel construction, and grooved to ensure the proper lay of the cable. Grooves shall have a minimum depth of 0.375 times the rope diameter. The minimum groove pitch shall be the rope diameter plus 1/8 in. The drums shall be designed so that not less than three (3) wraps of each part of hoisting rope will remain in the grooves when the hook is at the lowest position for the lift specified and so that at least two (2) reserve wraps are available, without overlapping of the rope, when the block is in the uppermost position corresponding to tripping of the block operated limit switch. The pitch diameter of the drums shall be not less than 24 times the rope diameter when 6 x 37 rope is furnished. Drum flange height shall be not less than 2.5 times the rope diameter. The drums shall be arranged in such a way that rope fleet angle does not exceed 3 degrees on either side for entire travel of gate.

## 2.8 TACKLE BLOCKS AND SHEAVES

The tackle blocks shall be all-steel, bolted construction, consisting of sheaves with bronze bushings, side plates and end fittings. Each hoist unit shall have an upper and lower tackle block of the size arrangement shown in the drawings. Tackle blocks shall be designed and rated for the working load limits and shall accommodate the required rope diameter (bronze bushed sleeves). The pitch diameter for running sheaves shall be not less than 24 times the outside rope diameter. The pitch diameter of equalizer sheaves shall not be less than one half of the diameter of running sheaves. The sheave pins shall be corrosion resistant. All sheaves shall be equipped with standard replaceable roller bearings with dust and water resistant seals. Each sheave shall be lubricated by an individual grease fitting.

## 2.9 WIRE ROPE AND FITTINGS

See Section 35 01 70.13 WIRE ROPE FOR GATE OPERATING DEVICES for wire rope and fittings requirements.

## 2.10 FLEXIBLE COUPLINGS

Flexible couplings shall have a minimum 2-1/2-inch bore to match shaft diameters. Couplings shall be provided with means for field adjustment and

with suitable means for permanent attachment to torque shafts after field adjustment.

2.11 GATE POSITION SWITCH AND INDICATOR ASSEMBLIES

General: The Gate hoist shall be provided with a potentiometer based gate position indicator arrangement as shown on the specification drawings. The LCC (local control cabinet) shall be equipped with a display unit to receive signals from the position transmitter and indicate the gate position. Position indication function shall be accurate within plus or minus 10 mm of gate travel.

2.12 PILLOW BLOCKS

Pillow blocks shall be split housing type, for easy removal of bearing from the shaft. All bearings shall be placed as closely as possible to the shaft loading points. Pillow blocks shall include accessible grease fittings. Bearing housing shall be held securely and accurately to alignment by means of fitted bolts, dowels, or shear lugs, which shall also resist all lateral forces, without considering any lateral resistance due to fasteners or friction. Bearings shall have oil-tight enclosures which will preclude the entrance of foreign matter. Special covers or other devices shall be furnished to protect the bearings against entry of dust and rain

2.13 HOIST FRAME

A. All equipment shall be mounted on a structural steel frame to form a single self contained unit as indicated in the contract drawings in accordance to ASTM A36/A36M Steel.

B. The frame shall be a rigid design to limit deflection that could damage or disturb the alignment of the supported mechanical components. Mounting shall be common type readily available from stock.

C. Provide aluminum diamond plate over the areas of the frame which are above the galvanized steel fasteners.

D. Provide lifting hooks for handling the hoist, if required.

E. Components:

1. Steel: unless otherwise indicated or specified, W shapes to conform to ASTM A992/A992M, channels to conform to ASTM A572 GR/ 50, angles and plates to conform to ASTM A36/A36M, and steel pipe to conform to ASTM A501/A501M

2. Stainless Steel: conform to ASTM A240/A240M, type 316

3. Connection bolts, nuts and washers:

   a. Bolts shall conform to ASTM A325, unless otherwise indicated or specified

   b. Galvanized when connecting to galvanized steel.

   c. Welding: All welding shall be shielded metal arc, submerged arc or flux cored arc. Other welding processes may be used if qualified by

applicable tests as prescribed in the AWS D1.1 code. Use E70 electrodes for shielded metal arc welding, F7 series electrodes for submerged arc, and E70T series electrodes for flux cored arc welding.

d. Galvanizing: Galvanize steel after fabrication to conform to ASTM A123 and ASTM A153/A153M, where indicated or specified. Nuts, bolts, and washers may be hot-dip galvanized to conform to ASTM A153/A153M.

F. Steel frame fabrication:

1. Fabricate all steel to conform to AISC specifications, codes, and standards

2. Permissible variations for sweep, camber, length and cross-section of all steel members shall conform to ASTM A6/A6M, AISC Manual of Steel Construction, Part 1 and AISC Quality Criteria and Inspection Standards , unless indicated otherwise

G. Contractor shall coordinate final dimensions with specific equipment provided.

2.14 COVERS

Hinged, flip-up housings shall be provided for the wire rope drums and the gears. Housings and enclosures shall be dust-resistant and weatherproof constructed of aluminum not less than 10 gage thick for permanent outdoor installation. Housings shall provide easy and convenient access to lubricating points. All lubricating points shall be provided with drip trays. Design shall provide for easy cleaning and emptying of trays. Exposed portions of shafts shall be treated with manufacturer's standard primer and two coats of moisture proof varnish.

2.15 NAMEPLATES

A. Nameplates shall be provided and attached to the motor frame and a part of the brake which ordinarily will not be renewed during its life service.

1. Nameplates attached to a part of the brake shall clearly indicate the manufacturer's name, identification symbols, serial number and salient design features such as type, frame, torque, rating, voltage, phase and frequency.

2. Nameplates attached to the motor frame shall indicate clearly motor characteristics per NEMA MG-2 and show a lead connection diagram. Identification or serial numbers shall be die stamped on the frame.

B. Nameplates shall conform to standard practice using permanently embossed or engraved lettering.

C. If adjustment to the nameplate is required, pertinent information for making adjustments shall be provided.

## 2.16 ALUMINUM CHECKERED PLATE

Fabricate from Alloy 6061-T6, pattern tolerances in accordance with AA Standards and Data; 3/8 inch thick unless indicated otherwise on Drawings. The Contractor shall provide stiffener angles at checkered plate joints welded to one plate and fastened to other plate. The Contractor shall also provide stiffener angles, bars or other supports to limit deflection to 1/300 of span.

## 2.17 WELDING

Welding shall be performed in accordance with AWS D1.1 and AWS D1.2.

## 2.18 GREASE

The grease shall be nontoxic of the type used in the food industry, shall be water resistant, shall have rust and corrosion inhibitors and a NLGI 1 grade. The grease shall be 4024 Quinplex Food Industry Lubricant as manufactured by Lubrication Engineers, Inc., Fort Worth, Texas 76111, or approved equal.

## 2.19 QUALITY CONTROL REQUIREMENTS

A. Tests of Materials:

1. General: All materials or parts used in the equipment shall be tested, in conformity with applicable methods prescribed by the ASTM, or such other organization as may be specifically required, and in general accordance with the best commercial methods.

2. Nondestructive Tests: All hoist drums and drum shafts shall be ultrasonically tested in accordance with the ASTM E114.

B. Workmanship:

1. General:

   a. All work shall be performed and completed in a thorough workmanlike manner and shall follow the best modern practices in the design and manufacture of hoist. All work shall be done by personnel skilled in the related professions. All parts shall be made accurately to standard gages so as to facilitate replacement and repairs. All bolts, nuts, screws, rivets, threads, pipe, gages, gears, and measurements or dimensions shown on the Drawings shall conform to US standards. All special gages and templates necessary for field erection shall become the property of the District.

   b. Like parts shall be interchangeable wherever possible. Machining of fits on renewable parts shall be accurate and to specific dimensions so that replacements made to the size shown on the Shop Drawings may be readily installed.

2. Welding:

   a. General: All welds shall be continuous and watertight. All welding shall be performed by the electric-arc method, by a process that excludes the atmosphere from the molten metal, and where

practicable, by automatic machines. Machined surfaces of parts affected by welding shall be machined to final dimensions after welding. Machined surfaces of parts requiring stress relief shall be machined to final dimensions after the parts have been stress relieved. Localized stress relieving shall not be performed on shop welded parts.

b. Minimum Weld Requirements: The minimum size of fillet welds shall be in. measured on the leg except if otherwise specified. Welds larger than 3/8 in. shall be made in not less than 2 passes. All groove welds including butt welds shall be full penetration, welded from both sides.

c. Preparation of Base Material: Members to be joined by welding shall be cut to shape and size by mechanical means such as shearing, machining, grinding, or by gas or arc cutting, to suit the conditions. The design of welded joints and the selection of weld filler metal shall allow thorough penetration and good fusion of the weld with the base metal. The edges of surfaces (up to the thickness of the metal) to be welded shall be sound metal free of visible defects, such as laminations or defects caused by cutting operations, and free from rust, oil, grease, and other foreign matter.

d. Technique of Welding: The technique of welding, the appearance and quality of the welds, and the methods used in correcting defective work on structural steel shall conform to AWS D1.1. Special care shall be taken to avoid undercuts along the seams or warping of the structure. If undercuts appear along the welds, they shall be filled using a small diameter electrode of the same composition as the original electrode after slag, if any, is removed. Continuous and uniform maintenance of preheat and inter-pass temperatures will be required for all welds. Local preheating shall be used only for repairs on welds. Preheat and inter-pass temperatures shall also be as outlined in the welding procedure according to the applicable sections of AWS D1.1.

e. Welding Qualifications: The qualification of welding procedures, welders, welding operators, and tackers shall conform to standards at least equal to Section 4, Qualification of AWS D1.1 (for structural steel welding). The Contractor shall furnish all facilities and all equipment, materials, and other articles required to conduct qualification tests of his welders and welding operators. Certificates of welders' qualifications shall be submitted when requested.

f. Weld Finish: Welds shall in general be treated so that they will display good appearance and a surface suitable for painting. Structural welds shall be ground and blended to avoid stress raisers. All welds that require nondestructive examinations shall be dressed by chipping and grinding as required for good interpretation by the selected weld examination methods.

3. Castings:

a. General: Castings shall be free from injurious defects and shall be satisfactorily cleaned for their intended use. All bronze

castings for bushings and bearings shall be centrifugally cast. Surfaces of castings which are not machined shall be dressed for good appearance and for painting. The location of existing defects shall be determined, and all defects which impair the strength or utility of the casting shall be removed to sound metal before repair. The structure of the castings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a casting will be cause for its rejection.

b. Repair Welding: Minor defects that will not impair the strength or serviceability of the castings may be repaired by welding in accordance with accepted foundry practice. Defects shall be considered minor when the depth of cavity properly prepared for welding is not greater than 25% of the actual wall thickness but in no case greater than 3/4" in. and when the area to be welded is smaller than 8 inches square. However, an accumulation of minor defects which casts doubt as to the general quality of the casting shall be considered as a major defect. If removal of defects reduces the stress-resisting cross-section of the casting by more than 30%, the casting may be rejected. All castings repaired by welding of major defects after heat treatment shall be heat treated again.

C. Shop Assembly and Tests:

1. The hoist shall be completely assembled and tested in the shop to verify that all parts properly fit and operate as specified. The field connections between the various components shall be fitted and checked in the shop to assure proper fit during field erection. The hoist shall be operated and checked for proper controls. Reeving of drums and sheaves will not be required. The hoist shall be carefully match marked before dismantling for shipment.

2. All control elements, including brakes and limit switches, shall be connected and operated for the shop test. The control shall be tested and all relay operations checked.

D. Nondestructive Testing.

1. General: Unless otherwise indicated, all nondestructive tests shall be in accordance with the applicable sections of ASTM Volume 03.03. The Shop Drawings submitted for review shall define the areas, extent, and type of nondestructive examination to be employed.

2. Examination of Welds: All butt welds shall be given complete nondestructive examination by magnetic particle testing, supplemented on a spot check level by ultrasonic testing. All other welds shall be examined by dye penetrant method throughout their entire length. The District shall have the right to request random spot-check examination of welds, as part of the equipment inspection. Examination of welds shall be in accordance with the technique and acceptance standards of AWS D1.1.

3. Examination of Castings: All castings shall be given a magnetic particle testing, both, before and after the final heat treatment in accordance with ASTM E709 or equivalent.

4. Examination of Forgings: Major forgings shall be given ultrasonic examination and other applicable nondestructive tests, to determine that they are sound. Nondestructive examination of minor forgings shall be in accordance with accepted good practice to assure their soundness, and the type of examination shall be indicated on the Shop Drawings. The structure of forgings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a forging will be cause for its rejection.

E. Machine Work:

1. General: Sufficient machining stock shall be allowed on all parts to be machined to ensure true finished surfaces of solid material. Finished contact or bearing surfaces shall be true and exact to secure full contact. Journal and sliding surfaces shall be polished, and all surfaces shall be finished with sufficient smoothness and accuracy to insure proper operation when assembled. No machining shall be done on working surfaces of self-lubricating bushings or washers.

2. Finished Surfaces: All surfaces that require machining for their intended function and those surfaces that are normally machined in good shop practice shall be machined.

3. Pins and Pin Holes: Pin holes shall be drilled smooth and straight and at right angles to the axis of the member. The drilling shall be done after the member is securely fastened in position and shall be line bored in one set-up where practicable.

4. Unfinished Surfaces: All work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the Drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in an approved manner.

5. Assembly: Before assembly, all bearing surfaces, journals, and grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. Solvents shall not be used on self-lubricating bearings. After assembly, each lubricating system shall be filled with an approved lubricant. Self-lubricating bearings shall not be greased and shall be assembled dry according to the manufacturer's instructions.

6. Surface Finish: The qualities of all surface finishes shall be selected with due regard for the nature and function of the surface and in accordance with conservative design practice.

7. Tolerances: Tolerances shall be selected by the Contractor to correspond to the accuracy required for the proper operation of the equipment, considering the nature and function of the part.

## 2.20 PAINTING

Shop finishing (for all components not Stainless Steel or Galvanized):

A. Protective Coatings:

1. Coating systems include surface preparation, prime coat, finish coats, inspection, cleaning, and touch-up of surfaces and equipment

2. Concealed surfaces are not required to have finish coats, but prime coat should be applied and touched up prior to concealment

3. All structural steel and the mechanical assembly shall be painted gray

B. Coating Systems: (Section 09 06 90 PROTECTIVE COATINGS)

1. Structural steel frames and support steel: System S-2

2. Reduction gear housing, couplings, pillow blocks, motor and brake: System S-2

# PART 3 EXECUTION

## 3.1 INSTALLATION

A. All items of equipment furnished under this Section shall be installed at the locations indicated on the Drawings according to manufacturer's recommendations and to the American Standards and Recommendations. Each hoist unit shall be properly aligned and secured on the concrete operating platform as indicated on the Drawings. All anchor bolts shall be accurately set with the use of a template and firmly held in position at the time of placing the concrete. Where it is impracticable to place anchor bolts for installation of comparatively light metal accessories before the concrete is placed, holes shall be drilled in the concrete and concrete anchors installed as directed. The wire rope hoisting cables shall be properly revved through the hoist mechanisms, attached to the gate connections and adjusted for uniform loading. All work of installation shall be done by personnel skilled in the particular trade. Competent supervisors shall direct the installation of all equipment. All moving parts of mechanical equipment and machinery shall be carefully and accurately installed, tested for proper operation and adjusted so that all parts move freely and function properly.

B. Erection Supplies: All labor, tools, supplies, bracing, spiders, shims (including special shim to suit a particular item of equipment), temporary fixtures, alignment tools, clamps, and all other items or materials necessary to assemble, erect, and install the hoist in a thorough workmanlike manner shall be provided. The proper grades and centerline to which hoist is to be set shall be established. Items to be grouted shall be checked for alignment, clearances, and fit before grouting.

C. Field Welding: All field welding required on the parts to be modified at the project site and any welding required for proper erection and installation of the equipment shall be performed. The welding procedures and welder s qualification shall be per AWS D1.1. The equipment, materials, consumables, facilities, and labor for non-destructive testing of welds shall be furnished by the Contractor.

D. Preliminary Checks: Before field assembly and erection, the hoist equipment shall be examined for damage during shipment. It shall be checked for rain or moisture damage to motors and panels, inadequate painting, accumulations of dirt and rubbish, and oil leaks.

## 3.2 FIELD SERVICING

After final installation has been completed, all hoist unit subassemblies, including sheaves, shall be greased. The wire ropes shall be wiped with wire rope lubricant. After all servicing has been completed; the gate operating machinery shall be tested, regulated, and adjusted for satisfactory operation. The Contractor shall perform all servicing, testing, and adjusting in the presence of one or more representatives of the hoist unit manufacturer who shall advise and assist in these operations. Any changes or adjustments required to secure completely satisfactory operation shall be made by and at the expense of the Contractor.

## 3.3 FIELD TESTING

Field testing shall include a load test on each hoist unit while the gate is in the dry, using a dial type strain gage interposed between one gate hoist base connection and its respective hoist rope socket and a length-equalizing link between the other base connection and its hoist rope socket. The strain gage, equalizer link and all necessary pins, shackles and accessories will be furnished by the District. The gate will then be raised and lowered by the hoist through three complete cycles (or as near complete travel as is possible with the strain gage in position) and simultaneous readings taken on the rope load, motor current and line voltage for each 6 inches of gate travel, except that motor readings will not be taken while lowering the gate. The above-described tests will be conducted by the Contractor in the presence of the Contracting Officer. Above test shall be repeated to verify hoist rated capacity, under wet condition with gate under full design head, unless such test is waived by the District. See Section 35 20 20 ELECTRICAL EQUIPMENT FOR GATE HOISTS for additional testing requirements. The Contractor shall furnish a written record of the tests in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

-- End of Section --

# SECTION 35 31 18

# MARINE MATTRESS

## PART 1 GENERAL

### 1.1 SCOPE

A. Summary of Work: The Contractor shall furnish all labor, equipment and materials necessary for performing all operations required to provide marine mattress with structural geogrid, braid, mechanical connection elements and stone fill as specified herein and shown on the Drawings. The geogrid material for the mattress shall include sufficient quantities to form lifting hoops for the units. Fabrication, filling and placing marine mattress units shall be in accordance with this Section and in reasonably close conformity with the lines, grades and dimensions shown on the Drawings or approved by the District. The marine mattress is to be used as the bedding for all riprap that is to be constructed underwater (in the wet).

B. Related Work Specified Elsewhere:

1. Section 01 33 00 SUBMITTAL PROCEDURES

2. Section 35 31 19 RIPRAP SYSTEM

### 1.2 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D1388 | (2018) Standard Test Method for Stiffness of Fabrics Option A |
| ASTM D4355/D4355M | (2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus |
| ASTM D4759 | (2011; R 2018) Standard Practice for Determining the Specification Conformance of Geosynthetics |
| ASTM D6637 | (2011) Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method |
| ASTM D7737 | (D2015) Standard Test Method for Individual Geogrid Junction Strength |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA SW-846 | (Third Edition; Update IV) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods |

1.3 SUBMITTALS

A. Submittals shall be accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

B. Submittals shall include the details of mattress filling and closing, lifting, transporting, and stacking.

SD-02 Shop Drawings

Proposed layout, mattress dimensions, and quantities

Fabrication of the marine mattresses including all connections

SD-04 Samples

Geogrid

Braid

Mechanical Connection Elements

Filter fabric

SD-06 Test Reports

Dive Video

Survey Report

SD-07 Certificates

SD-08 Manufacturer's Instructions

Proposed plan

1.4 SUBMITTAL REQUIREMENTS

1.4.1 Marine Mattress

1. The shop drawings shall show proposed layout, mattress dimensions, and quantities.

2. Marine Mattress Installation: Shop drawings showing the mattress layout patterns for the Project in relation to the feature alignment, including but not limited to mattresses tying into existing riprap and terminating at the Project extents. The layout shall meet all requirements as shown on the Drawings and included specifications.

3. Marine Mattress: The Contractor shall provide shop drawings, specifically for this Contract, depicting the fabrication of the marine mattresses including all connections.

1.4.2 Samples

Contractor shall submit samples of geogrid, braid, mechanical connection elements, and filter fabric for District approval.

1.4.3 Proposed Plan

The Contractor shall submit for approval its proposed plan for fabricating and filling the marine mattresses. Equipment, labor, materials, and methods shall be detailed for this task, as well as submit manufacturer's fabrication instructions, if a pre-assembled system is selected from a system supplier, installation instructions and general recommendations.

1.5 DEFINITIONS

A. Marine Mattress: A non-metallic compartmental structure filled densely and tightly with stone prior to installation. Units are comprised of structural geogrid, braid, and mechanical connection elements fabricated to allow placement and provide containment of aggregate fill.

B. Flexural Stiffness (Also Known as Flexural Rigidity): Resistance to bending force measured via ASTM D1388. Values shown are minimum average roll values.

1.6 DESCRIPTION

The compartmental rectangular mattresses, lined with filter fabric, shall be filled with stone. The required width and depth of the mattresses shall be as shown on the Drawings. The mattresses may be fabricated and filled on-site, for lifting into place. The Contractor shall have the proper lifting equipment (including spreader bar) to lift and place the mattresses.

1.7 STORAGE

A. The mattress materials shall be stored in conditions as recommended by the materials manufacturer. The Contractor shall prevent excessive mud, wet cement, epoxy, and like materials from affixing to the mattress materials. Stockpiles of mattresses, at the point of fabrication and at the Site, shall be covered and protected if not installed within one (1) month of production.

B. Mattresses shall not be stacked higher than four (4) mattresses high at all time.

1.8 ON-SITE TECHNICAL ASSISTANCE

The Contractor shall coordinate for a qualified representative of the marine mattress supplier to be present at the job Site during the first week of preparation and installation to provide technical assistance as needed. The Contractor shall remain solely responsible for the quality of the marine mattress and the installation.

1.9 QUALITY ASSURANCE

Prior to the installation of the units, the Contractor shall arrange a meeting at the Site with the system supplier, if applicable, and, where applicable, the system installer. The District shall be notified in writing at least three (3) working days in advance of the time of the meeting. The Contractor shall coordinate for a qualified representative of the marine mattress supplier, if applicable, to be present at the Site during the first week of installation to provide technical assistance as needed. The Contractor shall remain solely responsible for the quality of installation.

1.10 QUALIFICATION OF CONTRACTOR

The Contractor conducting the marine mattress placement work shall possess a minimum of 10 years' experience in the construction of underwater structures.

1.11 WARRANTY

The Contractor shall warrant the Work against defects for one (1) year from the date of Substantial Completion and as described in Article 13 of Section 00700 GENERAL TERMS AND CONDITIONS.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Structural Geogrid for Marine Mattresses

The structural geogrid shall be an integrally formed grid structure manufactured of a stress resistant polypropylene or high density polyethylene (HDPE) material with molecular weight and molecular characteristics which impart high resistance to loss of load capacity or structural integrity when the geogrid is subjected to mechanical stress in installation and/or long-term environmental stress. The geogrid shall possess the following minimum properties: Mechanical Connection Elements: Bodkin type connector rods, unless otherwise approved by the District, shall be 3/8-inch diameter, round and composed of HDPE.

| | **MD/XMD(1)** |
|---|---|
| True Initial Modulus at 1% Strain(2), lb/ft | 24,000/28,400 |
| Junction Strength(3) | 1665/1911 |
| Flexural Stiffness(4), mg-cm | 2,000,000 |
| Aperture Size, in. (Nominal) | 1.0/1.2 |
| Minimum Rib Thickness, in. (nominal) | 0.07 |
| Resistance to long term degradation(5) | 100% |
| Resistance to installation damage (GP) | 85% |
| Resistance to UV Degradation(6) | 98% |

Note:

1. MD = Machine Direction (longitudinal), XMD = Cross Machine Direction (transverse direction). MD dimension is along roll length. XMD dimension is

| | MD/XMD(1) |
|---|---|
| across roll width. Unless indicated otherwise, values shown are determined in accordance with ASTM D4759. Brief descriptions of test procedures are given in the following notes.<br><br>2. True resistance to elongation when initially subjected to a load measured via ASTM D6637 without deforming test materials under load before measuring such resistance or employing "secant" or "offset" tangent methods of measurement so as to overstate tensile properties.<br><br>3. Load transfer capability determined in accordance with ASTM D7737.<br><br>4. Resistance to bending force measured via ASTM D1388.<br><br>5. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments measured via EPA SW-846,EPA 9090 Method immersion testing.<br><br>6. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D4355/D4355M. | |

2.1.2 UV Stabilized Braid

The braid material, unless otherwise approved by the District in writing, shall be a hollow-core polyethylene braid and shall have a minimum diameter of 3/16-inch (nominal) with a breaking strength of not less than 400 lb load on a test specimen 36 inches in length. The braid shall be UV stabilized.

2.1.3 Filter Fabric

Filter fabric shall be as specified in Section 31 05 19 GEOTEXTILE.

2.1.4 Stone Fill Materials

The stone fill material shall correspond to the bedding stone size designed for the overlying rubble riprap as specified in Section 35 31 19 RIPRAP SYSTEM as well as the manufacturer recommendations.

2.1.5 Geogrid Extension

Geogrid shall be integrally formed structural geogrid. The geogrid shall meet the same minimum material properties as the structural geogrid for marine mattress in subparagraph STRUCTURAL GEOGRID FOR MARINE MATTRESSES.

2.1.6 Depth

Refer to Drawings for depth of marine mattress.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

The Contractor shall check the geogrid, braid and mechanical connection elements upon delivery to verify that the proper material has been received.

These materials shall be inspected by the Contractor to be free of flaws or damage occurring during manufacturing, shipping, or handling.

3.2 TEST MATTRESS

A. General: The Contractor shall fabricate a test mattress (geogrid, filter fabric and stone). The District shall be present during the assembly of the test mattress. The test mattress shall be fabricated at the location/facility where all the mattresses are to be fabricated. The Contractor shall utilize and demonstrate the personnel, equipment, materials, and methods proposed in the approved work plan for fabricating the mattresses. The Contractor shall not fabricate any other mattresses until the test mattress is approved by the District in writing. Photos of the fabrication operation shall be taken.

B. Coordination: The Contractor shall provide 14 calendar days advance written notification to the District prior to commencing the construction of the test mattress.

3.3 FINAL FABRICATION AND FILLING

A. General: Empty mattress units shall be fabricated as recommended by the materials manufacturer and as indicated on the Drawings. The joints where the ends and baffles of each unit join the top or bottom of the unit shall be made with a mechanical connection.

B. Seaming: The joints along the sides of each unit shall be secured by seaming with braid using a lock-stitch configuration to provide complete closure of each unit. All cut ends of braid material shall be knotted within one (1) inch to two (2) inch of the end to prevent raveling of the braid material. The braid material shall be securely knotted to the geogrid at all ends of all stitched seams, and at a spacing not to exceed six (6) feet along any stitched seam. Pieces of braid material may be spliced end to end by securely knotting. The stitches along each seam shall be sufficiently tight to close the gap between the adjacent pieces of geogrid. The braid material shall be stitched through each pair of apertures along each seam at least once. The spacing of stitches shall be reasonably uniform at approximately six (6) (minimum) stitches per foot along the entire length of each seam. The braiding shall be sufficiently tight to prevent openings greater than one (1) inch along the seam but shall not be cinched so tightly that overlaps and binding result.

C. Lifting Hoops: Lifting hoops shall be formed by joining the top and bottom layers of grid from each unit by means of approved mechanical connections.

D. Filter Fabric Inside Mattresses:

1. The properties of the filter fabric shall be in accordance with Section 31 05 19 GEOTEXTILE.

2. The inside of the marine mattresses shall be lined with filter fabric. Each individual compartment of the marine mattresses shall be lined with one continuous piece of filter fabric. The completed mattresses shall consist of stone-filled compartments in which the stone is completely wrapped, top, bottom, sides, ends, diaphragms (both sides), in filter fabric. Fabric overlaps shall occur along the top of each

compartment and shall be a minimum of one foot. All fabric that is torn or punctured, prior to filling, shall be replaced by the Contractor at no additional cost to the District.

E. Extensions: The two (2) foot geogrid extension shall be attached to the marine mattresses as indicated on the Drawings. Filter fabric shall be attached to a portion of the underside of the mattress and the geogrid extensions utilizing fasteners spaced a maximum of 12 inches apart. The filter fabric shall be one continuous piece. The filter fabric shall be attached to the required portion of the underside of the mattress and the mattress's extension as shown in the Drawings.

F. Filling with Stone:

1. The stone fill material shall correspond to the bedding stone size designed for the overlying rubble riprap as specified in Section 35 31 19 RIPRAP SYSTEM.

2. Each unit shall be filled and the fill densified while the unit is supported in an upright position resting on its side. The filling sequence of the compartments within each unit shall be appropriate to prevent excess deformation or displacement of the interior diaphragms. Densification of the stone fill material and complete filling of each compartment shall be accomplished by rodding and/or vibration. The mattresses shall be filled with stone prior to placement as specified below. During stone filling operations, the Contractor shall take care to protect the mattresses and filter fabric from all damage such as crushing, breaking, excessive bulging, tearing, etc. by use of wood forms. Stone filling operations shall carefully proceed with placement by hand or machine to assure a minimum of voids between the stones and to avoid deformation throughout the filling process. The maximum height from which the stone may be dropped into the basket units shall be one (1) foot. The stone shall be overfilled to allow for raking the stone level with the top of the mattress. When filling and fabrication of a unit are complete, the unit shall be rotated to a horizontal position resting on its bottom in order to facilitate subsequent lifting.

G. Closing Mattresses: The filter fabric shall be protected and carefully handled during the lid closing operation. The mattresses shall be closed over the stone as recommended by the materials manufacturer. Mattress lids shall be attached to the perimeter and diaphragms of the mattresses using braid with half hitches and a knot spaced six (6) to nine (9) inches apart.

## 3.4 PROTECTION OF MATTRESSES DURING TRANSPORTATION

The Contractor shall utilize appropriate methods to protect the edge and corners of the mattresses during transportation.

## 3.5 PREPARATION

Subgrade: The subgrade soil shall be prepared as indicated on the Drawings or as directed by the District.

## 3.6 INSTALLATION

A. Position: The units shall be placed in a staggered position at the proper elevation, alignment and orientation as shown on the Drawings or as directed by the District.

B. Installation of Mattresses: During movement and placement of the pre-filled mattresses the Contractor shall insure that the mattresses are supported throughout their entire length and that the mattress and fasteners are protected from being damaged. All adjoining mattresses shall be overlapped along the entire perimeter of their contact surfaces in order to obtain a monolithic structure. Adjoining mattresses shall be set to the required lines and grades as shown on the Drawings. The units shall be placed at the proper elevation, alignment and orientation as shown on the Drawings. The procedure used in placement of the units shall be in accordance with the recommendations of the manufacturer, if applicable, and as approved by the District in writing. For lifting of each unit, a spreader beam and/or spreader bars shall be used in a manner that the unit is not subjected to severe bending or distortion and that the top and bottom layers of geogrid are tensioned uniformly across their width. Units should generally be lifted from a horizontal position. Personnel shall stay clear of the area beneath units and rigging during lifting. Any gaps between adjacent mattresses or a mattress and a structure interface as found by surveys or visually shall be filled with bedding stone as defined and described in Section 35 31 19 RIPRAP SYSTEM to an elevation even with the top of the marine mattress to a tolerance of +4 inches minus 0-inches.

C. Splicing and Anchoring: Where applicable, splicing and/or anchoring of the units shall be accomplished as shown on the Drawings, the shop drawings, or as directed by the District.

D. Construction Tolerances: Horizontal tolerances are the minimum and maximum spacing between adjacent mattresses or a mattress and structure interface. (i.e. The gap between adjacent mattresses or mattress and a structure shall be no greater than 0.5 feet.)

| **Vertical Tolerances** | |
|---|---|
| **Above Neatline** | **Below Neatline** |
| 0.5 feet | 0.5 ft |
| **Horizontal Tolerances** | |
| 0.0 feet to 0.5 feet | |

## 3.7 REPAIR

Damaged geogrid shall be repaired by placing a geogrid patch over the damaged area such that it overlaps onto the acceptable geogrid material by at least one foot in all directions; the perimeter edges of the patch shall be attached to the mattress in accordance with the seaming requirements, above. Damaged braid shall be repaired by installing a new braided seam in accordance with above and extending at least one foot in either direction beyond the location of the damaged braid. Any measures required will be at no additional cost to the District.

## 3.8 SURVEY REQUIREMENTS

The Contractor shall conduct survey periodically for real-time confirmation of the placement location and elevation of the installed SF marine mattresses.

## 3.9 CONTRACTOR QUALITY CONTROL

A. The Contractor shall use divers at all times to guide the placement of mattresses under water to ensure proper placement to meet all requirements as shown on the Drawings and included specifications.

B. The Contractor shall conduct an inspection of each fabricated mattress prior to and after filling with stone. The results of these inspections shall be documented in the daily Quality Control reports.

C. Before the placement of riprap, The Contractor shall conduct an underwater inspection and survey. The results shall be documented in dive video and survey report and shall be provided to the District prior to the placement of riprap above the marine mattress.

-- End of Section --

# SECTION 35 31 19

# RIPRAP SYSTEM

## PART 1 GENERAL

### 1.1 SCOPE

A. Summary of Work: The Contractor shall furnish all labor, equipment, hauling and materials necessary for the proper placement of stone riprap, bedding stone and geotextile where indicated. Riprap stone shall consist of either limestone or granite as indicated on the drawings.

B. Related Work Specified Elsewhere: There are other specification sections that relate to this section that are not necessarily cited herein. See Section 35 31 18 MARINE MATTRESS for bedding for riprap placed in the wet.

### 1.2 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C127 | (2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate |
| ASTM C295/C295M | (2012) Petrographic Examination of Aggregates for Concrete |
| ASTM C33/C33M | (2018) Standard Specification for Concrete Aggregates |
| ASTM D3744/D3744M | (2011a) Standard Test Method for Aggregate Durability Index |
| ASTM D5240/D5240M | (2013) Standard Test Method for Evaluation of Durability of Rock for Erosion Control Using Sodium Sulfate or Magnesium Sulfate |
| ASTM D5312/D5312M | (2012; R 2013) Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions |
| ASTM D5313/D5313M | (2012; R 2013) Evaluation of Durability of Rock for Erosion Control Under Wetting and Drying Conditions |

| | |
|---|---|
| ASTM C535 | (2016) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO T 85 | (2014; R2018) Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate |
| AASHTO T 210 | (2015) Standard Method of Test for Aggregate Durability Index |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Constructions |

FLORIDA METHODS (FM)

| | |
|---|---|
| FM 5-538 | Sampling and Testing Riprap Material |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| ERDC/GL TR-81-8 | Evaluation of Quality and Performance of Stone as Riprap or Armor |
| EM 1110-2-1601 | (1991; 1994 Change 1) Engineering and Design -- Hydraulic Design of Flood Control Channels |
| EM 1110-2-1100 | Part VI, Coastal Engineering Manual: Design of Coastal Project Elements |
| EM 1110-2-2302 | Engineering and Design: Construction with Large Stone |

## 1.3 DEFINITIONS

Not Used

## 1.4 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-03 Product Data

Bedding Stone

Riprap

SD-04 Samples

Riprap Stone

SD-06 Test Reports

Riprap

Gradation Tests

Evaluation Testing of Stone

Bedding Stone

Bulk Specific Gravity

SD-07 Certificates

Bedding Stone

State Licensed Professional Geologist

## 1.5 QUALITY CONTROL

### 1.5.1 Stone

Submit suitable riprap stone samples prior to delivery of any such material to the worksite.

### 1.5.2 General

All stone shall be durable material as approved by the District. Stone shall be of a suitable quality to ensure permanence in the structure and in the climate in which it is to be used. It shall be free from cracks, blast fractures, bedding, seams and other defects that would tend to increase its deterioration from natural causes. Inspections for cracks, fractures, seams and defects shall be made by visual examination. If, by visual examination, it is determined that 10 percent or more of the stone produced contains hairline cracks, then all stone produced by the means and measures which caused the fractures shall be rejected. A hairline crack that is defined as being detrimental shall have a minimum width of 4 mil and shall be continuous for one-third the dimension of at least two sides of the stone. The stone shall be clean and reasonably free from soil, quarry fines, and shall contain no refuse.

### 1.5.3 Acceptance of Materials

Acceptance of a source of stone is not to be construed as acceptance of all material from a source. The right is reserved to reject materials when such materials are unsuitable for stone as determined by the District. The District also reserves the right to reject individual units of produced specified materials in stockpiles at the quarry, all transfer points, and at the project construction site when such materials are determined to be unsuitable. During the course of the work, Quality Assurance testing of the stone may be conducted by the District, if the District determines that testing is necessary. If such tests are determined necessary, the testing will be done in a Quality Assurance laboratory. Materials shall meet all the requirements herein. The cost of the Quality Assurance testing will be at the District's expense. During the contract period, both prior to and after materials are delivered to the job site, visual inspections and

measurements of the stone materials may be performed by the District. If the District, during the inspections, finds that the stone quality, gradation or weights of stone being furnished are not as specified or are questionable, re-sampling and re-testing is required. Sampling of the delivered stone for testing and the manner in which the testing is to be performed shall be as directed by the District. This additional sampling and testing shall be performed at the Contractor's expense when test results indicate that the materials do not meet specified requirements. Any material rejected shall be removed or disposed of as specified and at the Contractor's expense.

## 1.6 CERTIFICATIONS

### 1.6.1 Riprap Test Reports

The Contractor's riprap supplier shall submit certified test reports prepared by a qualified independent testing laboratory selected and compensated by Contractor for the tests required in the table below. The table shown below also specifies the minimum number of tests for each test to establish quality control. Contractor shall submit certified gradation tests report, bulk specific gravity and other test results for the riprap as shown in the following table. These test results shall be provided for a sample of each riprap type, for samples delivered to the project, prior to the start of the work, as well as during the work at the frequencies shown below.

| Test Required | Number of Tests | Test Method | Test Frequency |
|---|---|---|---|
| Specific Gravity | 2 | ASTM C127 | Every 5,000-ton stockpile |
| Absorption | 2 | ASTM C127, AASHTO T 85 | Every 5,000-ton stockpile |
| Sodium Sulfate Soundness | 2 | ASTM D5240/D5240M | Every 5,000-ton stockpile |
| Durability Index | 2 | ASTM D3744/D3744M, AASHTO T 210 | Every 5,000-ton stockpile |
| L.A. Abrasion | 2 | ASTM C535 | Every 5,000-ton stockpile |
| Gradation | 1 | FM 5-538 | Every 5,000-ton stockpile |
| Freeze and Thawing | 1 | ASTM D5312/D5312M | Every Project |
| Wetting and Drying | 1 | ASTM D5313/D5313M | Every Project |
| Petrography | 1 | ASTM C295/C295M | Every Project |

### 1.6.2 Bedding Stone Test Reports

The Contractor's bedding stone supplier shall submit certified test reports prepared by a qualified independent testing laboratory selected and compensated by Contractor for confirmation of weight and gradation.

### 1.6.3 Geotextile

The geotextile shall be as specified in Section 31 05 19 GEOTEXTILE.

1.7 REGULATORY REQUIREMENTS

The regulatory requirements of the FDOT form a part of this specification to the extent referenced. The regulatory requirements are referred to in the text by basic designation only.

1.8 CONSTRUCTION TOLERANCES

The finished surface and stone layer thickness shall not deviate from the lines and grades shown by more than the tolerances listed below. Tolerances are measured perpendicular to the indicated neat lines. Extreme limits of the tolerances given shall not be continuous in any direction for more than five times the nominal stone dimension nor for an area greater than 100 square feet of the structure surface.

| **NEATLINE TOLERANCES** | | |
|---|---|---|
| **MATERIAL** | **ABOVE NEATLINE (inches)** | **BELOW NEATLINE (inches)** |
| Bedding | 2 | 1 |
| Riprap | 9 | 4 |

The intention is that the work shall be built generally to the required elevations, slope and grade and that the outer surfaces shall be even and present a neat appearance. Placed material not meeting these limits shall be removed or reworked as directed by the District.

1.9 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide the District at least 48 hours notice of its intention to begin new Work activities.

1.10 WARRANTY

The Contractor shall warrant the Work against defects for one (1) year from the date of Substantial Completion and as described in Article 13 of Section 00700 GENERAL TERMS AND CONDITIONS.

PART 2 MATERIALS

2.1 RIPRAP

A. The Contractor shall furnish stone for riprap that is sound, durable and angular in shape. No more than 10 percent of the stone for any gradation shall have an elongation (ratio of greatest dimension to least dimension) greater than 3:1, and no stone shall have an elongation greater than 4:1. The riprap material shall be provided by a Florida Department of Transportation (FDOT) certified pit and conform to the following additional requirements. The Contractor shall provide the District product data for the riprap, and Riprap Test Reports as described in paragraph RIPRAP TEST REPORTS.

B. Material shall be free from cracks, seams, moldic porosity after shells, non-mineralized or other defects that would tend to increase its deterioration from natural causes. Riprap shall consist of dense, natural rock fragments. Stones shall be resistant to weathering and to water

action; free from overburden, spoil, shale and organic material; and shall meet the gradation requirements below. Shale and stones with shale seams and limestone with moldic pores after shells are not acceptable.

C. General: The riprap sizes have been separated into four types, Type A, B, C and D. Tables found in paragraph RIPRAP of this specification section define the size ranges for each type. The riprap stone material will be either limestone or granite. The type (size) and the material will be indicated on the drawings as follows:

| **Designation** | **Type (size)** | **Material** |
|---|---|---|
| A-L | A | Limestone |
| B-L | B | Limestone |
| C-L | C | Limestone |
| D-L | D | Limestone |
| A-G | A | Granite |
| B-G | B | Granite |
| C-G | C | Granite |
| D-G | D | Granite |

D. Stone for riprap shall have the following properties:

| **Property Test** | **Limestone** |
|---|---|
| Unit Weight (Saturated Surface-dry) | 148 pcf min |
| Specific Gravity (Saturated Surface-dry) | 2.38 min |
| Absorption | 5% max |
| Sodium Sulfate Soundness | 10% max loss, 5 cycles |
| LA Abrasion | 40% max loss, 1000 revolutions |
| Freeze and Thawing | 15% max, 20 cycles |
| Wetting and Drying | 1% max, 10 cycles with no progressive cracking |
| Durability Index | Refer to Durability Absorption Ratio Stone shall have wear no greater than 40% (ASTM C535) |
| Petrography | Fresh, interlocking crystalline, no clay minerals, no shell fragments, no voids, and no soluble materials |

| Property Test | Granite |
|---|---|
| Unit Weight (Saturated Surface-dry) | 165 pcf min |
| Specific Gravity (Saturated Surface-dry) | 2.64 min |
| Absorption | Less than 2% |
| Sodium Sulfate Soundness | Less than 5% loss, 5 cycles |
| LA Abrasion | Less than 20% loss, 500 revolutions |
| Freeze and Thawing | Less than 10%, 12 cycles |
| Wetting and Drying | No major progressive cracking |
| Durability Index | Refer to Durability Absorption Ratio. Stone shall have wear no greater than 30% (ASTM C535) |
| Petrography | Fresh, interlocking crystalline, no clay or soluble minerals |

E. Freezing and Thawing and Wetting and Drying. Stone material shall be subjected to freezing and thawing and wetting and drying testing in accordance with ASTM D5312/D5312M and ASTM D5313/D5313M respectively. Photographs for freezing and thawing and wetting and drying testing shall be taken for each sample tested both before and after testing. Slabs cut for freeze and thawing testing shall have a surface area of 144 square inches on each sawed faced. Any changes observed in the testing specimen including, but not limited to, cracking, spalling, rock popping, or dissolving shall be recorded and photographed at the completion of next test cycle.

F. Stones shall consist of durable, sound, hard, angular rock meeting the following requirements for durability absorption ratio, soundness test, and abrasion test:

| Durability Absorption Ratio | Acceptability |
|---|---|
| Greater than 23 | Passes |
| 10 to 23 | Passes only if Durability Index is 52 or greater |
| Less than 10 | Fails |
| Durability Absorption Ratio = | Durability Index (Coarse)<br>% absorption + 1 |

1. Petrography. Stone material shall be subjected to comprehensive petrographic evaluation in accordance with ASTM C295/C295M. Stone material shall be fresh (no signs of weathering), with interlocking crystalline structure, and free of material such as expansive clays or any detrimental or deleterious features discussed in subparagraph "Stone Material Quality". Crystalline structure refers to igneous, metamorphic, or sedimentary rock texture consisting of interlocking, crystalline grains. Matrices of any stone consisting of argillite, sericite, smectite, talc, chloritic, soft material, or highly weathered material shall be identified and noted. Examination shall include description of any seams, veins, shell fragments, visible pores or joints and an estimate of alteration, degree of weathering, and probable rock durability. The comprehensive petrographic examination

shall also include description of dominant, accessory and alteration minerals. The petrographic examination shall be conducted by a State Licensed Professional Geologist specializing in the field of Mineralogy or Petrography. Photographs of stone material examined shall accompany the petrography testing results. Petrography may be completed at a laboratory other than an approved USACE validated commercial testing laboratory; however, certification proving that a State Licensed Professional Geologist specializing in the field of Mineralogy or Petrography will be completing this evaluation must be included in the Evaluation Testing of Stone Submittal for review and approval.

G. Stone Material Quality. All stone material shall be free of any detrimental geologic features such as, but not limited to, clay seams, shale seams, argillaceous material, any styolites, schistose seams, detrimental vugs zones or seams, zones of high foliation, and/or other adverse diagenetic features or seams. No schistose stone material or any highly foliated stone material will be acceptable. Sedimentary or metamorphic stone containing carbonaceous, coal, clay seams/lenses/joints or similar deleterious features will not be permitted or accepted. All stone material utilized shall be free of cracks, blast fractures, bedding seams, foliation seams, foliation joints, joints, any deleterious features such as splits, spalls, delaminations, disaggreations, dissolvement, shalely parting, or combination thereof of such features, and/or other defects that would tend to increase its deterioration from natural causes. An independent licensed Professional Geologist, licensed in any U.S. State, that issues a Professional Geologist License, shall determine if the aforementioned features are present within stone material from any of the proposed Stone Source(s). Discussion of Stone Material Quality and any detrimental or deleterious features present within any source shall be included in Evaluation Testing of Stone and the Stone Source Submittal for that Stone Source. Examples of deleterious and detrimental features in stone can be viewed in ERDC/GL TR-81-8. EM 1110-2-1601, EM 1110-2-1100 Part VI and EM 1110-2-2302 provide guidance on the stone properties, characteristics, and gradations specified herein.

H. Stone gradation based on a representative sample of not less than 2.0 cubic yards. Each stone in the sample shall be individually weighed, and a cumulative plot of percent lighter (by weight) versus stone weight in pounds shall be submitted.

I. The riprap shall be graded as follows:

| **Type A (6-inch Average Size)** | | |
|---|---|---|
| **Sieve Size** | | **Percent Passing by Weight** |
| **Maximum** | **Minimum** | |
| 12" | 9" | 100 |
| 8" | 7" | 50 |
| 6" | 5" | 15 |

| Type B (12-inch Average Size) | | |
|---|---|---|
| Sieve Size | | Percent Passing by Weight |
| Maximum | Minimum | |
| 21" | 15" | 100 |
| 14" | 12" | 50 |
| 11" | 8" | 15 |

| Type C (18-inch Average Size) | | |
|---|---|---|
| Sieve Size | | Percent Passing by Weight |
| Maximum | Minimum | |
| 30" | 22" | 100 |
| 20" | 18" | 50 |
| 16" | 12" | 15 |

| Type D (24-inch Average Size) | | |
|---|---|---|
| Sieve Size | | Percent Passing by Weight |
| Maximum | Minimum | |
| 42" | 31" | 100 |
| 28" | 24" | 50 |
| 22" | 17" | 15 |

J. Control of gradation shall be by visual inspection. The Contractor shall furnish a sample of the proposed gradation of at least 5 tons or 10 percent of the total riprap weight, whichever is less. If approved, the sample may be incorporated into the finished riprap at a location where it can be used as a frequent reference for judging the gradation of the remainder of riprap. Any difference of opinion between the District and the Contractor shall be resolved by dumping and checking the gradation of two (2) random truckloads of stones. Arranging for and the costs of mechanical equipment, a sorting site, and labor needed in checking gradation shall be the Contractor's responsibility.

K. The acceptability of the stones will be determined by the District prior to placement. Any visual variability and deviation in the test results of the individual rocks is unacceptable.

## 2.2 GRANULAR BEDDING

### 2.2.1 General

Bedding for riprap that is to be installed in the wet shall be a marine mattress. Refer to Section 35 31 18 MARINE MATTRESS. Bedding for riprap that is to be constructed in the dry shall conform, to the granular bedding as specified herein.

A. The Contractor shall place a layer of bedding material beneath the riprap materials to the lines and grades shown on the Drawings. Submit product data for all bedding stone. The bedding stone aggregates shall meet the quality and gradation requirements of the FDOT Standard Specifications

for Road and Bridge Constructions. Submit certifications that the bedding stone meets the specified requirements.The material shall be composed of tough, durable particles, shall be reasonably free from thin, flat and elongated pieces, and shall contain neither organic matter nor soft, friable particles in quantities considered objectionable by the District. Bedding stone shall be placed within the limits shown on the Drawings and shall be reasonably well graded in accordance with FDOT Section 901. The bedding stone for each type of riprap shall be as follows:

| **Type of Riprap** | **Bedding Stone** |
|---|---|
| Type A | ASTM C33/C33M Size No. 4 |
| Type B | ASTM C33/C33M Size No. 3 |
| Type C | ASTM C33/C33M Size No. 2 |
| Type D | ASTM C33/C33M Size No. 1 |

Provide granite bedding stone for the granite riprap.

2.3 GEOTEXTILE

The geotextile shall be as specified in Section 31 05 19 GEOTEXTILE.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. The Contractor shall transport to the Project Site, and place in a location acceptable to the District. The size of the riprap stockpiled at the site shall be clearly identified for reference.

3.2 SUBGRADE PREPARATION

3.2.1 Dry Installation

The Contractor shall prepare the subgrade to the lines, slopes and elevations indicated on the Drawing. The Contractor shall clear the subgrade of sticks, stones, debris and other materials that could puncture the overlying geotextile. The finished subgrade shall not vary from design grade by more than two (2) inches at any location.

3.2.2 Subaqueous Installation

The Contractor shall excavate the subgrade to the lines and grades shown on the Drawing plus the additional riprap thickness required for underwater installation. Tolerance shall be plus 0.0 feet to minus 0.5-feet in the Canal invert, and plus or minus 0.5-feet on the Canal banks.

3.3 GEOTEXTILE

Provide and install geotextile in accordance with Section 31 05 19 GEOTEXTILE.

3.4 GRANULAR BEDDING

A. For dry installation the Contractor shall place bedding material beneath the riprap, to depths as indicated.

B. Bedding material shall be spread uniformly over geotextile material. Placement shall not commence until the District has approved subgrade preparation and geotextile installation.

C. Placement methods, which segregate the bedding particles, will not be permitted.

D. Compaction of the bedding material will not be required, but material shall be finished to a reasonably even surface.

E. Tolerance shall be + three-tenths foot provided this tolerance is not continuous over an area greater than 200 square feet when placed in the dry, or greater than 400 square feet when placed subaqueous.

F. The Contractor shall maintain the bedding material until the riprap is in place.

3.5 RIPRAP

The Contractor shall proceed placing the riprap upon completion of geotextile and bedding material and after receiving written approval of the District to proceed. The Contractor shall place riprap in accordance with the following.

A. Stone shall be placed in such a manner as to produce a reasonably well-graded mass with the minimum practicable percentage of voids.

1. Place to full course thickness in one (1) operation in a manner to avoid displacing or puncturing geotextile. Stone shall not be dropped from a height greater than three (3) feet above the fabric.

2. Finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Hand place or adjust if necessary to secure the desired results, to the satisfaction of the District.

B. Surface Tolerances:

1. Dry Installation: The finished stone surface shall not vary from design grade by more than three (3) inches at any location, except that any extreme of the tolerance shall not be continuous over an area greater than 100 square feet.

2. Subaqueous Installation: The finished stone surface shall not vary from design grade by more than plus one (1) foot, minus one-half feet at any location; either extreme of the tolerance shall not be continuous over an area greater than 225 square feet.

C. Riprap Thickness:

1. Place riprap to the thicknesses indicated for the Types indicated. In subaqueous areas the Contractor shall excavate for the riprap for a subaqueous installation to a depth of 1.5 times the design thickness of the rip rap that is called for on the drawings.

## 3.6 MAINTENANCE

The Contractor shall maintain the riprap until accepted by the District. The Contractor shall replace riprap displaced by any cause prior to acceptance.

-- End of Section --

# SECTION 35 31 19.20

# ARTICULATING CONCRETE BLOCK REVETMENTS

## PART 1 GENERAL

### 1.1 SUMMARY

The Contractor shall provide all labor, materials, and equipment necessary for the construction of articulated concrete block (ACB) mattresses. The ACB mattress system is to be used for the maintenance boat ramp in the intake canal, a portion of the parking area at the boat ramps inside the reservoir cells, parking area for the equestrian facility, the kayak/canoe launch and the drainage outfalls located on the Townsend Canal maintenance bench, and shall include the bedding stone, concrete block units, cable and connectors. The ACB system shall include a geotextile (also referred to as filter fabric).

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 288 | (2015) Standard Specification for Geotextile Specification for Highway Applications |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C140/C140M | (2017) Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units |
| ASTM C42/C42M | (2013) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| ASTM D4873/D4873M | (2016) Identification, Storage, and Handling of Geosynthetic Rolls and Samples |
| ASTM D6241 | (2014) Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe |

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

| | |
|---|---|
| FHWA RD-89-199 | (1989) Hydraulic Stability of Articulated Concrete Block Revetment Systems During Overtopping Flow |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Construction - Current Edition |

## 1.4 DEFINITIONS

### 1.4.1 Articulating Concrete Block (ACB) Revetment System

A matrix of interconnected concrete block units for erosion protection. Units are connected by geometric interlock and/or cables, geotextiles, or geogrids, and typically include a geotextile underlayment for subsoil retention. Blocks may be open or closed cell. The open cell may be filled with aggregate.

### 1.4.2 Blocks

Articulating concrete block revetment units will be referred to as blocks.

### 1.4.3 Interlocking Blocks

Each pair of abutting blocks shall have interlocking keys that limit lateral expansion. The key and keyhole shall have an interference fit such that the joint movement has a minimum aperture at closure, and a maximum aperture when pulled apart. The joint freeplay shall allow articulation of each individual block.

### 1.4.4 Free Play

Free Play shall be the maximum lateral joint movement for interlocking blocks (difference between maximum and minimum aperture).

### 1.4.5 Geotextile Fabric

The geotextile fabric may also be referred to as filter fabric.

## 1.5 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Block Installation

Geotextile Installation

SD-03 Product Data

Blocks, cables, cable fittings, and geotextile

SD-04 Samples

Articulating Concrete Block

SD-06 Test Reports

Flume Test

SD-07 Certificates

Bedding Stone

## 1.6 DELIVERY, STORAGE, AND HANDLING

Check products upon delivery to assure that the proper material has been received and is undamaged. For geosynthetics, the guidelines presented in ASTM D4873/D4873M shall be followed.

### 1.6.1 Blocks

Provide blocks which are sound and free of defects that would interfere with proper placement or that would impair the strength or longevity of the installation. Discard blocks with the following defects:

a. Broken appendages.

b. Chips larger than 2 inches in any dimension.

c. Cracks wider than 0.02 inches and longer than 33 percent of the nominal height.

Minor cracks, incidental to the usual method of manufacture, or chipping that results from customary methods of handling in shipping, delivery and placement will not be deemed grounds for rejection. Store blocks in a suitable location away from mud, paint, wet cement, and other contamination or disturbance. Submit block installation shop drawings.

### 1.6.2 Geotextiles

#### 1.6.2.1 Labeling

Label each roll with the manufacturer's name, product identification, roll dimensions, lot number, and date manufactured.

#### 1.6.2.2 Handling

Geosynthetic rolls shall be handled and unloaded by hand, or with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Geosynthetic rolls shall not be dragged, lifted by one end, lifted by cables or chains, or dropped to the ground.

#### 1.6.2.3 Storage

Protect geotextiles from cement, paint, excessive mud, chemicals, sparks and flames, temperatures in excess of 160 degrees F, and any other environmental condition that may degrade the physical properties. If stored outdoors, the rolls shall be elevated from the ground surface and protected with an opaque

waterproof cover. Geotextiles shall be delivered to the site in a dry and undamaged condition.

## 1.7 SCHEDULING

To limit ultraviolet light exposure of the geotextile, place the blocks within 7 days after placing the geotextile, and the void filler within 14 days after placing the geotextile.

# PART 2 PRODUCTS

## 2.1 ARTICULATING CONCRETE BLOCK

The Contractor shall provide open or closed cell blocks, which comprise the mat, constructed of high strength concrete. Refer to the drawings for open or closed cell applications. The blocks shall have a length no longer than 26 inches and a width no greater than eighteen (18) inches. Each block shall have at least one (1) preformed hole through the block in order to allow cable to pass through each block. Submit articulating concrete block product data.

### 2.1.1 Open Space Between the Concrete Blocks or Openings in the Blocks

The Contractor shall provide concrete blocks that comprise the mat spaced in such a manner as to provide open space in the mat. The open space may be provided by openings in the concrete blocks and/or open spaces between adjacent blocks. Openings in the blocks shall be spaced in such a manner that will enhance the removal of water from the bedding layer. The open space in the blocks or between adjacent blocks shall be at least 1/4 inch but no more than 3-1/2 inches wide.

### 2.1.2 Cables, Cable Fittings, and Geotextile

Submit product data on the blocks, cables, cable fittings, and geotextile. Include all material properties specified under paragraph PRODUCTS. Catalog cuts, technical data sheets, or test data shall be submitted showing that the products meet the specifications. The submittal shall also include a copy of any standard manufacturer's warranties for the products. See below under "geotextile" for more requirements. The ACB shall meet the following criteria:

**TABLE 1. ACB Requirements**

| Criteria | Required Value | Test Method |
|---|---|---|
| Matrix Assembly: Cabled System | | |
| Thickness, minimum | 4 inches | Physical measurement |
| Net Weight/Area, minimum | 30 psf | Note a. |
| Critical Shear Stress, minimum | 3.5 psf | FHWA RD-89-199 |
| Critical Velocity, minimum | 15 ft/sec | FHWA RD-89-199 |
| Curvature Radius, maximum | 3 feet | Note b. |
| Surface Void Area Ratio | 20 - 40 percent | Note c. |
| Drainage Correction Factor (DCF) | 20 - 35 percent | Note d. |

| **TABLE 1. ACB Requirements** | | |
|---|---|---|
| **Criteria** | **Required Value** | **Test Method** |
| Block/Geotextile Interface Friction Angle | 35 degrees | Note e. |
| a. Determine the weight of the mattress per unit area with the nominal joint spacing, in a non-submerged condition. | | |
| b. The curvature radius shall be indicative of the ability of the assembled mattress to conform to one dimensional subgrade curves without binding, such as for anchor trenches and swales. The curvature radius shall be demonstrated, if requested by the District. | | |
| c. The surface void area ratio shall be determined at the visible (with filled voids) surface of the blocks, with the joints spaced in a neutral position (50 percent), and shall be expressed as a percentage of the gross mat area. The void area shall include area between the blocks and open cells within the block. | | |
| d. The drainage correction factor shall be the minimum void area ratio (usually taken at the base of the blocks), with the joints spaced in a neutral position (50 percent free play in each direction), and shall be expressed as a percentage of the gross mat area. | | |
| e. The concrete surface shall be sufficiently rough to prevent sliding of the blocks on the geotextile. The interface friction must be matched with the selected block and geotextile combination, and shall be included with the ACB and Geotextile Data submittal. The block/geotextile interface friction angle shall be demonstrated, if requested by the District. | | |

2.1.3 Hydraulic Stability

2.1.3.1 Flume Test

Submit a report of testing for the ACB in substantial conformance with FHWA RD-89-199, except that a drainage layer is not required, at the same time as the ACB and Geotextile Data submittal. The report shall clearly state if the critical shear stress associated with the stability threshold of the ACB system was derived from laboratory testing that included a sub-block drainage layer as a component of the tested system. The ACB product shall have been tested in a flume chamber in substantial conformance with FHWA RD-89-199. If the product was tested with a drainage layer, the installed product shall incorporate a similar drainage layer with adequate filtration design for the site soils. The flume test shall be based on conservative assumptions for field placement of the blocks (such as block orientation, and joint spacing within construction tolerances). The critical shear stress (and critical velocity) shall be indicated in the test report.

2.1.3.2 Extrapolation of Hydraulic Stability

Extrapolation of critical shear stress for untested blocks within a similar family of ACB shall be subject to limitations. Extrapolation shall only be used for blocks having a similar footprint area and interlock mechanism, but with variable thickness or net weight/area. Extrapolation shall only be accepted if the following conditions are met:

a. The extrapolation is in strict accordance with hydraulic similitude methods commonly accepted by the industry, and includes quantitative treatment for a block overturning failure mode.

b. The tested block is the smaller product size in both thickness and net weight/area, and extrapolation does not extend the critical velocity more than 10 feet per second from the tested product size.

2.1.4 Matrix Assembly - Cabled Systems

The Contractor shall provide concrete blocks incorporated into the mat that are connected in such a manner as to form a flexible mat. The joints shall provide resistance to movement along the long axis of the embankment. In the event the blocks are pre-assembled into panels then placed on the slope, each panel shall be connected to the adjacent panel to provide a continuous mattress. The connections may be made by utilizing anchor cable couples with longitudinal cables. Locking devices shall be provided at the toe end of the lateral cables and at each end of the longitudinal cables to contain the blocks.

2.1.5 Structural requirements

Articulating concrete block shall be wet cast using concrete as specified herein, or dry-cast by a vibratory block forming machine. The blocks shall be manufactured to the following requirements:

2.1.5.1 Compressive Strength

The minimum compressive strength shall be 4000 psi for an average of 3 units, and 3500 psi for an individual unit. Compressive strength shall be determined by ASTM C42/C42M for wet cast blocks, or by ASTM C140/C140M for dry cast blocks.

2.1.5.2 Water Absorption for Dry Cast Units

The maximum water absorption for dry cast units shall be 9 pcf for an average of 3 units, and 12 pcf for an individual unit. Water absorption shall be determined by ASTM C140/C140M.

2.2 GEOTEXTILE

The geotextile shall be as specified in Section 31 05 19 GEOTEXTILE.

2.3 CABLE

2.3.1 Installation Requirements for Cable

Cable used for preassembled mattresses shall be sufficiently sized and fastened for the size/weight of the assembled mattresses such that the

assembled mattresses can be placed in compliance with OSHA standards. The manufacturer shall be responsible for determining the minimum cable strength compatible with the mattress size for safe handling. Cable strength shall be based on a minimum factor of safety of 5, and include appropriate reduction factors for mechanically crimped cable, and other fasteners. If applicable, loading conditions shall include the use of a spreader bar for placing the mattresses.

2.3.2 Fasteners Other than Cable

Any systems which rely on geotextiles (or other fabric integral with the mattress) to maintain block-to-block interconnection shall meet the applicable portions of this specification for cables. Geosynthetics strength shall include appropriate factors of safety, with particular attention given to the grab points.

2.3.3 Design Requirements for Cable

ACB's that rely on cables to maintain block to block interconnection shall use stainless steel wire. The cable shall have a minimum breaking strength of 20,000 pounds.

2.4 BEDDING STONE

Contractor shall submit certification that the aggregate for the bedding stone conforms to the requirements of No. 57 stone conforming to FDOT Specifications.

2.5 VOID FILLER

Aggregate for filling the voids between the blocks and the cells in the open cell blocks shall meet the requirements of No. 57 stone conforming to FDOT Specifications.

2.6 CONCRETE

Concrete for joints or anchoring the revetment shall conform to the 3,000 psi concrete as specified in Section 03 31 01.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

Place the ACB revetment on undisturbed native soils, or acceptably placed and compacted fill. Do not place the ACB on surfaces that contain mud, frost, organic soils, embankment that has not met compaction requirements, or where the District determines that unsatisfactory material remains in or under the subgrade.

3.1.1 Clearing

All vegetation shall be completely removed as specified in Section 31 00 00 EARTHWORK. Remaining roots from trees and brush shall be removed to a depth of 1 foot below the subgrade surface. Loose roots and twigs, turf clods, stones larger than 1/2 inch diameter, and other debris shall be raked and

removed from the final surface. Rills and gullies from erosion shall be corrected.

3.1.2 Bank Grading

Grading shall be finished to a smooth surface, typical of that obtainable with a dozer and blade. A rough surface typically obtained with a backhoe or dragline will not be acceptable, except when ACB placement in water is shown on the drawings or approved by the District.

3.1.3 Compaction and Subgrade Finishing

Fill soils shall be compacted to the specified density in Section 31 00 00 EARTHWORK. Incidental grading (where embankment is not otherwise specified) shall be stabilized by compacted with heavy equipment or by tamping with a bucket to a density characteristic of the surrounding soils. The final surfaces accessible by compaction equipment shall be compacted with a smooth drum roller or vibratory plate tamper until there is no further evidence of consolidation. Where slopes limit operation of compaction equipment, the final surface shall be back-dragged to a dense smooth surface with bladed equipment. Localized loose or soft zones shall be corrected.

3.1.4 Grade Tolerances

The grading tolerance shall be within 2 inches from the prescribed elevations, with no abrupt variations that would cause unacceptable projections of individual blocks.

3.1.5 Subgrade Surface Tolerances

The subgrade shall be maintained in a smooth condition between installation of the geotextile and the blocks. Windrows, stones, clods of cohesive soil, and irregularities shall be raked smooth. Ruts, rills and gullies resulting from traffic, precipitation runoff, groundwater seepage, etc. shall be corrected prior to installation of blocks.

3.2 GEOTEXTILE INSTALLATION

3.2.1 General

See "Block Installation" paragraph for drawing requirements. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall be free of tension, folds, and wrinkles. The number of seams and overlaps shall be minimized by selective orientation of geotextile panels, within the limitations of maintaining a consistent pattern. Geotextile shall be placed immediately prior to block installation to limit damage to the geotextile from equipment or repeated pedestrian traffic and limit disturbance of the subgrade from precipitation or runoff.

A layer of the geotextile fabric shall also be placed on top of the bedding stone prior to the placement of the ACB.

Submit shop drawings of the geotextile installation. Placement of the geotextile fabric shall be reviewed and approved by the District.

### 3.2.2 Geotextile Seams

Seams shall be overlapped a minimum of 18 inches. Seams on slopes and butt end seams shall be shingled so that runoff and channel flow passes over the fabric. Geotextile panels shall be secured before bedding stone or block placement by adequate sandbags, spare blocks, or pins/staples.

## 3.3 BEDDING STONE PLACEMENT

After the placement of the geotextile fabric has been approved by the District place the bedding stone to the depth indicated. Distribute the bedding stone so that the thickness is no less than 0.5 inch or no more than 1.0 inch thicker than required.

## 3.4 BLOCK INSTALLATION

All placement of blocks shall be in accordance with the manufacturer's recommendations and the Contractor's approved shop drawings. Submit drawings showing details of the ACB and Geotextile Installation, including the block layout patterns in relation to the feature alignment, anticipated locations of cast-in-place concrete joints, mattress junction details, soil anchors, and proposed installation methods for void filling materials.

### 3.4.1 Placement of Pre-Assembled Mattresses

Placement of pre-assembled mattresses shall be done with mattresses attached to a spreader bar to aid in lifting, aligning and placing the mattresses. The mattresses shall be placed directly into position, with a maximum space or gap between mattresses of 3 inches in excess of the nominal joint spacing of blocks within the mattress. Mattresses out of alignment shall be lifted and reset. Mattresses shall not be pushed or pulled laterally after they are in contact with the geotextile. No overlapping of mats will be accepted and no blocks shall project vertically more than 1 inch beyond the adjacent blocks. As adjacent mats are placed, they shall be secured to each other by fastening the protruding horizontal and vertical cable connections and end cable loops together along each side of the mats.

### 3.4.2 Hand Placement of Interlocking Blocks

Space hand placed blocks to maximize the ACB ability to articulate. Use adequate alignment control, such as string lines, to keep the block pattern in alignment and the joint spacing consistent and uniform. Initially, no more than two working block rows shall progress simultaneously in the direction of placement. Additional working rows may be added after experience shows that true lines are maintained. The starting position for ACB placement shall be a convenient location for control of the block pattern alignment. The District shall approve of the starting position for placement of the ACB.

#### 3.4.2.1 Target Joint Spacing

Interlocking blocks shall be installed with a uniform aperture in the interlocking connections. The target joint spacing shall be neutrally spaced with equal free-play for the joint to open and close.

#### 3.4.2.2 Correction of Joint Spacing

If the block pattern becomes skewed to an extent that blocks bind, joints close, or blocks stickup, then the placed ACB that is determined to be out of tolerance shall be removed and replaced. Where the nonconformance of the joint spacing is due to project features, such as warped slopes or anchor trenches, then cast-in-place concrete joints shall be field located in concurrence with the District.

#### 3.4.2.3 Maintenance of Joint Spacing

If the block pattern becomes skewed to an extent that the joint free play is not acceptable to the District, then cast-in-place concrete joints shall be field located as directed by the District.

#### 3.4.2.4 Block Layout Pattern Dependent on Project Features

If the block pattern is shown to be maintained parallel and perpendicular to selected project features, such as the crest/toe of levee/channel slopes, then field location of cast-in-place concrete joints shall be implemented as needed, and as directed by the District.

### 3.4.3 Tolerances

Maximum acceptable block projections (vertical offset from adjacent blocks) for "installation in the dry" shall not exceed 0.5 inches for interlocking blocks 1.0 inch for cabled systems. Typical block projections shall be less than half the maximum projections.

## 3.5 CONCRETE JOINTS

### 3.5.1 General Requirements

Use of cast in place concrete joints shall be minimized to the extent practicable. The District shall be informed of all concrete joints not shown on shop drawings prior to field placement. Joints that shall require concrete include:

a. Joints where block interlock is discontinuous.

b. Abutments where the ACB meets headwalls, pipe penetrations, or sidewalks.

c. Any areas where there are partial blocks (to avoid small blocks with reduced hydraulic stability).

Field placed concrete shall be proportioned for similar strength and durability properties as the ACB concrete, and shall meet applicable portions of Section 03 31 01.00 10 CAST-IN-PLACE CONCRETE FOR CIVIL WORKS. All cable ties and anchoring shall be completed prior to placing concrete.

### 3.5.2 Anchoring ACB Revetment

Excavate trenches as indicated to accept the revetment edges. Secure and anchor the revetment edges using 3,000 psi concrete. Backfill the concrete trench no sooner than 3 days after the concrete has been placed.

### 3.5.3 Abutments

The ACB shall abut pipe outlets, retaining walls, flood walls, head walls, sidewalks, and other abutments in a neat appearance. Unless a specific detail is indicated on the drawings, voids shall be filled with partial blocks and the gap shall be filled with cast-in-place concrete. The concrete shall be installed flush with the surface of the blocks, and shall be float finished.

## 3.6 VOID FILLER

The voids of the articulating concrete block mats shall be filled with aggregate void filler. All cable ties and anchoring shall be completed prior to filling voids.

## 3.7 PROTECTION OF WORK

Work shall be protected against damage from subsequent operations. Displaced or broken blocks shall be removed and replaced to conform to all requirements of this section. Damaged material shall not be incorporated. Equipment shall not be allowed on the ACB that could crack, cause abrasion, or otherwise damage the blocks. Vehicles shall not operate directly on geotextile, except that rubber tired vehicles may operate directly on short reaches of geotextile that meets or exceeds AASHTO M 288 survivability requirements for Class 1 geotextile, if there is no rutting, if the vehicle access is necessary to accomplish the work, and if the District observes the operation and approves. Vehicles shall not operate on the ACB until (during or after) placement of void filler. Vehicle traffic on the ACB shall be restricted to light weight rubber tired vehicles, and where intermittent access is necessary to accomplish the work. Routine haul routes shall not be established on the ACB. These allowances shall not waive the Contractor's obligation to maintain the installation until acceptance, and verify that vehicle access does not crack, or in any way damage, the ACB.

## 3.8 QUALITY CONTROL TESTING

The following testing shall be performed independent of the manufacturing process, by an agency other than the manufacturer. The ACB blocks shall be sampled and tested for compressive strength, water absorption and unit weight. The sample frequency shall be 3 specimens for each 3000 SY. Test methods shall be consistent with those specified in PART 2 PRODUCTS and shall be the Contractor's cost.

-- End of Section --

# SECTION 35 41 21

# PRESSURE RELIEF SYSTEM

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of work: The Contractor shall furnish all labor, equipment, and materials for installation of Pressure Relief Systems along the east bank of the Townsend Canal, and in the Intake Canal, and in an area southeast of Pump Station S-476. The Pressure Relief System construction is associated with, but not limited to, the following related work activities specified elsewhere:

DIVISION 1 - GENERAL REQUIREMENTS

Section 01 33 00 SUBMITTAL PROCEDURES

Section 31 00 00 EARTHWORK - EARTH DAM

Section 31 41 16 METAL SHEET PILING

Section 31 52 10 DEWATERING AND COFFERDAM

Section 35 31 19 RIPRAP SYSTEM

Section 33 11 53 MONITORING WELLS

Section 33 46 13 FOUNDATION DRAINAGE SYSTEM

The Contractor shall be aware that no Pressure Relief System construction may begin prior to excavation of a bench at elevation +8 feet along the east bank of the Townsend Canal, and excavation of and dewatering of the Intake Canal between the Local Access Bridge and the northwest side of the S-470 Pumping Station. Bid Package 4 Contractor shall coordinate installation of Pressure Relief System in Intake Canal with Bid Package 3 Contractor.

### 1.2 CRITERIA FOR BIDDING

#### 1.2.1 Base Bids on the Following Criteria

1. Surface elevations are as indicated.

2. Subsurface conditions are described in the Geotechnical Site Characterization Report. Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent groundwater elevation at the time of construction.

3. A portion of the Pressure Relief System, consisting of Sand Relief columns, a Blanket Drain, and Outfall pipes are to be installed on a bench along the east side of the Townsend Canal at elevation +8 feet, in an area that is dewatered as needed for construction equipment.

4. Another portion of the Pressure Relief System, consisting of San Relief Columns, shall be constructed in the Intake Canal at the grade consistent with the bottom of the proposed Rip Rap section in a fully dewatered and dry excavation.

5. A portion of the Sand Relief Columns are to be installed in an area southeast of the S-476 Pumping Station, in a dewatered excavation with bottom elevation +15 feet. This portion of the sand relief column installation will involve several phases, namely initial installation of sand columns, installation of steel sheet piling, excavation to elevation -2 feet, installation of drainage piping, and backfilling of the excavation.

6. Surface water elevations in the Townsend Canal are subject to considerable fluctuation as a result of ongoing farming operations to the south, and the size of the drainage basin that drains through the Townsend Canal. Following the passage of Hurricane Irma in September 2017, the Townsend Canal stage was estimated to be above Elevation +8 feet NAVD. The Contractor shall regularly and intentionally coordinate work activities along the Townsend Canal with local farmers and land owners to limit the impact of potential high stages in the Townsend Canal that may affect the timing, progress, the need for removal of damaged work, and associated re-work. Additional temporary cofferdams may be required provided they do not impede flow in the Townsend Canal. The Contractor shall pay all additional costs for the required coordination and potential rework as necessary.

7. Contractor shall be aware of east-west overhead power corridors that cross the alignment of the Pressure Relief System installation along the Townsend Canal. These locations are called out on the Drawings.

## 1.3 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM C136/C136M | (2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D2487 | (2011) Soils for Engineering Purposes (Unified Soil Classification System) |

FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

| | |
|---|---|
| FDOT | Standard Specifications for Road and Bridge Constructions |

| | |
|---|---|
| FDOT 449 | Precast Concrete Drainage Products-Standard Specifications for Road and Bridge Constructions |
| FDOT 902 | FINE AGGREGATE-Standard Specifications For Road and Bridge Construction |

## 1.4 MISCELLANEOUS PROJECT DATA AVAILABLE UPON REQUEST

Geotechnical Site Characterization Report, C-43 West Basin Storage Reservoir Project.

## 1.5 DEFINITIONS

### 1.5.1 Pressure Relief System

A combination of Sand Relief Columns and Blanket Drain Outfall pipes installed to provide pressure relief in the Intake Canal, along the eastern side of the Townsend Canal, and in an area southeast of Pumping Station S-476.

### 1.5.2 Sand Relief Columns

Installed columns of imported sand materials to provide pressure relief in the Intake Canal, along the eastern side of the Townsend Canal, and in an area southeast of Pumping Station S-476. Sand Relief Columns are to be installed at the locations shown on the drawings.

### 1.5.3 Temporary Casing

Steel cylindrical casing used to form the walls of the Sand Relief Column during excavation process.

### 1.5.4 Sand Relief Column Backfill

Sand Relief Column Backfill materials shall be clean sand having a Unified Soil Classification System (ASTM D2487) designation of SP, free from debris, clods, seeds of nuisance or exotic species, and meeting the requirements of FDOT 902-4 Filter Sand, with the exceptions described in Paragraph SAND RELIEF COLUMN BACKFILL of this specification.

### 1.5.5 Blanket Drain Outfall Pipes

For the portion of the Pressure Relief System along the east bank of the Townsend Canal, the system shall outfall laterally to the Townsend Canal through a blanket of FDOT 902-4 Filter Sand and slotted PVC pipe.

### 1.5.6 Townsend Canal Bench

For the portion of the Pressure Relief System along the east bank of the Townsend Canal, the system shall be constructed on a bench cut into the existing canal bank at elevation +8 feet.

### 1.5.7 Proof of Concept

Demonstration by Contractor that means and methods utilized will accomplish the intended goals of the project, meet the quality control aspects of the

project, and establish protocols for communication of schedule, inspections, and documentation of the work.

## 1.6 SYSTEM DESCRIPTION

The Pressure Relief System consisting of Sand Relief Columns and Blanket Drain Outfall Pipes shall be furnished and installed complete by the Contractor, as shown on the Drawings. The Geotechnical Site Characterization Report dated March 2018 is part of the bid documents associated with this project. This data represents the best subsurface information available; however, variations may exist in the subsurface conditions between boring locations. Blasting will not be permitted.

## 1.7 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Dewatering Plan

Summary of Proof of Concept

Outfall Excavation Plan

SD-03 Product Data

Handling and Placing Pipe

Deflection Measuring Device

SD-06 Test Reports

Laboratory Testing of Backfill

SD-07 Certificates

Manholes

SD-11 Closeout Submittals

As-Built Details of Installed Pressure Relief Systems

Video Logs

## 1.8 DEWATERING PLAN

The Contractor shall submit a Dewatering Plan in accordance with the requirements shown in Section 31 52 10 DEWATERING AND COFFERDAM

## 1.9 SUMMARY OF PROOF OF CONCEPT

A written narrative with associated graphics as needed to summarize the means and methods utilized by the contractor for each aspect of the work, to achieve the quality objectives of the contract, and to document the work.

## 1.10 OUTFALL EXCAVATION PLAN

Contractor shall submit a design for support of the excavation that is to be made for the outfall located south of Structure S-476, as shown on the Drawings.

## 1.11 HANDLING AND PLACING PIPE

Submit printed copies of the manufacturer's recommendation for installation and handling procedures of the material being placed, prior to installation. Refer to Drawings and Section 33 46 13 FOUNDATION DRAINAGE SYSTEM for bedding and backfill materials and requirements.

## 1.12 DEFLECTION MEASURING DEVICE

The deflection measuring device shall be approved by the District prior to use. The horizontal tolerance for pipe placement shall be +/- 0.5 feet. The circumferential deflection of installed PVC Pipe shall not exceed 5 percent. Refer to Section 33 46 13 FOUNDATION DRAINAGE SYSTEM for pipe installation requirements.

## 1.13 LABORATORY TESTING OF BACKFILL

The Contractor shall submit laboratory test results on the materials proposed to be used as Sand Relief Column Backfill. At a minimum the laboratory testing shall include sieve analysis in accordance with ASTM C136/C136M, and USCS classification in accordance with ASTM D2487. Prior to construction, the Contractor shall provide the source of the backfill material proposed to be used and the sieve analysis results for that materials. During installation of Sand Relief Columns, the Contractor shall submit sieve analyses results for each 800 cubic yards of material delivered to the site.

## 1.14 AS-BUILT DETAILS OF INSTALLED PRESSURE RELIEF SYSTEMS

The Contractor shall be responsible for preparing and submitting signed and sealed as-built documents that include the following:

a. Surveyed As-Built locations of Sand Relief Columns, Collection Pipe, Blanket Drain, and Outfall Pipes.

b. Verification of quantities used to backfill each Sand Relief Column.

c. Laboratory test results for Sand Relief Column Backfill.

## 1.15 RESPONSIBILITIES

1. The Contractor shall excavate to the subgrades shown on the drawings and maintain the excavations in a dewatered and dry condition for the entire duration of the work.

2. In the Intake Canal, dewatering shall be performed such that the piezometric head in the dewatered soils in the vicinity of the column tip elevation is not higher than -20 feet.

3. Groundwater elevations along the Townsend Canal may be above elevation +8 feet NAVD. Along the Townsend Canal Bench, the Contractor shall

dewater the work area as needed to maintain a dry and stable working surface during installation of the pressure relief system. Placement of an all-weather granular surface material will likely be required for construction of the Pressure Relief System along the Townsend Canal. Contractor shall assess this condition and provide for trafficability of equipment at no additional cost to the District. Further, artesian conditions may exist in this area during installation of the sand relief columns once the column excavations advance through the clay layer. The Contractor shall install temporary monitoring wells not more than 1,000 feet apart, or as needed to assess this condition.

4. At each column location, the Contractor shall excavate any material encountered to the depth and grades shown on the Drawings, shall backfill such excavations as required with Sand Relief Column Backfill materials, and shall dispose of materials from excavations in the locations shown on the Drawings, or as directed by the District.

5. Temporary casing of excavations for Sand Relief Columns shall be carried out so as to prevent any possibility of undermining or disturbing the adjacent landform, and so that all Work may be accomplished and inspected. Casing shall be removed for each of the Sand Relief Columns at the conclusion of each installation.

6. The Contractor shall furnish, at his expense, the services of a Professional Engineer for inspection and certification of the work.

7. The Contractor shall furnish, at his expense, the services of a Professional Surveyor and Mapper licensed in the State of Florida for the field layout of all Work indicated or specified in this Section.

## 1.16 CERTIFICATIONS AND TESTING

1. The responsibility to retain the services of an independent testing laboratory shall be as defined in Section 01 45 00.00 10 QUALITY CONTROL.

2. The Contractor shall furnish, at his own expense, all laboratory testing required to establish and maintain his Quality Control (QC) processes required or as specified in this Section.

3. The Contractor shall provide certification that the Manholes conform to the FDOT Standard Specifications for Road and Bridge Construction, Section FDOT 449.

## 1.17 INSPECTION COORDINATION

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide at least 48 hours advanced notice of his/her intention to begin new Work activities.

# PART 2 PRODUCTS

## 2.1 MATERIALS ENCOUNTERED

1. The Contractor shall excavate all materials encountered in the Sand Relief Column excavations.

2. Rock encountered shall be removed by the Contractor at no additional cost to the District. Blasting shall not be permitted.

## 2.2 STEEL CASING

Steel Casing shall be five feet in diameter and shall be set for each Sand Relief Column location to the tip elevation shown on the Drawings. The weight, wall thickness and section modulus for the casing shall be determined by the Contractor. Each Sand Relief Column shall be cased, excavated, backfilled, and the casing shall be retrieved either during the backfilling process or at the conclusion of it.

## 2.3 SAND RELIEF COLUMN BACKFILL

Provide Sand Relief Column Backfill material. Materials shall be silica based sand conforming to FDOT 902-4 Filter Sand (Type I through 4) with a maximum of 2 percent by weight passing the No. 200 sieve.

## 2.4 MANHOLES

Shall conform to the FDOT Standard Specification Section 449. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure.

## 2.5 STEEL LADDER

Steel ladder shall be provided where the depth of the manhole exceeds 12 feet. The ladder shall be not less than 16 inches in width, with 3/4-inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8-inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A123/A123M.

# PART 3 EXECUTION

## 3.1 PREPARATION

1. Prior to beginning the work, the Bid Package 4 Contractor shall coordinate the work in the Intake Canal with the Bid Package 3 Contractor. The Intake Canal work area shall be excavated to the grade consistent with the bottom of the Rip Rap section, the Townsend Canal Bench shall be excavated to +8 feet, and the area southeast of the S-476 Pumping Station shall be excavated to elevation +15 feet. All these areas shall be fully dewatered to enable dry construction activities. See Section 1.11 No. 1 of this specification for dewatering requirements.

2. Contractor shall layout alignment of and locations of Sand Relief Columns in accordance with locations shown on the Drawings.

3. Dewatering shall be required for construction activities for all Pressure Relief System areas.

## 3.2 INSTALLATION

### 3.2.1 Set Casing

Contractor shall drive, spin, vibrate or otherwise install temporary steel casings to the tip elevation of Sand Relief Columns shown on the Drawings. The casings may be advanced in concert with pre-drilling, so long as in-place materials are not removed from the excavation in advance of the casing. Casing length shall provide for at least 4 feet of stick up above ground surface for safety purposes. The casings are to be installed with an out of plumbness of not more than 2 percent.

### 3.2.2 Excavation

Excavate to the elevation shown on the drawing for each Sand Relief Column. All materials from the excavation shall be removed from the work area and placed in stockpile areas as shown on the Drawings. Contractor shall probe bottom of each excavation at four equally spaced locations around the perimeter of casing and once in the center to verify that the design tip elevation has been reached. A maximum tolerance of 0.5 feet shall be considered acceptable. Water shall be introduced to the casings to maintain hydrostatic head above the piezometric heads in the dewatered strata in the vicinity of the tip elevation of the columns. Water for this purpose may be obtained from an on-site source. Water that spills out of the casings during the excavation process shall be routed away from the alignment of previously placed and backfilled columns.

### 3.2.3 Backfill

Backfill meeting the requirements of Paragraph SAND RELIEF COLUMN BACKFILL of this specification shall be placed using a tremie pipe that extends to a depth of not more than 10 feet above the excavation bottom or active backfill surface. At 10-foot vertical intervals during backfilling, the active backfill surface shall be sounded to verify that the materials are reaching the base of the excavation. The volume of materials used to backfill each column shall be measured and recorded by the Contractor. Records of the volumetric measurements and probes shall be maintained by the Contractor's Professional Engineer and submitted as part of the As-Built Details of Installed Pressure Relief Systems. Water from an on-site source may be introduced to the tremie to promote flow of the sand backfill. Compaction of the backfill shall not be required.

### 3.2.4 Retrieve Casing

At the conclusion of backfilling each Sand Relief Column, the casing shall be pulled from the excavation. Alternatively, the casing may be pulled incrementally, provided the tip of the casing is not less than 5 feet below the active backfill surface. The casing shall be pulled carefully and slowly such that disturbance to the surrounding landform does not occur.

### 3.2.5 Sequence of Installation

The Contractor shall install Sand Relief Columns at every other location initially, then return to install the in between columns.

3.2.6 Limits of Work

Sand Relief Columns are to be installed at the locations shown on the Drawings, including along the centerline of the Intake Canal, and shall overlap at least 10 feet laterally with the previously placed Bid Package 3 contract sand relief columns.

3.2.7 Finished Sand Relief Columns

The area of the Sand Relief Columns shall be finished to match the grade of the bottom of the proposed Stone Rip Rap section. If fill is needed to reach the grade of the bottom of the Stone Rip Rap section, that fill shall be composed of Sand Relief Column Backfill materials. The area shall be protected from equipment traffic, rutting, erosion, backfilling of soils other than Sand Relief Column Backfill until such time as the filter fabric, bedding stone, and Stone Rip Rap are placed. Stone Rip Rap is to be installed in accordance with the requirements of Section 35 31 19 RIPRAP SYSTEM. Note that the filter fabric covering the Pressure Relief System in the Intake Canal shall differ from that placed elsewhere in the Intake Canal as shown on the Drawings.

3.2.8 Blanket Drain Outfall

The Contractor shall excavate for and place the filter sand, PVC Pipe, Blanket Drain, Outfall piping, aggregate stone and filter sand surrounding the drains, and the Stone Rip Rap in accordance with the details shown on the Drawings, and as outlined in Sections 33 46 13 FOUNDATION DRAINAGE SYSTEM and 35 31 19 RIPRAP SYSTEM.

3.2.9 Area Southeast of S-476

For the portion of the pressure relief system located southeast of Pump Station S-476, the Contractor shall excavate to provide a working grade elevation of +17 feet, and install sand relief columns to the grades shown on the Drawings. The Contractor shall then install two rows of steel sheet piling, and excavate between the sheeting to elevation -2 feet for the placement of drainage piping. Once the piping is installed, the excavation shall be backfilled with FDOT filter sand, all as indicated on the Drawings. Steel sheet piling shall conform to the requirements of Specification Section 31 41 16 METAL SHEET PILING.

3.2.10 Outfall

The pressure relief system shall be terminated at a manhole at the location shown on the Drawings. Outfall from the manhole shall be provided using an 18-inch diameter RCP pipe that discharges to the Townsend Canal at the location and invert shown on the Drawings. The outfall pipe shall be installed in a contractor designed, dewatered, sheet pile supported excavation, and the outfall pipe excavation shall be backfilled with Embankment Fill, placed in 3-foot thick lifts, with each lift tamped using the backhoe bucket. The sheet piles are to be removed at the conclusion of the backfilling process.

3.2.11 Manholes

Construction shall be of reinforced concrete, complete with covers and fixed steel ladders. Pipe connections to concrete manholes shall be made with

flexible, watertight connections. Ladders shall be anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be installed to provide at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

### 3.2.12 Maintenance

Contractor shall clean (via pressure washing from inside the pipes) conduits associated with the pressure relief system within two weeks following installation of each 500-foot section of the system. This procedure shall be repeated for all completed sections of the system at a frequency of once per 3 months to the end of the contract. Pressures associated with this work shall be controlled to not alter the filter sand and/or No. 89 Stone surrounding the conduits.

### 3.2.13 Video Logs

Contractor shall video log 10 percent of the total length of the pressure relief system, after sections are cleaned (per previous section), and shall submit Video Logs to the District. A written narrative shall accompany each video log submittal indicating date, location and results of the work.

-- End of Section --

# SECTION 35 42 34

# REINFORCED SOIL SLOPE

## PART 1 GENERAL

### 1.1 SUMMARY

As a component of the grassing work plan the Contractor shall furnish all materials, equipment, and labor necessary for the installation of high performance turf reinforcement mat (HPTRM) and geotextile. In this application of the HPTRM it is being placed below the finished grade and intended to provide erosion protection should the materials above the HPTRM be eroded away to the depth of the HPTRM. See the drawings for the details of the application.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 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.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D2487 | (2011) Soils for Engineering Purposes (Unified Soil Classification System) |
| ASTM D2488 | (2009a) Description and Identification of Soils (Visual-Manual Procedure) |
| ASTM D4759 | (2011) Determining the Specification Conformance of Geosynthetics |
| ASTM D4873/D4873M | (2016) Identification, Storage, and Handling of Geosynthetic Rolls and Samples |
| ASTM D4354 | (2012) Sampling of Geosynthetics for Testing |
| ASTM D4355 | Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus) |
| ASTM D4435 | Standard Test method for Rock Bolt Anchor Pull Test |
| ASTM D6524 | Standard Test Method for Measuring the Resiliency of Turf Reinforcement Mats (TRMs) |
| ASTM D6525 | Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products |

| | |
|---|---|
| ASTM D6567 | Standard Test Method for Measuring the Light Penetration of a Turf Reinforcement Mat (TRM) |
| ASTM D6818 | Tensile Test of Turf Reinforcement Mats |

## 1.4 DEFINITIONS

### 1.4.1 Fill

Soil or aggregate placed in, behind, or below the embankment or slope will be referred to as fill.

### 1.4.2 HPTRM

A High Performance Turf Reinforcement Mat (HPTRM) that is a long term, non-biodegradable rolled erosion control product composed of 100% UV-stabilized, non-degradable, synthetic materials processed into a three-dimensional reinforcement matrix designed for permanent and critical hydraulic applications where discharges exert velocities and shear stresses that exceed the limits of mature natural vegetation. The EPA designates a turf reinforcement mat as "high performance" when the tensile strength is equal to or greater than 3,000 lbs/ft.

### 1.4.3 Maximum Average Roll Value (MaxARV)

Property value calculated as typical plus two (2) standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will be below the value reported.

### 1.4.4 Minimum Average Roll Value (MARV)

Property value calculated as typical minus two (2) standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

### 1.4.5 Typical Roll Value

Property value calculated from average or mean obtained from test data.

## 1.5 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Grassing Work Plan (see Section 32 92 19 SEEDING)

SD-02 Shop Drawings

Installation plan

SD-03 Product Data

HPTRM Manufacturer's Literature

Calculations

SD-04 Samples

HPTRM

SD-06 Test Reports

Anchor Pullout Tests

SD-07 Certificates

Certified Test Results

Certificate of Compliance

## 1.6 QUALITY CONTROL

Submit Shop Drawings laying out the installation plan, including sequencing and construction procedures, to the District for approval prior to delivery of the HPTRM to the jobsite. Nontraditional construction methods may be required to perform the installation of HPTRM.

Submit product data including:

1. HPTRM Manufacturer's Literature.

2. Calculations.

### 1.6.1 Manufacturer Representative

Provide a qualified and experienced representative from the HPTRM Manufacturer on an as-needed basis during the construction. The representative shall visit the site for consultation as requested by the District.

### 1.6.2 Classification of soil materials

Classification of soil materials shall be performed by the Contractor in accordance with ASTM D2488. The District reserves the right to revise the Contractor classifications. In the case of disagreement, the District's classification will govern unless the soils are classified in accordance with ASTM D2487. All testing completed by the Contractor in conjunction with soil material classification will be considered incidental to the contract Work.

### 1.6.3 Certifications

The HPTRM shall be subject to sampling and testing to verify conformance with this specification. Sampling for testing shall be in accordance with ASTM D4354. Certified test results shall be provided for the HPTRM prior to furnishing the material. Submit one HPTRM sample (minimum 4 sf).

Acceptance shall be in accordance with ASTM D4759 based on testing of either conformance samples obtained using Procedure A of ASTM D4354, or based on manufacturer's certifications and testing of quality control samples obtained using Procedure B of ASTM D4354.

The Contractor shall provide a certificate of compliance from a Geosynthetic Accreditation Institute Laboratory Accreditation Program (GAI-LAP) lab stating the name of the HPTRM manufacturer, product name, style, chemical and other pertinent information to fully describe the HPTRM.

The Contractor shall submit, in booklet form, the manufacturer's literature for the product used on the job. The Contractor shall also submit the manufacturer's ISO 9001 certification or state their quality control is in accordance with ASTM D4354.

1.6.4 Inspection Coordination

The Contractor shall provide access to the Work for the District as requested for inspection. The Contractor shall provide at least 48 hours advance notice to the District of its intention to begin new Work activities. Inspections shall be conducted by the District for the following portions of the installation of the HPTRM:

The District shall inspect the final grading of the slopes for which the Contractor proposes to install the HPTRM to confirm that it meets the requirements of Section 3.1. If a rainfall event occurs that damages the final grading of the slopes during the HPTRM installation process, the District must be present to approve further installation of the HPTRM.

The District shall conduct random pull out tests of the earth percussion anchors. The earth percussion anchors shall have a pullout resistance of ~~500~~ 300 lbs and shall be tested at random locations identified by the District in accordance with ASTM D4435. The Contractor shall replace all failed percussion anchors at no additional cost to the District. Replacement anchors shall be installed to a depth sufficient to meet minimum required pullout resistance.

Prior to backfilling the HPTRM, the District shall inspect the following:

1. There are no surface irregularities or damage that could present a potential failure in the system.

2. All pins and earth percussion anchors are installed per Section 3.2.

3. All excess tendons from installed earth percussion anchors are removed.

1.6.5 Anchor Load Tests

The Contractor shall submit earth percussion anchor pullout tests reports testing the minimum required pullout resistance as stated in this specification. At each wave wall opening where the HPTRM is installed from the crest of the dam to the toe of the dam perform a minimum of 4 pullout tests (approximately 1 per 400 sf). At wave wall openings where the HPTRM does not reach the toe of the dam perform a minimum of 2 pullout tests per 400 sf.

1.7 DELIVERY, STORAGE, AND HANDLING

Check products upon delivery to assure that the proper material has been received and is undamaged. Protect the materials from damage and exposure following the guidelines presented in ASTM D4873/D4873M.

### 1.7.1 Labeling

Label each roll with the manufacturer's name, product identification, roll dimensions, lot number, and date manufactured.

### 1.7.2 Handling

Geosynthetic rolls shall be handled and unloaded by hand, or with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Geosynthetic rolls shall not be dragged, lifted by one end, lifted by cables or chains, or dropped to the ground.

### 1.7.3 Storage

Prior to use, the Contractor shall store the HPTRM in a clean, dry place, out of direct sunlight, not subject to extremes of either hot or cold and with the manufacturer's protective cover in place. Protect geosynthetics from cement, paint, excessive mud, chemicals, sparks and flames, temperatures in excess of 160 degrees F, and any other environmental condition that may degrade the physical properties.

If stored outdoors, elevate the rolls from the ground surface. Protect geosynthetics, except for extruded grids, with an opaque waterproof cover.

Deliver geosynthetics to the site in a dry and undamaged condition.

HPTRM shall not be exposed to direct sunlight for more than 7 days.

Protect the HPTRM during installation from clogging, tears, and other damage. Damaged HPTRM shall be repaired or replaced as directed.

Any rolls or partial rolls that may be installed must be protected from sunlight, erosion, weather and anything else that may harm the integrity of the HPTRM.

## 1.8 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

# PART 2 PRODUCTS

## 2.1 HPTRM

The Contractor shall furnish and install a HPTRM manufactured for the purpose of protecting the landside dam embankment slope at the wave wall openings. The HPTRM shall be made of 100 percent UV-stabilized polypropylene and contain no biodegradable components or materials to ensure long term design life. The HPTRM shall be composed of a three dimensional matrix, that will maintain its three dimensional stability without laminated or stitched layers. The HPTRM shall not lose its structural integrity and shall not unravel or separate when it is cut in the field. The following attributes differentiate a HPTRM:

The mat shall meet the following requirements: (range, minimum, or maximum)

| Property | Test Method | Test Parameter | Units | Property Requirement |
|---|---|---|---|---|
| Thickness | ASTM D6525 | Range | in | 0.25 - 0.50 |
| Resiliency | ASTM D6524 | Minimum | percent | 70 |
| Mass Per Unit Area | ASTM D6566 | Range | oz/yd2 | 8.0 - 15 |
| Ultimate Tensile Strength | ASTM D6818 | Minimum | lbs/ft | 3,000 x 3,000 |
| Tensile Elongation | ASTM D6818 | Maximum | percent | 65 |
| Light Penetration (% Passing) | ASTM D6567 | Minimum | percent | 10 |
| UV Resistance | ASTM D4355 | Minimum | percent | 80 @3000 hours |

2.1.1 Manufacturing Quality Control

Testing shall be performed at a laboratory accredited by GAI-LAP for tests required for the geosynthetic, at frequency exceeding ASTM D4354, with following minimum acceptable testing frequency:

| Property | Test Frequency (yd2) |
|---|---|
| Mass Per Unit Area | 1/24,000 |
| Thickness | 1/24,000 |
| Tensile Strength/Elongation | 1/24,000 |
| Light Penetration (% passing) | 1/24,000 |
| Resiliency | 1/120,000 |
| UV Resistance | Every 3 years |

2.2 ANCHORING DEVICES

2.2.1 Pins

The Contractor shall furnish metal pins with a minimum length of 24 inches with a steel washer located at the head of the pin. Locations of the pins along the HPTRM at the crest of the dam are indicated in the Drawings at the center of the one (1) foot x one (1) foot trench spaced one (1) foot apart. Locations of the pins along the overlaps are spaced one (1) foot apart except for where an earth percussion anchor is located or per the manufacturer's recommendation, whichever is more stringent.

| Component | Physical Properties |
|---|---|
| Metal Pin | 0.2 in diameter steel |
| Metal Washer | 1.5 in. diameter |

### 2.2.2 Earth Percussion Anchors

The Contractor shall furnish earth percussion anchors with minimum drive depths of 36 inches and minimum pullout resistance of 500 lbs for permanent tie down of the HPTRM to the slope in the locations specified in the Drawings.

Percussion anchors shall be placed in a grid pattern throughout the HPTRM at no more than four (4) feet spacing between anchors. Percussion anchor spacing shall include anchors along top and bottom trenches, along each side in the overlap areas and at ends of HPTRM.

The earth percussion anchor components shall be made of materials suitable to resist corrosion and UV degradation particularly at the soil/ air interface. The anchor head shall have relatively smooth edges to minimize abrasion and installation damage to the HPTRM. The anchor shall consist of a self-setting wedge grip used to lock and hold the loading applied to an anchor. The anchor shall reside at a minimum depth of 36 inches after it is locked in place.

## PART 3 EXECUTION

### 3.1 SURFACE PREPARATION

The Contractor shall grade the surface on which the HPTRM is to be placed to the depth, neat lines and grades as shown on the drawings. The surface shall be smooth and free of loose rocks, clods, holes, depressions, projections, muddy conditions, and standing or flowing water. All slopes to receive HPTRM are to be finish graded (including repair of erosional rills and gullies) immediately prior to placement of the HPTRM.

Install the HPTRM after the dam embankment has reached the design elevation for the fill. Install the HPTRM at each wildlife opening in one operation covering the landside embankment from crest to toe as shown on the drawings.

### 3.2 INSTALLATION

Install the HPTRM at the locations indicated in the drawings and in accordance with the approved installation plan. The width of the HPTRM shall be created from a single roll of material. See the drawings for the specified width.

Secure the HPTRM into the slope as indicated in the drawings, ensuring that the HPTRM is permanently anchored with earth percussion anchors spaced 4-feet apart, in between lapped ends and at the lapped ends.

Unroll HPTRM up the slope. The HPTRM shall be unrolled along the placement area and loosely laid (not stretched) in such a manner so that it will conform to the underlying soils. The upstream HPTRM shall overlap the abutting downstream HPTRM so to shingle panels of the HPTRM in such a manner that works with the flow of water down the slope to reduce undermining of the HPTRM at vertical overlaps.

Secure the HPTRM to the prepared slope with pins installed in a pattern of 1.5 pins per square yard or per Manufacturer's installation guidelines, whichever is more stringent. Vertical overlaps or seams will not be allowed.

Increased anchoring frequency may be required if site conditions are such that the District determines it necessary.

Alternate installation methods must be approved by the District prior to execution.

Should the HPTRM be torn or punctured, or the overlaps disturbed, as evidenced by visible damage, subgrade pumping, intrusion, or grade distortion, the backfill around the damaged or displaced area shall be removed and replaced. Torn or punctured HPTRM must be replaced.

3.3 INSPECTIONS

The District shall conduct inspections of the HPTRM installation at each wave wall opening.

3.4 PROTECTION OF WORK

Work shall be protected against damage from subsequent operations.

-- End of Section --

# SECTION 35 45 02

# VERTICAL AXIAL FLOW PUMPS - ELECTRIC MOTOR/BELT DRIVEN

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work: This specification SECTION covers furnishing all labor, equipment and materials to provide and install vertical axial flow pumps for water supply and flood control pumping. The pumps shall be electric motor driven through a belt drive transmission. All pumps shall be furnished complete with suction bells, impellers, bowls, columns, shafts, couplings, discharge head assemblies, bearings, seals, pedestals, anchor bolts, lubrication systems, a complete set of special tools (one set of tools per location) and all other parts and accessories indicated, specified, or required for proper installation, operation and maintenance.

### 1.2 APPLICABLE STANDARDS AND PUBLICATIONS

Standards or Codes: The edition of the publications of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. See the various paragraphs for the specified standard. In the case of a conflict between the requirements of this SECTION and those of the listed document, the requirements of this SECTION shall prevail.

American Welding Society (AWS)

| | |
|---|---|
| AWS D1.1 | Structural Welding Code - Steel |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME BPVC SEC VIII | (2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel |
| ASME BPVC SEC IX | (2010) BPVC Section IX-Welding and Brazing Qualifications |
| ASME B16.1 | (2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250 |
| ASME B16.3 | (2011) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.11 | (2011) Forged Fittings, Socket-Welding and Threaded |
| ASME B17.1 | (1967; R 2013) Keys and Keyseats |
| ASME B31.3 | (2016) Process Piping |
| ASME B106.1M | Design of Transmission Shafting |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A36 | Standard Specification for Carbon Structural Steel |
| ASTM A48 | Standard Specification for Gray Iron Castings |
| ASTM A53 | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A106 | Standard Specification for Steel Pipe Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A193 | Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Services |
| ASTM A234 | Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A276 | Standard Specification for Stainless Steel Bars and Shapes |
| ASTM A283 | Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates |
| ASTM A516 | Standard Specification for Pressure Vessel Plates, Carbon Steel for Intermediate and Higher Temperature Service |
| ASTM A609 | Standard Specification for Castings, Carbon and Low Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof |
| ASTM A743 | Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, for Corrosive Resistant Services |
| ASTM B584 | (2014) Standard Specification for Copper Alloy Sand Castings for General Applications |
| ASTM E165 | Standard Specification for Liquid Penetrant Examination |
| ASTM E709 | (2015) Standard Guide for Magnetic Particle Examination |
| ASTM F593 | (2013a; E 2016) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C207 | (2013) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in. |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)/
HYDRAULIC INSTITUTE (HI)

| | |
|---|---|
| ANSI/HI 2.1 | Vertical Pumps, Nomenclature, and Definitions |
| ANSI/HI 2.6 | Vertical Pump Test |
| ANSI/HI 9.8 | Pump Intake Design |
| ANSI/HI 2.4 | Vertical Pumps, Installation, Operation, and Maintenance |
| ANSI/HI 9.3 | Pump General Guidelines |
| ANSI/HI 9.6.4 | Centrifugal and Vertical Pumps, Vibration Measurements |

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 325 | (2011; Errata 1 2012; Errata 2 2013; Errata 3 2015) Steel Construction Manual |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 1940 | Mechanical Vibration Balance Quality Requirements of Rigid Rotors |
| ISO 9001 | Quality Management Systems |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC SP 2 | (1982; E 2000; E 2004) Hand Tool Cleaning |
| SSPC SP 3 | (1982; E 2004) Power Tool Cleaning |
| SSPC SP 5/NACE No. 1 | (2007) White Metal Blast Cleaning |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-55 | (2011) Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities |
| MSS SP-80 | (2013) Bronze Gate, Globe, Angle and Check Valves |

US Army Corps of Engineers manual EM 1110-2-3105 Mechanical and Electrical Design of Pumping Stations, August 1994

US Army Corps of Engineers guide specification USGS-15131A, Section 15131A Vertical Pumps, Axial Flow and Mixed Flow Impeller-Type, February 2002

US Army Corps of Engineers manual EM 1110-2-3102 General Principles of Pumping Station Design and Layout, February 1995

HI/Europump (Draft) ISO 9906 Test Standard Revision

## 1.3 DEFINITIONS

The following definitions apply to this specification and generally comply with ANSI/HI 2.1 and ANSI/HI 2.6.3:

### 1.3.1 ALLOWABLE OPERATING REGION (AOR)

The range of flows recommended by the pump MANUFACTURER over which the service life of a pump is not seriously compromised. Minimum bearing life will be reduced and noise, vibration, and component stresses will be increased when a pump is operated within its AOR but outside its POR (see definition below).

### 1.3.2 BEST EFFICIENCY POINT (BEP)

The rate of flow at which the pump efficiency is at a maximum.

### 1.3.3 BOWL ASSEMBLY EFFICIENCY

The efficiency obtained from the bowl assembly, excluding losses within the pump components:

bowl assembly efficiency = $P_w$ (pump output power) plus other pump component mechanical & hydraulic losses ÷ Pba (bowl assembly input power) x 100

### 1.3.4 BOWL ASSEMBLY INPUT POWER ($P_{ba}$)

The bowl assembly input power is the horsepower delivered to the bowl assembly shaft. See HI Engineering Data Book, second edition for an estimate of the line-shaft horsepower losses.

### 1.3.5 DRIVER INPUT POWER ($P_{drv}$)

The electrical power input to the motor driver (kilowatts) or pump input power ($P_p$) divided by the driver efficiency.

### 1.3.6 HEAD (h)

Head is the expression of the energy content of the water referred to a datum elevation. It is expressed in units of energy per unit weight of the water. The unit used in this specification shall be feet (ft) of water.

### 1.3.7 MINIMUM SUBMERGENCE (S)

The minimum water surface height above the suction bell inlet (reference ANSI/HI 9.8.7.3)

1.3.8 NET POSITIVE SUCTION HEAD REQUIRED (NPSHR)

The total suction head in feet absolute, determined at the suction nozzle and corrected to datum, less the vapor pressure of the liquid in feet absolute. It is an analysis of energy conditions on the suction side of a pump to determine if the liquid will vaporize at the lowest pressure point in the pump.

1.3.9 OVERALL EFFICIENCY

This is the ratio of the energy imparted to the liquid ($P_w$) by the pump to the energy supplied to the driver ($P_{drv}$); that is the ratio of the water horsepower to the power input to the primary driver expressed in percent.

1.3.10 PREFERRED OPERATING REGION (POR)

The pump is nominally designed for optimum performance in a relatively narrow band the preferred operating region described about the BEP. For pumps with specific speeds less than 4,500, this range is from 70 to 120 percent of BEP. For higher specific speed pumps this range nominally extends from 75 to 115 percent of BEP. Within this region the service life of the pump will not be significantly affected by hydraulic loads, vibration or flow separation.

1.3.11 PUMP EFFICIENCY

The ratio of the pump output power ($P_w$) to the pump input power ($P_p$); that is, the ratio of the water horsepower to the brake horsepower expressed in percent.

1.3.12 PUMP INPUT POWER ($P_p$)

The pump input power (brake horsepower) is the power needed to drive the complete pump rotating assembly including the propeller-bowl assembly input power, line-shaft power loss, stuffing box loss and thrust bearing loss. With pumps that rely on the driver thrust bearing, the thrust bearing loss shall be added to the power delivered to the pump shaft.

1.3.13 PUMP OUTPUT POWER ($P_w$)

The power (water horsepower) imparted to the liquid by the pump.

1.3.14 PUMP TOTAL DISCHARGE HEAD ($h_d$)

The pump total discharge head ($h_d$) is the sum of the discharge gauge head ($h_{gd}$) measured after the discharge elbow plus the velocity head ($h_{vd}$) at the point of the gauge attachment plus the elevation head ($Z_d$) from the discharge gauge centerline to the pump datum.

1.3.15 PUMP TOTAL HEAD (H commonly called Total Dynamic Head or TDH)

The pump total head (H) is the difference between the pump total discharge head (hd) and the total suction head (hs). This is the measure of the net energy increase per unit weight of the liquid, imparted to the liquid by the pump.

1.3.16 RATED CONDITION POINT

Rated condition point applies to the rate of flow, pump total head, speed, NPSHR, efficiency and pump input power as required by the Contract specifications. The rated condition is the point at which the pump Manufacturer certifies the pump s performance is within the acceptance criteria tolerances stated in this specification.

1.3.17 RATE OF FLOW (Q)

The rate of flow (capacity) of a pump is the total volume throughput per unit of time at the suction conditions.

1.3.18 SHUTOFF HEAD

The pump total head (H) when the pump operates at the rated speed and the pump is at zero flow.

1.3.19 SPEED (n)

The number of revolutions of the shaft in a given unit of time. Speed is expressed as revolutions per minute (rpm).

1.3.20 TOTAL SUCTION HEAD (hs), Open Suction

The total suction head (hs) at datum is the vertical distance in feet from free water surface to datum. The average velocity head of the flow in the intake shall be neglected.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications

SD-02 Shop Drawings

Mechanical Details and Drawings

SD-03 Product Data

Manufacturer's Standard (Catalog) Performance Curves

Coating System Data

SD-05 Design Data

Pump Data

SD-06 Test Reports

Factory Performance Test Setup and Test Procedure

Factory Test

Component Balance Procedures and Acceptance Criteria

Field Test Procedure

Field Performance Test

Pump Manufacturer's Certification of Equipment Installation

SD-07 Certificates

Manufacturer's Certification

SD-08 Manufacturer's Instructions

Erection and Installation Manual

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual

SD-11 Closeout Submittals

1.5 SUBMITTAL REQUIREMENTS

A. Contractor's Manufacturer's Selection Proposal: Submit the following with Contractor's proposal of the pump Manufacturer, see Paragraph titled CONTRACTOR'S MANUFACTURER'S SELECTION PROPOSAL.

1. Manufacturer's Qualifications:

a. ISO 9001 Certification

b. References

c. Technical support documentation

d. Service support documentation

i. Service rate schedule for five (5) years forward

ii. Location of service shop with crane capacity to lift pump

iii. Location of service people for service support

e. Company Financial Report

2. Manufacturer's standard (catalog) performance curves for each pump furnished. Curves shall cover the range from shutoff (or as near shutoff as is possible) to 120 percent of rate of flow at the rotary speed specified. Both the allowable and preferred operating regions (AOR and POR) shall be shown on each curve. Submit the following curves:

a. Rate of flow (Q) (cubic feet per second (cfs) and gallons per minute (gpm)) vs. pump total head (H) (ft)

b. Rate of flow (Q) (cfs and gpm) vs. pump input power (Pp) (bhp) include data point at zero flow

c. Rate of flow (Q) (cfs and gpm) vs. efficiency (np) (%)

d. Rate of flow (Q) (cfs and gpm) vs. NPSHR (ft)

3. Pump data:

a. Minimum recommended submergence at design and at the maximum recommended flow (inches (in))

b. Maximum hydraulic down-thrust, (and up-thrust considerations if required) for the specified operating conditions

c. Maximum pump weight (Maximum allowable weight = 10,000 lbs), dry (pounds (lb)), including belt drive/motor assembly ( driver )

d. Maximum pump weight (Maximum allowable weight = 12,000 lbs), wet (lb), including driver and water weight in the pipe column

e. Calculations of internal column pipe, bearings, packing and discharge head losses for the rated condition point (ft)

f. Calculated first and second rotor natural frequencies (cycles per minute (CPM))

4. Mechanical details and drawings including:

a. General arrangement layout of complete pump system, including driver

b. Cross-sectional drawings of complete pump system with component descriptions

c. Make and model numbers of equipment

d. Manufacturer's equipment (catalog) engineering data

e. Bearing Manufacturer's performance data, materials of construction and sizing calculations

f. Shaft size, material and design calculations

g. Driver Manufacturer's performance data, materials of construction and sizing calculations

h. Shaft seals

i. Base plate and anchorage details

j. Driver horsepower, service factor and rpm ratings

5. Materials of construction, with justification for any exceptions for the pump components as listed in Paragraph 2.4

6. Coating system data:

a. Description

b. Manufacturer

c. Applicator

d. Experience

e. Bond strength

f. Surface preparation requirements

g. Application procedure

h. Test procedure

7. Description of proposed factory performance test setup and test procedure, including:

a. Dimensioned drawings of the test setup indicating location of instruments and all pretest data

b. Methodology to scale data from test set-up to prototype performance

8. Foundry responsible for supplying the following pump components:

a. Propeller

b. Suction bell, impeller and diffuser bowls

9. Manufacturer's Certification (agreement with Contract Documents) as per paragraph titled MANUFACTURER'S CERTIFICATION

10. Manufacturer's Certification of review and acceptance of the operating floor final design as per Paragraph 2.1.

B. Test Reports and Procedures:

1. Factory Test:

a. Submit factory test procedures and sample performance data

b. Include basis for NPSHR margin

2. Component balance procedures and acceptance criteria

3. Field Test Procedure:

a. Vibration test

b. Operation test

4. Field Performance Test (submit pretest information for approval)

5. Pump Manufacturer's certification of equipment installation

C. Manuals (submit at the time of delivery):

1. Erection and Installation manual

2. Operation and Maintenance Manual

E. Warranty

1.6 PUMP MANUFACTURER'S QUALIFICATIONS

The pump Manufacturer shall have the following minimum qualifications to be considered as an acceptable MANUFACTURER to provide, install, and service the equipment specified in this Contract:

1.6.1 ISO 9001 Certification

The Manufacturer shall be ISO 9001 registered for the design, development, production, installation, and servicing of pumping equipment as required and specified in this Contract.

1.6.2 Experience

The Manufacturer shall have experience within the last five (5) years, from the date of submittal, with the design and manufacture of large diameter vertical axial flow pumping systems, of equal or larger capacity as specified herein.

The Contractor shall provide a minimum of five (5) references of projects that the Manufacturer has provided pumps of equal or larger capacity. These project references shall include the name and telephone number of the contract person who has direct knowledge of the performance of the pump Manufacturer. The reference must indicate an acceptable performance by the Manufacturer to be considered by this Contract.

1.6.3 Technical Support

The Manufacturer shall have an engineering service department to support the Project design, perform the required tests, and provide field supervision of the installation. The engineering service department shall include Registered Professional Engineers on staff.

1.6.4 Service

The Manufacturer shall have a service department capable of providing immediate response (24-hour coverage) to service calls. The Manufacturer's service department shall include skilled technicians and mechanics that can diagnose and repair the equipment supplied by this Contract.

1.7 MANUFACTURING REQUIREMENT

The pumps shall be manufactured (machining, quality control, inspection and testing) by the pump Manufacturer at the facilities owned and operated by the Manufacturer. No sub-manufacturing is permitted unless noted otherwise herein or unless agreed to by the District prior to acceptance of the

Manufacturer. Castings and fabrications (elements) weighing over 100 lbs shall either be cast or fabricated by the pump Manufacturer or by a sub-supplier that specializes in casting or fabricating of pump components. Weld and heat treat procedures shall be submitted for approval prior to manufacture. Weld maps of casting repairs shall be submitted for approval. The sub-supplier shall have a minimum of five (5) years experience in casting or fabricating similar components. Submit foundry or fabricator qualifications for District approval.

1.8 PRODUCT QUALIFICATION

The pumps shall be from the product line of vertical axial flow pumps that has been used in similar applications and backed with after-sales service from direct factory engineering representatives. The following technical data of the proposed pump shall be submitted to the District as part of the Contractor's selection proposal of the pump Manufacturer:

A. Manufacturer's standard (catalog) performance curves for each pump furnished. Curves shall cover the range from shutoff (or as near shutoff as is possible) to 120 percent of rate of flow at the rotary speed specified. Both the allowable and preferred operating regions (AOR and POR) shall be shown on each curve. Submit the following curves:

1. Rate of flow (Q) (cfs and gpm) vs. pump total head (H) (ft)

2. Rate of flow (Q) (cfs and gpm) vs. pump input power (Pp) (bhp) include data point at zero flow

3. Rate of flow (Q) (cfs and gpm) vs. efficiency (np) (%)

4. Rate of flow (Q) (cfs and gpm) vs. NPSHR (ft)

B. Pump data:

1. Minimum recommended submergence at design and at the maximum recommended flow (in)

2. Maximum hydraulic down-thrust and up-thrust for the specified operating conditions

3. Maximum pump weight, dry (lb), including belt drive/motor assembly ( driver )

4. Maximum pump weight, wet (lb), including driver and water weight in the pipe column

5. Calculations of internal column pipe, bearings, packing and discharge head losses for the rated condition point (ft)

6. Calculated first and second rotor natural frequencies (CPM)

1.9 TEST AND INSPECTION COORDINATION AND NOTIFICATION

The Contractor shall provide a minimum of two (2) weeks advance notice to the District of the date of witness tests or other inspections as specified or indicated herein. The Contractor shall be responsible for ensuring all tests and inspections are coordinated with the Manufacturer and all other

appropriate subcontractors or trades people. All field test or inspection preparations shall be the responsibility of the Contractor or designated subcontractor. Failure to provide the required advance notification may require the District to request a delay in the inspection/test at the expense of the Contractor.

## 1.10 MANUFACTURER'S CERTIFICATION

A letter shall be submitted to the DISTRICT by the pump Manufacturer, signed by a senior executive officer, certifying that the Manufacturer's representative has read and studied the Contract Documents and agrees to the requirements of this Section. All exceptions to the requirements of this specification, including those addressed by Compliance Submittals, shall be stated in the letter.

## 1.11 MEASUREMENT AND PAYMENT

The Contract provides cost allowances for the major equipment as indicated in SECTION 01020 and as defined herein. The allowances are to cover the cost of the equipment and ancillary components. All incidental Contractor costs for installation and commissioning the pump shall be included in the Contractor's bid. In addition, the Contractor shall include in his bid all overhead, profit, bond costs or other related cost. These items will not be paid out of the allowance. Should the net cost of the equipment be more or less than the specified amount of the allowance, the Contract Sum will be adjusted accordingly by change order. Approval of net cost is required if over the allowance amount. The equipment to be supplied under this SECTION including spare parts and special tools shall be included in the Major Equipment Allowances shown on the bid form. The payment for the equipment shall be in accordance with the schedule presented in SECTION 01020.

## 1.12 CONTRACTOR'S MANUFACTURER'S SELECTION PROPOSAL

The Contractor shall select the Manufacturer who best satisfies the requirements of this specification at an economical price. The Contractor shall submit a proposal to the District for approval. The proposal shall include all Compliance Submittals required prior to placement of an order, detailed cost breakdown, delivery schedule and any other information that has importance in the selection of the pump Manufacturer for this Contract. The District may request alternative proposals from other Manufacturer's to compare costs and insure the District is receiving a fair and reasonable offer.

## 1.13 ERECTION AND INSTALLATION MANUAL

The Contractor shall submit, no later than at the time of delivery, the installation and erection manual describing procedures to be followed in erecting, assembling, installing and testing the pumps. The manual shall include such things as alignment procedures, bolt torque values, permissible blade/bowl clearances, permissible bowl out-of-roundness, permissible shaft misalignment, etc.

## 1.14 OPERATION AND MAINTENANCE MANUAL

The Contractor shall submit operation and maintenance manuals containing complete information on operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, re-assembly and trouble diagnosis

of the pump and its auxiliary units. The manual shall include cross-sectional drawings showing the pump and driver with a complete list of parts. All running clearances, including design and maximum recommended, shall be included.

1.15 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. General: Design, furnish, and install custom engineered vertical axial flow pumps with drivers and auxiliaries as shown in the Drawings and as specified herein. The pumps shall be enclosed line shaft, vertical propeller type pumps with a below-base plate discharge.

1. Manufacturers - One of the following, no substitution allowed:

a. FPI Pumps, Inc.

b. Cascade Pump Company

c. Morrison Pump Company

d. Ruhrpumpen, Inc.

2. Service: The pumps shall be designed and manufactured suitable for water service. This service includes turbid storm water that may contain sand, silt, and vegetative trash capable of passing the trash rack. Water temperatures can range from 60 Fahrenheit (F) to 90 F. The equipment including auxiliaries covered by this specification shall be designed and constructed for a minimum service life of twenty (20) years excluding normal wear parts. The average annual usage is estimated to be 1,500 hours per year, with the majority of the usage occurring during a few storm events.

3. Intake Design: The rectangular intake design is generally in accordance with ANSI/HI 9.8. The pump design shall accommodate the intake as shown in the Drawings. The pump Manufacturer shall review the pump station floor design with respect to its natural frequency, dimensions, and strength to ensure its suitability with the pump supplied. A letter of certification shall be submitted to the District by the Manufacturer indicating the firm s review and acceptance of the final design.

a. Trash Racks (Provided by Contractor): Trash racks will have a clear opening as shown on Drawing M21202.

b. Foundation: The framing and anchorage design shown in the Drawings is conceptual and shall be detailed by the pump Manufacturer. Pump supplier shall review platform dimensions and confirm proper mounting arrangement and clearance for pump removal. The District shall approve changes to the framing anchorage of the pump.

4. Maintenance and Operation: The Manufacturer shall reference ANSI/HI 2.4 for the standard for installation, operation, and maintenance of vertical pumps. All equipment shall be designed to permit rapid and economical maintenance. Major parts, such as the bowl components, shall be designed and manufactured to ensure accurate alignment on re-assembly. The propeller shall be removable from bottom of pump bowl without dismantling pump, except for suction bell removal.

B. Drivers: See SECTION 26 60 13.00 40 LOW-VOLTAGE MOTORS

2.2 DYNAMIC ANALYSIS

A. Manufacturer shall conduct dynamic analysis with the consideration that the pump is mounted to a steel frame as shown as shown on the Drawings.

B. Lateral Critical Speed: The Manufacturer shall determine the lateral (dry) critical speed of the pump rotor using static deflection calculations as described in ANSI/HI 9.6.4.2.1 or approved alternate method. A critical speed shall not occur within 25 percent above or below the operating speeds of the pump.

C. Torsional Critical Speed: The Manufacturer shall determine the torsional critical speed of the pump rotor using manual calculation methods as described in ANSI/HI 9.6.4.2.3 or approved alternate method. A critical speed shall not occur within 25 percent above or below the rated operating speed of the pump.

D. Submit the complete dynamic analysis report for 2.2 A and B above as required to the District prior to start of fabrication.

2.3 DESIGN REQUIREMENTS

A. Pumping Conditions: Pumping conditions have been determined in accordance with US Army Corps of Engineers manual EM 1110-2-3105, Mechanical and Electrical Design of Pumping Stations. These system requirements represent the operating range for the pump including the static heads, friction losses, exit losses and the velocity head. The losses in the portion of the pump that is supplied by the Manufacturer (between the basket strainer/screen and the end of the discharge elbow) are considered internal pump losses and are not included in the system head loss determination and shall be determined by the Manufacturer. The pump Manufacturer shall calculate these internal pump losses and shall submit these calculations to the District for approval. Static heads are calculated from the elevation of the water in the intake on the pump side of the trash rack. For the purposes of determination of system losses, and as a safety margin the entire velocity head will be considered unrecoverable and thereby added to the other losses. The following table represents the estimated pump operating range at the rated speed:

1. High Head Condition:

a. Maximum Static Head 8.4 ft

b. Maximum System Head* 9.9 ft

c. Minimum Rate of Flow 41.7 cfs and 18,700 cfs ~~gpm~~

2. Low Head Condition:

a. Minimum Static Head 5.9 ft

b. Minimum System Head * 7.4 ft

c. Maximum Rate of Flow 45.27 cfs and 20,500 cfs ~~gpm~~

(*) Represents the total system head requirements and does not include internal pump losses.

B. Performance Requirements: Pumps shall be designed for standby service, which is defined as a normally idle piece of equipment that is capable of immediate automatic or manual start-up and continuous operation. The rated capacity (Q) shall be within the region of 80 to 110 percent of the best efficiency point (BEP) for the furnished propeller. The pumping system shall satisfy the following criteria:

1. Rated Condition Point:

a. Rate of Flow (Q) 41.7 cfs

b. Pump Total Head (H) 9.9 ft (including internal pump losses)

c. Pump Rotary Speed (n) 500 to 700 rpm ~~( )~~

d. Minimum Pump Efficiency (np) 80 percent

e. Minimum Belt Drive Efficiency 95 percent

f. Propeller Diameter per manufacturer

g. Pump Driver Power (Pdrv) 100 hp

2. Run-out condition:

a. Pump Total Head (H) 6.5 ft

b. Minimum Pump Efficiency 60 percent

c. NPSHR 23 ft

d. Minimum Submergence (S) per ANSI/HI 9.8 Equation 9.8.6.3-2 92 inches

3. Tolerances: Acceptance criteria for pump performance test results shall be as follows:

a. Rate of flow tolerance at rated pump total head and speed can vary from +10 percent to 0 percent of the specified Q.

b. Efficiency shall be equal to or greater than the specified minimum efficiency at the rated flow and speed.

c. The pump input horsepower shall be non-overloading throughout the pump curve from shut off to the maximum flow range, i.e. shall not exceed the specified pump driver output horsepower.

d. Minimum submergence required shall not be less than the minimum submergence available at maximum design flow range.

C. Station Requirements: The pump shall satisfy the following criteria, as shown on Drawing M21202:

1. Number of Pumps Required 3 per station

2. Operating Floor Elevation 27.5 ft NAVD

3. Intake Floor Elevation 10 ft NAVD (approx.)

4. Centerline Discharge Pipe Elevation 23.25 ft NAVD (approx.)

5. Minimum Intake Water Elevation 18.5 ft NAVD

6. Maximum Intake Water Elevation 21.0 ft NAVD

7. Maximum Discharge Pool Elevation 26.9 ft NAVD (center of pipe)

8. Discharge Pipe Diameter 30 inches

D. Miscellaneous Design Requirements: The pump design shall also address the following requirements:

1. The pump, belt transmission and driver shall be designed such that no damage will occur in the event of reverse rotation caused by back-flow.

2. Identical Pumps: All pumps of the same type and designation shall be identical pumps as defined by ANSI/HI 2.1.6.3. This standard requires the pump to be a duplicate of the original pump as closely as manufacturing tolerances allow: performance characteristics shall be the same within the allowable limits permitted by this specification. Parts shall be interchangeable and allow for common spares.

3. Head-capacity curves shall be constantly falling from the shutoff head. The pumps shall be capable of operation without instability over the entire range of heads specified. Instability shall be considered when the pump has more than one flow rate at the same total head.

4. Rotation: The shaft rotation direction shall match the typical rotation direction of the driver.

## 2.4 MATERIALS OF CONSTRUCTION

A. The materials specified are considered the minimum acceptable for the purposes of durability, strength and resistance to erosion, corrosion, and cavitation. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose. All material selection for the pump components shall exceed the guidelines of ANSI/HI 9.3.2 for

corrosion, erosion, and abrasion resistance for fresh water applications. All material shall conform to the latest ASTM specification or other listed commercial specifications covering the class or kind of material to be used. Submit to the DISTRICT for approval the proposed grade, class, and specification of the material for the pump components listed below:

B. Materials:

| ITEM | MATERIAL |
|---|---|
| 1. Structural Support Steel | Carbon steel, ASTM A36 |
| 2. Discharge Column and Elbow | Carbon steel, ASTM A283 grade C (or) Carbon steel, ASTM A516 grade 70 |
| 3. Transmission Mounting | Carbon steel, ASTM A36 |
| 4. Impeller Bowls | Stainless steel - ASTM A240 type 316 |
| 5. Diffuser Bowls | Cast iron, ASTM A48 class 30 (or) Carbon Steel, ASTM A283 Grade C, epoxy coated |
| 6. Suction Bell | Cast iron, ASTM A48 class 30 (or) Carbon steel, ASTM A283 Grade C, epoxy coated |
| 7. Shafts | Stainless steel, ASTM A276 type 410 |
| 8. Shaft Couplings | Stainless steel, ASTM A276 type 410 |
| 9. Shaft Enclosure | Stainless steel, ASTM A276 type 410 |
| 10. Shaft Sleeves | Stainless steel, ASTM A276 type 410 |
| 11. Propeller | Copper alloy casting, ASTM B584-C87500 (or) Stainless steel, ACI CF8 |
| 12. Packing Gland | Stainless steel, ASTM A240, Type 316 or 304 |
| 13. Nuts, Bolts, Dowels, Keys, Fasteners | Stainless steel, ASTM A193, Type 316 or 304 |

C. Minimum wall thickness (in inches) shall conform to the following table:

| Nominal Discharge Dia. (in.) | Wall Thickness (Inches) | | | | | |
|---|---|---|---|---|---|---|
| | Diffuser Bowl | | Impeller Bowl | Suction Bell | | Discharge Column and Elbow |
| | Cast Iron | Carbon Steel | Stainless Steel | Cast Iron | Carbon Steel | Carbon Steel |
| 12 | 1/2 | 3/8 | 3/8 | 1/2 | 3/8 | 3/8 |
| 16 | 1/2 | 3/8 | 3/8 | 1/2 | 3/8 | 3/8 |
| 18 | 1/2 | 3/8 | 3/8 | 1/2 | 3/8 | 3/8 |
| 20 | 1/2 | 3/8 | 3/8 | 1/2 | 3/8 | 3/8 |
| 24 | 1/2 | 3/8 | 3/8 | 1/2 | 3/8 | 3/8 |
| 30 | 1/2 | 3/8 | 3/8 | 1/2 | 3/8 | 3/8 |
| 36 | 5/8 | 3/8 | 3/8 | 5/8 | 3/8 | 3/8 |
| 42 | 5/8 | 1/2 | 1/2 | 5/8 | 1/2 | 1/2 |
| 48 | 5/8 | 1/2 | 1/2 | 5/8 | 1/2 | 1/2 |
| 54 | 3/4 | 1/2 | 1/2 | 3/4 | 5/8 | 5/8 |
| 60 | 3/4 | 5/8 | 5/8 | 3/4 | 5/8 | 5/8 |
| 72 | 3/4 | 5/8 | 5/8 | 3/4 | 5/8 | 5/8 |
| 84 | 3/4 | 5/8 | 5/8 | 3/4 | 5/8 | 5/8 |

2.5 METALWORK

A. Welding:

1. Welding of piping, pressure containing parts and wetted parts, as well as repair to such parts shall be performed and inspected by operators and procedures qualified in accordance with Section VIII, Division 1 and Section IX of the ASME Code. All repairs and repair welds shall be properly heat treated and nondestructively examined for soundness and compliance with the applicable qualified procedures. Repair welds shall be nondestructively tested by the same method used to originally qualify the part.

2. Unless otherwise specified, all welding other than that covered by Section VIII, Division 1, of the ASME Code and ANSI/ASME B31.3, such as welding on base plates, non-pressure ducting, and lagging shall be performed in accordance with ANSI/AWS D1.1.

3. Pressure containing welds, including welds of the casing to horizontal and vertical joint flanges, shall be full fusion, full penetration welds.

4. Auxiliary piping welded to alloy steel casings shall be of a material with the same nominal properties as the casing material or shall be of a low carbon austenitic stainless steel.

B. Flame Cutting: Flame cutting of material other than steel shall be subject to approval of the District. Shearing shall be accurately done and all portions of Work neatly finished. Steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a smooth

surface, free from cracks and notches is secured. Surfaces and edges to be welded shall be prepared in accordance with ANSI/AWS D1.1. Chipping and/or grinding will not be required unless necessary to remove slag and sharp edges of mechanically guided or hand guided cuts not exposed to view. Visible or exposed hand guided cuts shall be chipped, ground, or machined to be free of voids, discontinuities, and foreign materials.

C. Alignment of Wetted Surfaces:

1. Exercise care to ensure correct alignment of wetted surfaces joined by flanged joints. Where plates of the water passage change thickness, transition shall occur on the outer surface, leaving the inner surface properly aligned. When welding has been completed and welds have been cleaned, but prior to stress relieving, joining of plates shall be carefully checked for misalignment. Localized misalignment between inside or wetted surfaces of adjoining flange connected section of the pump shall not exceed the amount shown in the table below:

| **Wall Thickness (in)** | **Maximum Allowable Offset (in)** |
|---|---|
| 1/4 | 1/16 |
| 3/8 | 3/32 |
| 1/2 | 1/8 |
| 3/4 | 5/32 |
| 1 | 5/32 |
| 1-1/8 | 3/16 |

2. Misalignment greater than the allowable amount shall be corrected by grinding away the offending metal, providing the minimum wall thickness is not less than 75 percent of the nominal wall thickness.

3. All corrective Work shall be finished by grinding the surfaces to a smooth taper. The length of the taper along each flow element shall be (10) times the depth of the offset error at the flow line. Ground areas shall be inspected by a liquid penetrant test for linear indications. Wetted surface irregularities that might have existed in an approved model shall not be reason for accepting comparable surface irregularities in the pump.

D. Castings:

1. Castings shall be sound and generally free from porosity, hot tears, shrink holes, blow holes, cracks, scale, blisters and similar defects. Minor surface imperfections shall be welded or ground down as necessary to preserve the correct contour and outline of the part and to restore the surface to the same degree of finish as the surrounding surfaces. Mold parting fins and remains of gates and risers shall be chipped, filed or ground. Correct surface pits, depressions, projections, and overlaps showing greater than 1/16 inch variation from the general contour for that section. Castings that exhibit surface imperfections covering an area more than 10 percent of the blade surface will be rejected. In addition, casting defects shall not exceed 12.5 percent of the total blade thickness. Where defects will not affect the strength and serviceability of the casting, casting

defects may be repaired by a welding procedure approved by the District. Weld maps and heat charts must be provided.

2. Surfaces of castings shall be cleaned by sandblasting, shot blasting, chemical cleaning, or any other standard method to meet the visual requirements of MSS-SP-55.

3. All castings shall be carefully examined for surface defects. All defects shall be further examined by a nondestructive means. The Manufacturer's examination personnel shall be certified in accordance with applicable ASTM requirements. The examination procedure shall be one of the following suited for the application:

a. ASTM A 609/A 606M Castings, Carbon and Low Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof

b. ASTM E 709 Magnetic Particle Examination

c. ASTM E 165 Liquid Penetrant Examination

4. Steel castings may be repaired by using a qualified welding procedure based on the requirements of Section VIII, Division 1 and Section IX of the ASME Code. Iron castings may be repaired by plugging within the limits of the applicable ISO (ASTM) specification. The proposed method of the casting repair shall be submitted to the District for approval.

E. Flanges: Provide flanges on major components of the pump casing (suction bell, impeller bowl, diffuser bowl, discharge column). Flanges shall be dimensioned in accordance with AWWA C207, Class B, and drilled per ANSI/ASME B16.1, Class 25. Design flanged joints to be air and water tight without the use of preformed gaskets. The flanges shall be parallel machined and mounted parallel to a plane that is normal to the pump shaft centerline. Flanges on each end of the same component shall have a parallel tolerance of 0.002 inch. Finish machine mating surface on the flange to 3.2 microns (125 micro-inches) RMS finish or better. Provide mating flanges with male-female rabbet or with not less than four tapered dowels equally spaced. If a rabbet fit is not provided, the Manufacturer shall provide the method used to determine concentricity of the connected pieces. Design flanges to be connected by at least two continuous fillet welds. One weld shall connect the inside diameter, the other the outside diameter. The final design of the flange connection shall be provided by the Manufacturer. Provide external stiffeners if required.

## 2.6 BALANCING

Balance impeller and couplings in accordance with ANSI/HI 9.6.4.5.1, "Unbalance of rotating parts and rotor balance." Component balance shall be a single-plane spin balance to ISO 1940 E balance quality grade G6.3. When the ratio of the component outside diameter divided by the distance between correction planes is less than (6) six, a two-plane balance shall be required. The propeller component shall be balanced not less than 2/3 of rated speed.

A. Quality of Balance Guidelines: The balancing equipment and procedures shall follow the guidelines of ANSI/HI 9.6.4.5.1. The Contractor shall submit the proposed balancing procedures and balancing equipment data.

B. Allowable Unbalance: The allowable unbalance for the rotating parts of the pump and its propeller shall be determined in accordance with the procedure defined in ANSI/HI 9.6.4.5.1.

C. Balance Correction: The material removal or addition for balance correction shall follow the guidelines in ANSI/HI 9.6.4.5.1 and paragraph 2.4. No material shall be added in hydraulic flow passages. The Contractor shall submit the procedure proposed to correct the unbalance of the component.

## 2.7 PUMP COMPONENTS

The following list of pump components shall not be considered a complete and comprehensive description of the all the component pieces of the finished pump. It is also recognized, pump designs vary from manufacturer to manufacturer and the component descriptions may not be representative of a particular design. The Manufacturer shall submit cross sectional drawings indicating the pump design to be supplied with a description of the component pieces of the unit.

A. Component Design Criteria: Combined stresses in cast, forged, rolled, or fabricated pressure retaining components, frames and supports shall not exceed that allowed for the given material in Section VIII, Division 1 of the ASME Code. Design pressures for pressure-retaining parts shall be not less than twice the pump s shutoff head at the maximum operating speed.

B. Base Plate: The horizontal plate shall provide a rigid support for all live and dead loads of the pump and speed reducer as shown on the Drawings. Combined stresses in steel base plates and supports shall not exceed those permitted by AISC Manual of Steel Construction. Lifting lugs or eye bolts shall be furnished for handling the pump during loading, unloading, erection, and installation. The base plate shall be designed and fabricated to provide a clear opening large enough for removal of the complete pumping unit. The clear opening shall be centered in the base plate. The plate dimensions and anchorage details shown on the Drawings are conceptual. Final dimensions shall be adjusted in accordance with the pump Manufacturer's recommendations.

C. Transmission Pedestal/Mounting: A pedestal shall be mounted on the pump column and house the stuffing box as well as provide support for the belt transmission and motor driver. Reinforcing ribs and braces shall be provided as required.

1. Water Leakage: The pedestal/mounting shall be designed to collect and drain water leakage from the shaft packing.

2. Access: Access holes that are sufficiently large, and sufficient in number, shall be provided for dismantling the drive shaft coupling, and for maintenance and inspection of the pump seal. Access holes shall be provided with steel guard screens designed for easy installation and removal.

3. Mounting Surfaces: The mounting surfaces shall be designed and machined to ensure the transmission can be adjusted to satisfy the shaft alignment requirements of the equipment. The pump Manufacturer shall closely coordinate with the motor Manufacturer to ensure the

proper compatibility of the component designs including required installation and alignment procedures.

D. Belt Drive Transmission: The belt drive transmission shall consist of a sheave and rubber V-belt assembly that converts the rated driver speed to the required lower rated output speed for the pump provided. The pump's head shaft and belt transmission shall be designed to address the pump's axial and radial loads and facilitate the adjustment of the vertical position of the propeller. The mounting characteristics and design shall be determined by the Manufacturer and shall be in accordance with accepted AGMA standards. The sheave assembly shall be designed for easy adjustment of belt tension and provide a means of locking the sheaves in position to prevent slippage from belt tension.

1. Thrust Bearing: Thrust axial loads, (up-thrust and down-thrust), shall be supported by a thrust bearing(s) in the belt transmission. The thrust bearing type shall be an angular contact ball or spherical roller. The thrust bearing shall be sized for continuous operation under all specified conditions as well as transient loads and shall provide full load capabilities if the pump s normal direction is reversed. The pump Manufacturer shall closely coordinate with the belt transmission Manufacturer to ensure the proper compatibility of the component designs.

E. Column and Discharge Elbow: The column and discharge elbow shall be designed to withstand the internal pressures and the external loads associated with the pump operation, transportation, erection, or testing required in the field. The elbow and the column section shall be provided with lifting lugs or lifting eyes to facilitate the handling of these parts during installation or maintenance. The column and elbow shall be suspended from the base plate assembly as shown on the Drawings. The Manufacturer shall provide all necessary fittings and cocks for venting and drainage as required.

1. Column: The support of the base plate and column shall maintain the proper alignment of the pump unit and propeller blade setting. Flanges shall be machined after welding to the pipe and heat treatment to ensure that they are concentric and perpendicular with the axis of the shaft. The column shall be flanged to the diffuser bowl, and shall have rabbet fits or dowels to maintain a concentric alignment. Provide an air/vacuum valve in the column pipe to allow the air to escape when the pump is started.

2. Elbow: The discharge elbow shall be a mitered type and welded. Turning vanes, if used, shall have clear spacing twice the trash rack spacing. The elbow shall terminate in a plain end with a circular section to allow connection to a standard diameter Victaulic flexible restrained coupling. Provide 1/2 inch NPT female gage connection on discharge horizontal centerline for test gage.

3. Flap Gates: Design the flap gate for pump discharge service with flange-frame with a resilient seat of neoprene of BUNA-N to prevent closing shock. Make the size of the flap gate the same of the discharge pipe size. The body and flap shall be cast iron in accordance with ASTM A126. The hinge arms shall be bronze in accordance with ASTM B584 - CA 865. The hinge pins shall be designed in double shear and of silicon bronze in accordance with ASTM B98/B98M - CA 655. Provide lubrication

fittings on the hinge arms. Provide an ant-locking bar to prevent excessive rotation about the lower hinge pin. Provide a stainless steel leaf spring with rubber pad to safely limit the travel of the flap gate during pumping.

4. Discharge Coupling: Discharge coupling shall be a Victaulic Style 232, one segment, type 2, restrained, flexible coupling, or Engineer approved equal. Coupling body shall be carbon steel in accordance with ASTM A36 or ASTM A1011 (for gauge thickness). Shoulders and closure plates shall be carbon steel in accordance with ASTM A36. Sealing plate shall be type 316L stainless steel in accordance with ASTM A240. Gaskets shall be EPDM. Studs, nuts and washers shall be type 316L stainless steel. Restraint rings shall be attached to the pipe ends to create a restrained joint. Restraint rings shall be carbon steel, grade 1018, in accordance with ASTM 108. Coupling manufacturer shall provide special tools for installation and removal of the coupling, if required.

F. Diffuser Bowl: The bowl shall be designed to convert the tangential component as well as a portion of the axial component of the velocity into pressure. The diffuser vane design shall optimize the pump performance by straightening and reducing the velocity of the flow as it leaves the propeller. The diffuser vanes should not be an even multiple of the number of propeller vanes to avoid amplification of the pulse energy at the vane passing frequencies. The diffuser bowl shall be flanged and bolted to the discharge column and impeller bowl to prevent rotation and ensure proper alignment. Alignment shall be maintained concentric to the pump centerline by use of a rabbet fit or dowels. The bowl shall contain support for the upper propeller shaft bearing.

G. Impeller Bowl: Bowl shall be flanged and bolted to the suction bell and diffuser bowl to prevent rotation. The mating flanges shall have a rabbet fit or dowels to maintain a concentric alignment. The machine finish of the propeller swept area interior of bowl shall be at least 3.2 microns (125 micro-inches) RMS and concentric with propeller axis. Tolerance for concentricity of propeller axis shall not be greater than 20 percent of the operating clearance between the propeller and the bowl.

H. Suction Bell: Provide flared suction bell of a design and size to provide constant acceleration to the propeller to prevent flow separation under all operating conditions. ANSI/HI 9.8.7.3 shall be used as a guide to determine minimum acceptable entrance bell diameters given the minimum required submergence and intake geometry. The bell shall be of a design that has been successfully proven in previous installations compatible with the propeller pump model proposed for the Project. The bell shall be one piece and flanged to the impeller bowl. The bell shall be supported entirely by the pump casing, supports from the pump floor will not be accepted. Alignment shall be maintained concentric to the pump centerline by use of rabbet fits or dowels.

1. Strainer: Provide a basket strainer/screen to minimize solids from entering the suction bell. Strainer shall be type 316 stainless steel, removable, and have a flow area of at least three times the column area. Openings shall prevent the passage of 1-inch diameter and larger objects.

I. Shafts: The shaft shall be designed and manufactured to transmit the maximum torque from the driver to the propeller and support the maximum thrust load with the proper factor of safety. In accordance with ASME B106.1M, the shafts shall be designed for two cases: safety factor of five (5) based on the ultimate tensile strength of the shaft material and the rated horsepower of the engine; 75 percent of the yield strength of the shaft material and the maximum horsepower of the driver.

1. Torsional and Combined Shaft Stress: All shafts shall be designed to carry the steady state and transient loads suitable for the unlimited number of load applications, in accordance with ASME B106.1M. Where shafts are subjected to fatigue stresses, such as frequent start and stop cycles, the mean stress shall be determined by applying the ASME method for determining the shear endurance limit. The mean stress shall be considered by using the modified Goodman Diagram. The maximum torsional stress shall not exceed the shear endurance limit of the shaft after application of the safety factor of 2.0. The stress concentration factors to account for the geometric discontinuities in the shaft section shall be considered. Fillets in the shaft and the key-ways shall be in accordance with ASME Standard B17.1. Petersen s Stress Concentration factors shall be used to determine appropriate stress concentration factors for the shaft system.

2. Shaft Deflections: The shaft stiffness shall limit deflections under the most severe dynamic conditions over the allowable operating range of the pump in accordance with the performance requirements of the shaft seals and bearings. The running clearances shall be sufficient to ensure dependability of operation and freedom of seizure under all specified operating conditions.

3. Critical Speed: All shafts shall be designed to operate within the allowable vibration tolerances in the preferred operating region and ensure the lateral and torsional first critical speeds occurs 25 percent above or below the rated pump speed.

4. Sleeves: Unless otherwise specified, renewable sleeves shall be furnished at seal and journal bearing locations. The sleeves shall be held in place by a press fit with keys, locking pins, threaded dowels or other approved methods. The finish of the sleeve shall be at least sixteen (16) micro-inches RMS for the seal locations and 32 micro-inches RMS for the guide bearing locations unless otherwise specified by the seal and bearing Manufacturers and approved by the District. The pump Manufacturer shall coordinate the required machining tolerances with these Manufacturers.

5. Head Shaft: The Manufacturer shall reference the ANSI/HI 2.1.4.2 standard for the requirements of the hollow/solid shaft driver. The mounting characteristics and design shall be determined by the Manufacturer. The shaft shall be threaded and shall be provided with a nut to facilitate the adjustment. A circumferential line shall be inscribed or etched on the shaft above the stuffing box and an adjustable pointer shall be provided and mounted opposite this line to indicate a change in vertical position of the shaft and to permit realignment after removal of the speed reducer.

6. Line Shaft/ Pump Shaft: The shaft design and machining requirements shall be as specified above.

7. Shaft Enclosure: Provide a shaft enclosure to cover the line shaft and couplings. The enclosure shall be easily assembled and disassembled in the field. External supports or bracing located in the pump water passage shall not be used for support of the tube unless necessary to support intermediate bearings. The enclosure tube shall be designed in accordance with the requirements of bearing water lubrication system to ensure a clean and adequate supply of water to the shaft bearings.

8. Shaft Seals: The seal system shall consist of lip-type seal with a stainless steel lip element. All proposed seal systems shall be submitted to the District for review and approval.

9. Shaft Couplings: Shaft couplings shall be of a rigid, keyed design of the same material as the shaft and shall allow the shaft to be readily disassembled, aligned and made up in the field. The coupling shall be capable of transmitting the full load torque required to operate the pump. The finished shaft assembly shall be concentric about the shaft centerline to within 100 microns (0.004 inch). The shaft couplings shall be factory balanced in accordance with this specification. Couplings furnished shall be shop mounted. The allowable coupling misalignment criterion shall not be used for determination of the parallel offset for the shafts. The axial spacing criteria specified by the coupling Manufacturer, however, shall be addressed during installation. All proposed shaft couplings shall be submitted to the District for review and approval.

10. Shaft Alignment: The shaft to shaft alignment shall be in accordance with SECTION 01 61 07 EQUIPMENT ALIGNMENT.

J. Bearings:

1. Hydrodynamic Water Lubricated Journal Bearings: This bearing type shall be used for all line shaft locations including the bowl assembly bearings located immediately above and below the propeller. The line shaft journal bearings shall be nonmetallic synthetic polymer alloy Thordon SXL bearings, manufactured by Thordon Bearings Inc., Ontario, or approved equal. The bearing design shall be the responsibility of the pump Manufacturer to ensure the proper diametrical clearance necessary for the satisfactory lubrication and the appropriate housing to support the bearing. The surface roughness and hardness of the shaft (sleeve) shall be in accordance with the bearing Manufacturer's recommendations. The bearing shall be easily removable for servicing in the field. The bearings shall be of sufficient number and length to ensure permanent shaft alignment and to prevent shaft whip and vibration. A maximum bearing spacing of five (5) feet shall be provided.

a. Bearing Lubrication System: The bearings shall be lubricated with water from the pump discharge. A line shall be routed back to the line shaft from the discharge nozzle to provide water to lubricate the line shaft bearings. The required system flow rate shall be in accordance with the recommendations of the bearing Manufacturer. Alternative lubrication methods shall be submitted to the District for approval.

i. Pipe: All piping shall comply with ASTM A53 or ASTM A106 steel pipe. Pipe smaller than two (2) inches in diameter shall be schedule 80. Pipe two (2) inches in diameter or larger shall be schedule 40.

ii. Flanges and Flanged Fittings: Flanges shall comply with ASTM A234 Grade WPB or WPC, Class 150 or ASME B16.11, 3000 lbs.

iii. Threaded Fittings: Threaded fitting shall be in accordance with ASME B16.3, Class 150.

iv. Valves: Valves shall be in accordance with MSS SP-80, Class 150.

b. Bowl Assembly Bearings (the bearings immediately above and below the propeller: the lowermost bearing shall be protected by a sand cap, to prevent sand or grit from entering.

2. Thrust Bearing: Thrust axial loads (up-thrust and down-thrust) shall be supported by a thrust bearing(s) in the pump. The thrust bearing shall be sized for continuous operation under all specified conditions as well as transient loads and shall provide full load capabilities if the pump s normal direction is reversed. The pump Manufacturer shall closely coordinate with the driver Manufacturer to ensure the proper compatibility of the component designs.

3. Alignment: The Manufacturer shall ensure the alignment of the shaft bearings is in accordance with the requirements of the bearing Manufacturer. The alignment shall include the fit of the bearing in the housing as well as on the shaft (sleeve). The alignment requirements and procedures shall be submitted as part of the operation and maintenance manual.

4. Vibration Monitoring: See ANSI/HI 9.6.4 for the vibration monitoring requirements.

K. Stuffing Box: Provide stuffing box to prevent leakage through casing. The packing gland shall be easily serviced by access through openings in the pedestal. Provide a grease-lubricated packing gland split longitudinally to facilitate removal and renewal without entering the pump from below the operating platform. Provide shaft sleeve at seal location.

L. Propeller: Provide axial flow propeller of smooth construction for maximum efficiency. Propeller shall be removable from bottom of pump bowl without dismantling pump, except for suction bell removal. Securely lock propeller with longitudinal and annular keys to prevent rotational and axial movement. Collets or taper fits will not be acceptable. The propeller shall be factory balanced.

M. Nameplates and Rotation Arrows:

1. Nameplate: A nameplate shall be securely attached at a readily visible location on the equipment and on any other major auxiliary equipment. The nameplate shall be stamped with the following information:

a. Manufacturer's size and model number

b. Pump serial number

c. Capacity (cfs and gpm) at rated condition point

d. Speed (rpm)

e. Pump total head (ft) at rated condition point

f. Nameplates shall be of austenitic stainless steel or nickel-copper alloy.

2. Rotation Arrows: Rotation arrows shall be cast in or attached to each major item of rotating equipment at a readily visible location.

## 2.8 SPARE PARTS

All spare parts shall be duplicates of the original parts furnished and shall be interchangeable. Spare parts shall be packed in crates. The Contractor shall furnish the following spare parts:

A. One (1) complete set of journal bearings, shaft couplings (if applicable) and seals for one (1) pump

B. One (1) complete set of wearing parts for the stuffing box for one (1) pump and sufficient packing and gaskets for all the pumps

C. Fifty percent (50 percent) of each size and length of the bolts, nuts and washers used in one(1) pump

D. One (1) rubber v-belt

## 2.9 SPECIAL TOOLS

The Contractor shall furnish one (1) set of special tools required for complete assembly, disassembly, or maintenance of the pump. Special tools refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

## 2.10 PROTECTIVE COATINGS

The units shall have the following paint system applications.

A. Shop Painting: The pump equipment including all ancillary equipment such as guards shall have a shop applied protective coating as indicated below. The Contractor shall submit the Manufacturer's product data for the proposed for the paint system.

1. Pump (wetted surfaces): The below base plate carbon steel or cast iron surfaces of the pump shall have the following coating system:

a. Surface Preparation: SSPC-SP5 and profile depth 1.5 to 2.5 mils as recommended by the coating Manufacturer

b. First & Second Coat: Epoxy zinc-rich primer. Apply each coat at three (3) mils dry film thickness.

c. Third & Fourth Coat: Coal tar amine or polyamide cured epoxy with minimum 70 percent solids by volume. Apply at eight (8) mils dry film thickness each coat for a total 16 mils.

d. Total system dry film thickness of sixteen (16) to twenty (20) mils

e. Metal surfaces of stainless steel, bronze, fiberglass, or neoprene shall not be coated.

2. Pump (non-wetted surfaces) and miscellaneous metal: The above base plate carbon steel or cast iron surfaces of the pump and the miscellaneous carbon steel such as the gear pedestal and the guards shall have the following coating system:

a. Surface Preparation: SSPC-SP2 or SSPC-SP3 hand or power tool cleaned

b. Prime Coat: Epoxy zinc-rich primer. Apply at three (3) mils dry film thickness.

c. Intermediate Coat: High solids polyamine or polyamide epoxy with 67 percent solids by volume. Apply at five (5) to eight (8) mils dry film thickness.

d. Top Coat: High solids aliphatic polyurethane gloss enamel with minimum 52 percent solids by volume. Apply at two (2) mils dry film thickness.

e. Metal surfaces of stainless steel, bronze, fiberglass, or neoprene shall not be coated.

B. Field Painting: Contractor shall touch-up coatings damaged during shipment or installation. Slings shall be used in lieu of chains for lifting to avoid damaging coated surfaces.

## PART 3 EXECUTION

### 3.1 FACTORY TESTS

A. Factory Performance Test: The pump Manufacturer shall conduct a factory performance test to demonstrate the pump complies with the specified performance. The test shall be in accordance to ANSI/HI 2.6.5, Vertical Pump Test, unless otherwise specified below. The test shall be conducted by a registered professional engineer employed by the Manufacturer and witnessed by the District. The Contractor shall provide the District with a minimum of five (5) days notice in advance of testing, and the Contractor's bid price shall include the cost of travel, lodging, and car rental for two (2) District representatives to travel to the site of each factory test required. The District reserves the right to substitute alternative pump performance test visits, not to exceed the total number of factory test trips. The Contractor shall also be present for all factory tests as well as coordinate all necessary pre-test preparations and preliminary tests to ensure the witness test is in compliance with the specifications.

1. The pump Manufacturer shall test each pump unit to be supplied in accordance with this specification. Model testing is not acceptable. In lieu of the proposed driver, a factory supplied driver may be used.

2. The test instrumentation and test setup shall be in accordance with ANSI/HI 2.6.5.4 and ANSI/HI 2.6.5.5.

a. Flow Measurement: Measurement of the rate of flow shall be in accordance with ANSI/HI 2.6.8. The flow measuring system shall have an accuracy of 1.5 percent at BEP.

b. Head Measurement: Measurement of pump discharge and suction heads shall be in accordance with ANSI/HI 2.6.9.

c. Power Measurement: Measurement of pump input power shall be in accordance with ANSI/HI 2.6.10.

d. Rotary Speed Measurement: Measurement of the rotary speed shall be in accordance with ANSI/HI 2.6.11.

3. Submit, prior to pump fabrication, the description of instrumentation, test setup and test procedure proposed. Include dimensioned drawings of the test setup indicating location of instruments.

4. Submit all applicable pretest data requirements as described in ANSI/HI 2.6.5.6.

5. Test throughout preferred operating region at the rated speed and specified runout condition. The pump test data shall be taken under steady state conditions. The maximum permissible short-term speed fluctuation shall be no more than 0.3 percent. Calculations shall be in accordance with ANSI/HI 2.6.5.8. Results shall be plotted in accordance with ANSI/HI 2.6.5.9and shall develop the following performance curves:

a. Rate of flow (Q) (cfs and gpm) vs. pump total head (H)

b. Rate of flow (Q) (cfs and gpm) vs. pump input power (Pp) include data point at zero flow

c. Rate of flow (Q) (cfs and gpm) vs. efficiency (np)

d. Rate of flow (Q) (cfs and gpm) vs. NPSHR

6. Submit test results to the District for review and approval. The test results shall be certified to be in accordance with the specifications by the Manufacturer's licensed engineer who conducted the test.

7. Pumps not satisfying the specified performance requirements shall be rejected. The Contractor shall provide the District a description of the proposed remedy for correction of the deficiencies or the Manufacturer shall replace the pump. The modified pump or the replacement shall be tested in accordance to this Paragraph 3.1, Factory Tests.

8. The District may require the Manufacturer to repeat the test if the data points are considered erroneous.

3.2 FACTORY INSPECTIONS

A. The District with the Contractor may make periodic visits to the Manufacturer's plant to inspect the fabrication and assembly of the pump. The Manufacturer shall have available for review detailed fabrication and assembly drawings for manufacture of the entire pump. Drawing details shall include all dimensions, tolerances, shaft clearances, bearings, diameter and tip clearance of the propeller, couplings, and packing gland. The Manufacturer shall also have available at the time of the inspections purchase orders, mill orders, or shop orders including certified material test reports that indicate components and/or materials to be used in the pump s manufacture. The District may review these records, drawing details and the pump unit for compliance with the specifications as well as standard industry practice. The District shall provide the Contractor a written report of the inspection that will include those items observed to be in non-compliance with the specifications. It will be the Contractor's responsibility to ensure all items are corrected by the Manufacturer. Re-inspection of the items in non-compliance may be requested by the District.

B. Material Certifications: Submit certified test reports of the materials used in the pump construction to the District for approval.

3.3 FACTORY ASSEMBLY

Pumps shall be completely shop assembled (in the vertical position) and aligned prior to shipping. Tolerances shall not exceed those specified or shown in the Manufacturer's drawings. Rotating elements shall be checked for binding. The District with the Contractor shall witness the shop assembly unless otherwise stated. After completion of the specified factory tests, pumps shall be prepared for shipment with the minimum amount of disassembly such that no field disassembly, cleaning or flushing is required. Rotor must be blocked to prevent movement during shipment. All openings must be covered for shipment. Any components removed for shipping shall be match-marked prior to removal and shipment.

3.4 STORAGE

All equipment placed in storage shall be stored indoors, protected from the weather, humidity and temperature variations, dirt, dust and other contaminants. The Contractor is responsible to locate and procure all off-site storage that may be required throughout the life of the Contract. All on-site and off-site storage provisions are subject to approval.

3.5 INSTALLATION

A. Installation, start-up, and testing of all equipment and associated construction shall conform to Manufacturer's recommendations and the installation and erection manual. The Manufacturer's field representative shall meet with Contractor to provide all necessary guidelines and specifications for installation and testing of equipment supplied. This field representative shall also inspect all equipment after installation and prior to start-up. The pump Manufacturer, upon completion of the installation, shall certify in writing to the District, the pump and

associated equipment has been installed in accordance with the Manufacturer's installation and erection manuals.

B. Pump Leveling: The pump shall be installed and leveled by millwrights experienced in setting and leveling heavy equipment. The base plate shall be leveled in accordance with the Drawings and ANSI/HI 2.4.3.5. The Contractor shall level the base plates against the anchor bolt nuts using steel leveling blocks and shims at every bolt location to a maximum tolerance of 0.005 in/ft unless more stringent requirements are recommended by the Manufacturer. Leveling equipment shall be precision surveying equipment. Grout as per Drawings and as indicated in ANSI/HI 2.4.3.7. Flowable, non-shrinkable grout shall be in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES. The grout shall be placed in manner to avoid air entrapment and shall be placed in one continuous operation. After the grout has attained the required compressive strength, the leveling blocks and shims shall be removed and the anchor bolts tightened to the clamping force required by the pump Manufacturer. The bolts shall be torqued in increments of not more than 25 percent of the final value in an alternating pattern to avoid stress concentration on the grout surface. Void spaces created by the removal of the leveling blocks and shims shall be filled with grout after the anchor bolts have been tightened to their final value.

C. Motor Mounting and Alignment: The motor and the V-belt assembly shall be factory installed and aligned. Final belt alignment and sheave adjustment shall be made by a factory representation after field installation in accordance with SECTION 01 61 07 EQUIPMENT ALIGNMENT. Check for correct rotation as per Manufacturer's instructions. Check for centering of pump shaft and make adjustments to correct alignment within Manufacturer's requirements. Check the non-reverse racket for proper operation. Raise the shaft assembly with propeller to the correct running position in accordance with the Manufacturer's instructions.

D. Belt Tension: The tension in the belts shall be in accordance with the Manufacturer's recommendations. The belts shall be re-tensioned shortly after start-up to ensure the belts are installed within the Manufacturer's recommended tolerances.

E. Discharge Connection: The discharge elbow connection shall be as shown on the Drawings and as specified in ANSI/HI 2.4.4.1.

## 3.6 FIELD OPERATING TEST

A. General: All field operating and equipment tests shall be performed by the Contractor and in the presence of the District. The Manufacturer's field representative shall be present during all operating tests. The Contractor's monitoring and control subcontractor and/or electrical subcontractor shall also be present during all operating tests. The Contractor shall be responsible for the coordination of the various trades and responsible parties for the successful performance of all field tests. Should the tests reveal a design deficiency or a manufacturing error; the problem shall be promptly corrected by and at the expense of the Contractor.

B. Wet Operating Tests: Conduct wet operational tests as necessary to determine that the performance of equipment and controls is as specified. Tests shall consist of placing all pump equipment in operation under the pumps preferred operating region for a period of four (4) hours. If the

water conditions are not suitable at the time of the test, the test shall be postponed until conditions are acceptable.

1. Pump Vibration Measurements:

a. Vibration testing shall be in accordance with ANSI/HI 9.6.4.

b. Allowable field vibration level of vibration of the assembled pumping units shall be in accordance with ANSI/HI 9.6.4.

c. The District will provide a qualified vibration specialist to verify compliance with vibration limits.

2. Driver Checks: See SECTION 26 60 13.00 40 LOW-VOLTAGE MOTORS.

C. Make all necessary equipment adjustments and corrective WORK indicated by tests.

D. Submit a written test report of all tests performed and their results to the District.

3.7 POST CONSTRUCTION INSPECTIONS

A. Sixty (60) Day Check: Recheck pumps for vibration in accordance with ANSI/HI 9.6.4 after the equipment has been placed in operation for approximately 60 days. All vibration checks shall be performed by an independent qualified testing consultant with all costs borne by the District. If the vibration measurements exceed the allowable limits as indicated in the referenced SECTION, the Contractor shall investigate the cause of the problem and, if determined to be a defect with the equipment or its installation, shall take the necessary action to correct the problem.

B. Warranty Period: The District may make regular vibration measurements of the pump units throughout the warranty period in accordance with ANSI/HI 9.6.4. All vibration checks shall be performed by an independent qualified testing consultant with all costs borne by the District. If the vibration measurements exceed the allowable limits as indicated in the referenced SECTION, the Contractor shall investigate the cause of the problem. If it is determined, the cause of the excessive vibration is due to defective design, workmanship, materials, or other causes that are the result of the equipment manufacture or installation and not from the normal operation of the unit in accordance with the operation and maintenance instructions, the Contractor, in accordance with the warranty agreement of this Contract, shall take the necessary action to correct the problem at the Contractor's expense.

-- End of Section --

# SECTION 35 51 24

# FLOATING TRASH BARRIER - TUFFBOOM

## PART 1 GENERAL

### 1.1 SUMMARY

Summary of Work: The Contractor shall furnish equipment, labor and materials for the installation of a fully engineered floating trash barrier as required for the Work. The trash barrier anchorage includes concrete piling and a concrete anchorage system.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

There are other specification sections that relate to this section that are not necessarily cited herein.

### 1.3 REFERENCES

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A325 | (2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A572/A572M | (2015) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| ASTM A492 | (1995; R 2013) Standard Specification for Stainless Steel Rope Wire |
| ASTM C578 | (2017a) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation |
| ASTM D1505 | (2010) Density of Plastics by the Density-Gradient Technique |

### 1.4 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

Trash Barrier

Concrete Anchor System

SD-03 Product Data

Trash Barrier

SD-07 Certificates

Testing certificate

1.5 SUBMITTAL REQUIREMENTS

The Contractor shall submit trash barrier shop drawings showing the general arrangement, full dimensions, assembly of materials and connections and anchor points, embedded items, anchoring loads at each anchor point and specifications of the barriers and accessory products.

The Contractor shall submit shop drawings of the concrete anchor system. Include calculations supporting the embedded hardware design.

The Contractor shall submit data sheets for the trash barrier and for all wire cable and attachment hardware.

Manufacturer shall provide a testing certificate attesting to the load capacity of the cable and all the connection shackles.

1.6 QUALITY CONTROL

The barrier supplied shall be manufactured by a company in the business of continuously designing and manufacturing the specified type or similar structure for at least 5 years.

Equipment shall be manufacturer's standard which has been successfully used for equipment of this size and type, except as modified herein.

Manufacturer shall make available for review and inspection all quality assurance/quality control documentation concerning equipment being furnished. In addition, manufacturer shall make available all design calculations concerning stress and capacity as well as design drawings used in fabrication of material.

1.7 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 GENERAL

The Contractor shall furnish a Tuffboom™ floating barrier system as manufactured by Worthington Products, or District approved equal, and shall include the following Manufacturer's accessory items:

a. Provide deflector plates to close the gaps between booms.

b. Provide hanging debris skirts.

c. The individual barrier sections shall be factory assembled.

d. The number of floating barriers provided for each barrier system shall consist of the number required to span the barrier length shown on the Drawings (which includes slack length for deflection) in accordance

with the Manufacturer's standard length for connected barriers. In no case shall less than four (4) barriers be provided per barrier system. ~~The length shall be as indicated.~~

2.2 DESIGN REQUIREMENTS

The Contractor shall furnish floating barriers capable of complying with the following performance conditions.

a. Waves: The floating barrier system shall be designed to withstand storm conditions of up to one-foot waves on a periodic, but not continual, basis.

b. Currents: Design for currents up to 10 feet per second.

c. Debris Loads: As a minimum design for 50 feet wide (across canal) x 2 feet deep.

d. Water Elevations: Design for an elevation change of +/- 6 feet.

2.3 MATERIAL DATA

The Contractor shall furnish floating barriers complying with the following material requirements.

a. Floating Logs/Devices:

1. Floatation logs shall have a nominal diameter of 16 inches and consist of an external encasement, internal foam fill and internal galvanized structural steel channel. Each floatation log shall maintain its original buoyancy even if structurally damaged or punctured or supplied with hanging debris skirt attachments.

2. The external encasement shall be manufactured of polyethylene and have a minimum density of 0.935 g/cm3, per ASTM D1505, be UV stabilized and have a nominal wall thickness of 0.170 inch.

3. The standard encasement color shall be international safety orange.

4. The internal foam shall be polystyrene meeting the requirements of ASTM C578 and shall have a minimum in-place density of 0.9 pounds per cubic foot and a maximum in-place density of 1.2 pounds per cubic foot.

5. The internal structural steel channel shall meet ASTM A572/A572M grade 50 structural steel, with a four (4) inch external channel width, a minimum ultimate tensile strength of 57,000 pounds (lbs) and shall not weigh less than 5.4 pounds per foot.

6. All internal structural steel channels shall be hot dipped galvanized.

7. Provide one (1), 3 inch wide by 12 inch long, horizontal piece of silver/white reflective tape at the end of each boom.

b. Inter-boom Connection Hardware:

1. Connecting hardware between floatation units shall consist of bottom steel connector plates, load-rated galvanized safety shackles and load-rated galvanized welded lines.

2. All load bearing connections between floatation logs shall be designed such that the load is distributed through the channel.

3. Bottom steel connector plates shall be fabricated from 5/8 inch thick x 3 inch wide steel plate, ASTM A572/A572M, grade 50 and shall be hot dipped galvanized.

4. Connection shackles shall have a minimum pin diameter of 3/4 inch, be of a safety type, have a working load limit (WLL) of not less than 4 - 3/4 tons stamped on the body of each shackle, and shall be hot dipped galvanized. The minimum average tensile breaking strength of each shackle shall be 60,000 lbs. and be certified to be proof tested to 57,000 lbs. working capacity.

5. Weldless links shall be 3/4 inch, hot dipped galvanized, and have a WLL of not less than 4-3/4 tons. The minimum average tensile breaking strength of each link shall be 60,000 lbs. and certified to be proof tested to 57,000 lbs. working capacity.

6. Connection opening between barrier sections shall not exceed 15 inches.

7. Bolts shall be galvanized structural steel and shall meet ASTM A325.

c. Hanging Debris Skirts:

1. Provide hanging debris skirts (screen) per Worthington Products, or District approved equal.

2. Debris screens shall be manufactured of galvanized steel with metal diamond mesh facing materials and shall attach to the underside of the boom via Manufacturer's supplied swivel connectors.

3. Skirts shall be 24 inches, standard, unless shown otherwise on the Drawings.

4. Provide angled debris screens at each end boom adjacent to the bank, Worthington Products part number SC2-24AR and SCR-24AL. (Right side and left side facing downstream, respectively.)

5. Deflector Plates: Provide deflector plate, galvanized hex bolts, lock washers and fender washers by Worthington Products or District approved equal at each boom interconnection point.

6. Provide all cable, thimbles, connection clamps and accessories necessary for attaching the floating barrier system to the pile anchor system.

7. All cable shall be 3/4 inch diameter stainless steel wire cable conforming to ASTM A492.

8. Cable clamps, fasteners, shackles, thimbles and accessories shall be able to resist maximum channel water velocities of 6 feet per second.

9. All cable, thimbles, clamps and accessory items for attachment purposes shall be stainless steel.

d. Buoy:

1. When shown on the Drawings, provide: a float collar can buoy per Worthington Products, part number FWFCCB-1428W, or District approved equal, at the locations shown on the Drawings.

2. Provide hazard warning symbol and standard message "Hazard Area", on each buoy.

3. Connect to floating barrier system using 3/4 inch diameter stainless steel cable, clamps and fasteners.

e. Floating Barrier Pile Guide for Intermediate Prestressed Concrete Piles:

1. Provide a square floatable pile guide for the Intermediate Prestress Concrete Piles. The pile guide shall be sized to fit an 18" sq. prestressed concrete pile. The pile guide shall consist of a square assembly consisting of structural steel. The structural steel shall meet the requirements of ASTM A572/A572M. The pile guide shall utilize four (4) Ultra High Molecular Weight (UHMW) roller assemblies which will allow the pile guide to adjust with the water levels. The pile guide shall consist of floatation assemblies which will allow the pile guide to float at the water surface and to provide stability. The floatation assemblies shall consist of foam filled PVC pipes or approved equal. The floatation assemblies shall be connected to the pile guide via steel straps. The pile guide shall be equipped with 2 steel tabs (1 on each side) to allow for the floating barriers to be connected to the pile guide. The steel tabs shall be welded to the pile guide. All fasteners shall be galvanized structural steel and shall meet ASTM A325. See Merco Marine (www.mercomarina.com) for custom pile guide or approved equal.

f. End Anchorage in Reservoir

1. See drawings for concrete anchoring system for anchoring the ends of the barriers within the reservoir.

## 2.4 PILING

The Contractor shall provide concrete piling conforming to Section 31 62 13.20 PRECAST/PRESTRESSED CONCRETE PILES.

## PART 3 EXECUTION

### 3.1 INSTALLATION

The Contractor shall install floating barriers as required for the Work and in accordance with the following.

a. Coordinate installation with the concrete anchoring system and the supporting concrete piles.

b. Field measure distances between anchor points to assure proper fit-up.

c. Install barrier according to Manufacturer's printed instructions.

### 3.2 ADJUST AND CLEAN

The Contractor shall adjust and clean the floating barriers as required to ensure their proper function and in accordance with the following.

a. Verify that connections have been properly installed to accommodate water level fluctuations.

b. Adjust as required and as permitted by the Manufacturer.

c. Clean abraded areas of shop coating, and touch-up damaged areas with same type coating as used for shop coating.

-- End of Section --

# SECTION 40 05 13

# PIPELINES, LIQUID PROCESS 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.

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

| | |
|---|---|
| ASSE 1001 | (2008) Performance Requirements for Atmospheric Type Vacuum Breakers (ANSI approved 2009) |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C111/A21.11 | (2012) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C209 | (2013) Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fitting for Steel Water Pipelines |
| AWWA C213 | (2015) Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines |
| AWWA C504 | (2015) Standard for Rubber-Seated Butterfly Valves |
| AWWA C508 | (2009; Addenda A 2011) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS |
| AWWA C550 | (2013) Protective Epoxy Interior Coatings for Valves and Hydrants |
| AWWA C606 | (2015) Grooved and Shouldered Joints |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.1 | (2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form) |
| ASME B1.20.1 | (2013) Pipe Threads, General Purpose (Inch) |

| | |
|---|---|
| ASME B1.20.2M | (2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric) |
| ASME B16.1 | (2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250 |
| ASME B16.11 | (2011) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.21 | (2011) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.3 | (2011) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.34 | (2013) Valves - Flanged, Threaded and Welding End |
| ASME B16.5 | (2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B16.9 | (2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B31.3 | (2014) Process Piping |
| ASME B36.19M | (2004; R 2015) Stainless Steel Pipe |
| ASME B40.100 | (2013) Pressure Gauges and Gauge Attachments |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A105/A105M | (2014) Standard Specification for Carbon Steel Forgings for Piping Applications |
| ASTM A108 | (2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished |
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A182/A182M | (2018) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A193/A193M | (2016) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications |
| ASTM A194/A194M | (2017a) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both |

| | |
|---|---|
| ASTM A234/A234M | (2018) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A269/A269M | (2015a) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service |
| ASTM A312/A312M | (2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A334/A334M | (2004a; R 2016) Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service |
| ASTM A380/A380M | (2017) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems |
| ASTM A395/A395M | (1999; R 2014) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures |
| ASTM A403/A403M | (2018) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings |
| ASTM A47/A47M | (1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A479/A479M | (2018) Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels |
| ASTM A513/A513M | (2015) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A536 | (1984; R 2014) Standard Specification for Ductile Iron Castings |
| ASTM A780/A780M | (2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A813/A813M | (2014) Standard Specification for Single- or Double-Welded Austenitic Stainless Steel Pipe |
| ASTM A814/A814M | (20015) Standard Specification for Cold-Worked Welded Austenitic Stainless Steel Pipe |

| | |
|---|---|
| ASTM A865/A865M | (2006; R 2017) Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints |
| ASTM A967/A967M | (2013) Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts |
| ASTM B124/B124M | (2018) Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes |
| ASTM D1784 | (2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D1785 | (2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D2464 | (2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2466 | (2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 |
| ASTM D2467 | (2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2564 | (2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM D2657 | (2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings |
| ASTM D2774 | (2012) Underground Installation of Thermoplastic Pressure Piping |
| ASTM D2855 | (2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings |
| ASTM D3308 | (2012; R 2017) PStandard Specification for TFE Resin Skived Tape |
| ASTM D3892 | (1993; R 2009) Packaging/Packing of Plastics |
| ASTM F1199 | (1988; R 2015) Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum) |

| | |
|---|---|
| ASTM F1290 | (1998a; R 2011) Electrofusion Joining Polyolefin Pipe and Fittings |
| ASTM F402 | (2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings |
| ASTM F477 | (2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F656 | (2010) Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-25 | (2013) Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-58 | (1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2014) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 704 | (2017) Standard System for the Identification of the Hazards of Materials for Emergency Response |

PLASTICS PIPE INSTITUTE (PPI)

| | |
|---|---|
| PPI TR-21 | (2001) Thermal Expansion and Contraction in Plastic Piping Systems |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC SP 1 | (2015) Solvent Cleaning |
| SSPC SP 6/NACE No. 3 | (2007) Commercial Blast Cleaning |
| SSPC SP 10/NACE No. 2 | (2007) Near-White Blast Cleaning |

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

| | |
|---|---|
| 29 CFR 1910 | Occupational Safety and Health Standards |

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Waste Water Disposal

SD-02 Shop Drawings

Materials and Equipment

SD-03 Product Data

Qualifications

Manufacturer's Field Services

Delivery, Storage and Handling

Materials and Equipment

Installation

Pipe Schedule

Valve Schedule

SD-06 Test Reports

Pipe Leakage Tests

Hydrostatic Tests

Valve Testing

SD-07 Certificates

Welders

Plastic Piping System

Plastic Pipe Installation

SD-10 Operation and Maintenance Data

Piping and Appurtenances

## 1.3 QUALIFICATIONS

### 1.3.1 Experience

Submit a statement certifying that the Contractor has the specified experience. Contractor shall have successfully completed at least three projects of the same scope and size or larger within the last six years. Demonstrate specific experience in regard to the system installation to be performed.

### 1.3.2 Welders

Submit the names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc. The welding of pressure piping systems shall be in accordance with qualifying procedures using performance qualified welders and operators. Procedures and welders shall be qualified in accordance with Section 40 05 13.96 WELDING PROCESS PIPING. Structural members shall be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense. During installation, piping shall be capped to keep out dirt and other foreign matter. A material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling shall be in accordance with ASTM F402. Storage facilities shall be classified and marked in accordance with NFPA 704. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe shall be packed, packaged and marked in accordance with ASTM D3892.

## 1.5 PROJECT/SITE CONDITIONS

### 1.5.1 Environmental Requirements

Buried piping at the site may be subject to corrosion from the surrounding soil. Testing and measurements shall be conducted in accordance with Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE). Piping system design, supply, and installation shall address the external corrosion conditions so indicated.

## 1.6 SEQUENCING AND SCHEDULING

For slab, floor, wall, and roof penetrations, keep on site pertinent wall pipes and sleeves before they are required for placement in concrete forms. Verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

## 1.7 MAINTENANCE

### 1.7.1 Service

Services for automatic valve systems shall be provided by a manufacturer's representative who is experienced in the installation, adjustment and operation of the equipment specified. The representative shall inspect the installation, and supervise the adjustment and testing of the equipment.

1.7.2 Extra Materials

Submit the manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation. Concurrent with delivery and installation of the specified piping systems and appurtenances, spare parts for each different item of material and equipment specified that is recommended by the manufacturer to be replaced any time up to 3 years of service shall be furnished. For each type and size of valve, the following extra materials shall be provided: lubricator, lubricant (with appropriate temperature rating), lubricator/isolating valve; galvanized operating wrench, 4.1 feet total length, for T-handled operators and shall be Mueller No. A-24610, Clow No. F-2520, or equal. Extra materials shall include 2 of the following spare parts for each type and size of valve: gaskets; O-ring seals all elastomer parts; stem packing.

1.7.3 Operation and Maintenance Manuals

Submit operation and maintenance manuals including all instructions for operation of equipment maintenance schedules, and recommended replacement parts and intervals.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

This specification covers the requirements for above and below grade liquid process pipe, pipe supports, fittings, equipment, and accessories located both inside and outside of treatment plants.

2.1.1 Design Requirements

Support systems shall be selected and designed in accordance with MSS SP-58 within the specified spans and component requirements. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout the facility. The structural design, selection, fabrication, and erection of piping support system components accounting for a 5,000 psf soil bearing capacity, a maximum wind speed consistent with the project wind speed, a maximum ambient air temperature of 100 degrees F and a minimum ambient air temperature of 32 degrees F.

2.1.2 Performance Requirements

The pressure ratings and materials specified represent minimum acceptable standards for piping systems. The piping systems shall be suitable for the services specified and intended. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings, and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

2.1.2.1 Buried Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure. Consideration shall be given to all operating and service conditions both internal and external to the piping systems. Buried ferrous piping shall have cathodic protection in

accordance with Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE).

2.1.2.2 Above Grade Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure, and installation factors such as insulation, support spans, and ambient temperatures. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.

## 2.2 MATERIALS AND EQUIPMENT

Submit manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings; thermal characteristics (coefficient of expansion and thermal conductivity); and chemical resistance to each chemical and chemical mixture in the liquid stream. Provide piping materials and appurtenances as specified and as shown on the drawings, and suitable for the service intended. Piping materials, appurtenances, and equipment supplied as part of this contract shall be of equal material and ratings as the connecting pipe, new and unused except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the piping systems shall be in accordance with TABLE I and are indicated by service in the Pipe Schedule. Submit a list of piping systems, pressure ratings and source of supply for each piping system broken out by material, size and application as indicated on the contract drawings. A list of any special tools necessary for each piping system and appurtenances furnished for adjustment, operation, maintenance and disassembly of the system. Pipe fittings shall be compatible with the applicable pipe materials.

### 2.2.1 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit the following: Equipment shop drawings and support system detail drawings showing piping systems and appurtenances, such as mechanical joints, valves, local indicators and hangers, including a complete list of equipment and materials. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. As-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices; if the contract drawings contained P&IDs, the P&IDs found in the contract drawings shall be revised to reflect the constructed process system, as directed by the Construction Manager. Nominal sizes for standardized products shall be used. Pipe, valves, fittings and appurtenances shall be supported by a service organization that is, in the opinion of the Construction Manager, reasonably convenient to the site.

### 2.2.2 Identification and Tagging

Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. Valves shall be marked in accordance with

MSS SP-25 and shall bear an identification tag securely attached using No. 12 AWG copper wire or plastic straps designed for that purpose. Identification tags shall be 2 inches minimum diameter, made of brass or engraved anodized aluminum. The service, valve identification number shown in the contract drawings, the manufacturer's name, and the valve model number shall be displayed.

## 2.3 CARBON STEEL PIPING SYSTEM

### 2.3.1 Carbon Steel Pipe

#### 2.3.1.1 General Service

Carbon steel pipe up to 12" in diameter shall meet the requirements of ASTM A53/A53M seamless electric-resistance welded, Grade B and shall be in accordance with Pipe Schedule. Buried carbon steel piping and fittings shall be Schedule 80.

All other carbon steel pipe shall meet the requirements per Section 40 05 22 DISCHARGE PIPING.

### 2.3.2 Carbon Steel Tubing

Tubing shall meet the requirements of ASTM A334/A334M, seamless, Grade 1 carbon steel with nominal size and wall thickness in accordance with Pipe Schedule.

### 2.3.3 Carbon Steel Joints

Carbon steel piping shall be joined by straight-threaded couplings, taper-threaded couplings, welding fittings, flanges, mechanical joints for grooved ends meeting the requirements of AWWA C606, in accordance with Pipe Schedule or as indicated on the Drawings. Tubing shall be joined using compression fittings. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

### 2.3.4 Carbon Steel Fittings

#### 2.3.4.1 Buried

Fittings shall be ASME B16.11, forged steel, or ASTM A234/A234M Grade WPB forged steel welding type.

#### 2.3.4.2 Exposed

Fittings shall be ASME B16.3, malleable iron, ASME B16.11, forged steel, or ASTM A234/A234M Grade WPB, forged steel welding type.

#### 2.3.4.3 Threaded Fittings

Exposed - 3 inches and smaller. Threaded fittings shall be Class 150, malleable iron, ASTM A47/A47M, conforming to ASME B16.3, black, banded and threaded in accordance with ASME B1.20.1. Threaded, rigid couplings shall be seamless carbon steel in accordance with ASTM A865/A865M and threaded in accordance with ASME B1.20.1. Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308 shall be used for lubricant/sealant.

2.3.4.4 Welding Fittings

Exposed - Over 3 inches. Welding fittings shall be butt-welding or socket-welding. Welding fittings shall be forged steel, ASTM A105/A105M Class 150 conforming to ASME B16.9 or ASME B16.11.

2.3.4.5 Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. The flanges shall be welding neck or slip-on type. Flanges and flanged fittings shall be forged steel, ASTM A105/A105M, faced and drilled to ASME B16.5 Class 150 flat face. Bolting shall be alloy-steel ASTM A193/A193M Grade B8M hex head bolts and ASTM A194/A194M Grade B8M hex head nuts. When mating flange on valves or equipment is cast iron, ASTM A193/A193M Grade B8 Class 1 bolts and ASTM A194/A194M Grade 8 heavy hex head nuts shall be used. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5. Nonmetallic gaskets shall conform to ASME B16.21 and be a maximum 0.125 inch thick chloroprene rubber, durometer hardness No.80, 1,500 psi minimum tensile strength, 175 percent minimum elongation, full face type for use with flat face flanges.

2.3.4.6 Compression Fittings for Tubing

Compression fittings shall be of carbon steel ASTM A108 nuts, ferrules and bodies rated to a minimum 200 psig. Threads shall be straight conforming to ASME B1.1.

2.3.5 Carbon Steel Coatings

Carbon steel piping components shall be coated with corrosion resistant materials as indicated in the Piping Schedule. Coatings and finishes shall be 100 percent holiday free and be tested.

Buried and submerged steel pipe and fittings shall be protected with a fusion bonded epoxy coating or a cold-applied laminated tape coating, as follows:

1. Fusion Bonded Epoxy Coating:

    a. Pipe and fittings shall be coated with fusion bonded epoxy in accordance with AWWA C213. Surface preparation shall be in accordance with SSPC SP 10/NACE No. 2. The application method shall be by the fluidization bed method and shall attain 12 mils minimum dry film thickness.

    b. Field welds, connections and otherwise damaged areas shall be patched according to the MANUFACTURER's instructions.

    c. Fusion epoxy coating shall be Scotchkote 226N or equal and shall attain not less than 50 mils minimum dry thickness.

2. Polyethylene Tape Coating:

    a. Pipe and fittings shall be coated with primer and wrapped in accordance with AWWA C209. The total coating thickness shall be not less than 50 mils.

b. Polyethylene tape coating system shall be Tapecoat CT 10/40W, or equal.

c. Exterior Protection for Buried or Submerged Piping Accessories: Exterior protection shall be in accordance with SECTION 09 06 90 PROTECTIVE COATINGS, System S-4. Coating shall be applied by a qualified coating applicator.

2.3.5.1 Zinc Coating

Galvanizing shall be hot-dip applied and meet the requirements of ASTM A153/A153M; electroplated zinc or cadmium plating is unacceptable. Stainless steel components may be substituted where galvanizing is specified.

2.3.6 Carbon Steel Lining

All carbon steel piping shall be lined with coal-tar epoxy, as noted in the Piping Schedule. The pipe supplier shall apply the lining.

2.4 STAINLESS STEEL PIPING SYSTEM

2.4.1 Austenitic Piping

2.4.1.1 Stainless Steel Pipe

Stainless steel pipe intended for general corrosive service shall meet the requirements of ASTM A312/A312M, welded ASTM A813/A813M for fit-up and alignment quality, Class SW ASTM A814/A814M for flanged and cold-bending quality, Class SW, Grade TP316in accordance with Pipe Schedule with dimensions conforming to ASME B36.19M.

2.4.1.2 Stainless Steel Tubing

Stainless steel tubing shall meet the requirements of ASTM A269/A269M seamless, Grade TP316 with nominal size and wall thickness in accordance with Pipe Schedule.

2.4.1.3 Stainless Steel Joints

Stainless steel piping shall be joined by threaded couplings, welded fittings or flanges. Tubing shall be joined using compression fittings. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.4.1.4 Stainless Steel Threaded Fittings

Threaded fittings shall be austenitic stainless steel, ASTM A182/A182M Grade TP316 and TP316L, conforming to ASME B16.11, and threaded in accordance with ASME B1.20.1. Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308 shall be used for lubricant/sealant.

2.4.1.5 Stainless Steel Welding Fittings

Welding fittings shall be butt-welding or socket-welding. Welding fittings shall be forged austenitic stainless steel, ASTM A403/A403M Grade TP316 and

TP316L, butt-welding fittings, Class CR, conforming to ASME B16.9 socket-welding fittings, Class WP-S, conforming to ASME B16.11.

2.4.1.6 Stainless Steel Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. The flanges shall be lapped or threaded type. Flanges and flanged fittings shall be forged austenitic stainless steel, ASTM A182/A182M Grade TP316 and TP316L, Class 150 or 300, drilled to ASME B16.5 with a 0.0625 inch flat face. When mating flange on valves or equipment is cast iron, ASTM A193/A193M Grade B8 Class 1 bolts and ASTM A194/A194M Grade 8 heavy hex head nuts shall be used. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5. Nonmetallic gaskets shall conform to ASME B16.21 and be a maximum 1/8 inch thick chloroprene rubber, durometer hardness No. 80, 1,500 psi minimum tensile strength, 125 percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.

2.4.1.7 Compression Fittings for Tubing

Compression fittings shall be of ASTM A479/A479M stainless steel, Grade TP316, nuts, ferrules and bodies rated to a minimum 200 psig. Threads shall be straight conforming to ASME B1.1.

2.4.1.8 Cleaning (pickling) and Passivation

1. Shop fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture.

2. Following shop fabrication of pipe sections, straight spools, fittings, and other piping components, clean (pickle) and passivate fabricated pieces.

3. Clean (pickle) and passivate in accordance with ASTM A380/A380M or ASTM A967/A967M.

   a. If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible.

      1) However, these treatments must be followed by inorganic cleaners such as nitric acid/hydrofluoric acid.

   b. Passivation treatments with citric acid are not allowed.

4. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.

## 2.5 PLASTIC PIPING SYSTEM

Submit documentation certifying that the manufacturer of each thermoplastic piping system is listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.

2.5.1 PVC Pipe

PVC, ASTM D1784, minimum cell classification 12545-C, pipe shall be Schedule 40 and 80 conforming to ASTM D1785.

2.5.2 PVC Tubing

Tubing shall be flexible and clear with nominal size and wall thickness and reinforcement.

2.5.3 PVC Joints

The piping system shall be joined by socket-weld, flanged or mechanical connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Connections at those points shall be threaded and back-welded. Tubing connections shall use compression fittings.

2.5.4 PVC Fittings

The schedule rating for the fittings shall not be less than that for the associated pipe. Fittings shall be ASTM D1784, minimum cell classification PVC conforming to the requirements of ASTM D2464, threaded in accordance with ASME B1.20.1, ASTM D2466, socket type or ASTM D2467, socket type, where applicable.

2.5.4.1 Push-on Joints

Push-on type joints shall be sealed with ethylene propylene rubber (EPR) gaskets in accordance with ASTM F477.

2.5.4.2 Flanged Fittings

Flanges and flanged fittings shall be Class 125, one piece, molded hub type, flat faced, and shall conform to ASME B16.1, ASME B16.5 backing flanges with ASME B16.1 drilling. Flanges shall be complete with one-piece, molded PVC stub ends. Flanged connections shall have the same pressure rating as the pipe or greater. Bolting shall be stainless steel, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M, Grade 8M hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full-faced, maximum 1/8 inch thick, fabricated from polytetrafluoroethylene (PTFE) in accordance with ASME B16.21. When the mating flange has a raised face, a flat ring gasket shall be used and a filler gasket shall be provided between outer diameter of the raised face and the flange outer diameter to protect the PVC flange from bolting moment.

2.5.4.3 Tubing Fittings

Fittings shall be compression type comprised of forged brass alloy C37700, conforming to ASTM B124/B124M, rated to a minimum 150 psig with straight threads conforming to ASME B1.1.

2.5.5 PVC Solvent Cement

Socket connections shall be joined with PVC solvent cement conforming to ASTM D2564. Manufacture and viscosity shall be as recommended by the pipe

and fitting manufacturer to assure compatibility. Joints shall be prepared with primers conforming to ASTM F656 prior to cementing and assembly.

2.5.6 PVC Piping Coatings

PVC pipe surfaces shall be coated with waterborne acrylic emulsion as indicated in the piping schedule:

2.5.6.1 Preparation

1. Remove all oil, grease, dirt, and other foreign material by solvent cleaning in accordance with SSPC SP 1.

2. Lightly sand all surfaces and wipe thoroughly with clean cotton cloths before applying coating.

2.5.6.2 Waterborne acrylic emulsion

As manufactured by one of the following or equal:

1. S-W: DTM Acrylic B66W1.

2. Tnemec: Tneme-Cryl Series 6.

2.5.6.3 Application

1. Apply 2 or more coats to obtain a minimum DFT of 5.0 mils.

2.6 ISOLATION JOINTS AND COUPLINGS

2.6.1 Dielectric Fittings

Dielectric fittings shall be provided between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure, temperature and corrosive application.

2.6.2 Isolation Joints

Isolation joints shall be provided between nonthreaded ferrous and nonferrous metallic pipe fittings and valves. Isolation joints shall consist of an isolation gasket of the dielectric type, isolation washers and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with an outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.6.3 Metallic Piping Couplings

Thrust ties shall be provided where shown on the contract drawings and where required to restrain the force developed by 1.5 times the maximum allowable operating pressures specified. For metallic pipe other than ductile iron, thrust ties shall be attached with fabricated lugs. For exposed installations, zinc-plated nuts and bolts shall be used. However, high-strength, low-alloy steel, in accordance with AWWA C111/A21.11, may be substituted for use on cast iron and ductile iron couplings. For buried and

submerged installations, TP304 or TP316 stainless steel bolts and nuts shall be provided. Steel middle rings and followers shall be fusion bonded epoxy-lined and coated in accordance with Section 09 06 90 PROTECTIVE COATINGS and pressure tested beyond yield point.

2.6.3.1 Sleeve-Type Couplings

Thrust ties shall be provided where shown on the contract drawings and where a thrust restraint is not required. Sleeve-type couplings shall be used for joining plain end pipe sections in a flexible manner with a diameter to properly fit the pipe. A coupling shall consist of one steel middle ring, two steel followers, two elastomeric wedge section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. For pipe sizes between 0.5 through 1.5 inch, the followers shall be ductile iron, and the middle ring shall be in accordance with ASTM A513/A513M with AWWA C111/A21.11 bolting. For pipe sizes 2 inch and larger, the followers shall be ASTM A395/A395M, and the middle ring shall be ASTM A513/A513M with AWWA C111/A21.11 bolting. Gaskets shall be ethylene propylene diene monomer (EPDM).

2.6.3.2 Transition Couplings

Transitional couplings may be used to connect two pipes of the same material that have small differences in outside diameter. A fully assembled transitional coupling shall be sized to properly fit pipe diameters. The coupling shall consist of one steel middle ring, two steel malleable iron followers, two elastomeric wedge section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. The coupling shall use ethylene propylene diene monomer (EPDM) wedge gaskets. The coupling shall be sized to match the associated piping.

2.6.3.3 Flanged Coupling Adapters

Flanged coupling adapters shall be fully assembled units manufactured to meet cast iron. The flanges shall mate with ASME B16.5 flanges of the same nominal size. The coupling shall use ethylene propylene diene monomer (EPDM) wedge gaskets. Where pipe movement out of the adaptor may occur, proper anchorage of the pipe shall be provided and couplings shall be furnished with lock pins. The coupling shall be sized to match the associated piping.

2.6.4 Couplings for Nonmetallic Piping

2.6.4.1 Bellows Coupling

A bellows coupling shall have a minimum of two polytetrafluoroethylene (PTFE) convolutions unless otherwise shown, with ductile iron flanged, faced and drilled to ASME B16.1 Class 150 end connections, and metal reinforcing bands. The maximum allowable working pressure shall be 140 psig at 120 degrees F. Bolting shall be limited to restrain the force developed by 1.5 times the specified maximum allowable operating pressure. The coupling shall be sized to match the associated piping.

2.6.4.2 Compression Coupling

A compression coupling shall consist of one steel middle section, two steel mechanical nuts, two elastomeric gaskets and two machined steel lock rings.

The coupling shall use ethylene propylene diene monomer (EPDM)wedge gaskets. The maximum allowable working pressure shall be 150 psig at 120 degrees F. The coupling shall be sized to match the associated piping.

## 2.7 VALVE BOXES

The box length shall adapt to the length required for the depth of the line without full extension. Boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. The boxes shall have housings of sufficient size to completely cover the valve or service stop and shall be complete with covers.

### 2.7.1 Valve Boxes

Cast-iron valve boxes shall have minimum metal thickness of 3/16 inch and boxes shall be extension type with slide-type adjustment and with flared base. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment.

## 2.8 VALVES

### 2.8.1 General Requirements For Valves

Valves shall include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation. The valves shall be suitable for the intended service. Renewable parts are not to be of a lower quality than those specified. Valves shall be the same size as adjoining pipe. Valve ends shall be compatible with adjacent piping system. An operator shall be sized to operate the associated valve for the full range of pressures and velocities. Valves will open by turning counterclockwise. Operators, actuators, and accessories shall be factory mounted.

### 2.8.2 Valve Schedule

Submit a list of valve materials, pressure ratings, valve operator's materials, air supply pressure, electrical service, location, source of supply, and reference identification as indicated in the contract drawings. Provide a list of any special tools necessary for each valve type and appurtenances furnished for adjustment, operation, maintenance and disassembly. Requirements relative to this paragraph are shown on the located in the contract drawings. For butterfly valves refer to the Piping and Butterfly Valve Application Schedule.

### 2.8.3 Factory Finishing

Valves shall have an epoxy lining and coating in accordance with AWWA C550 unless otherwise specified. The epoxy shall be either a two-part liquid material or a heat-activated (fusion) material except that only a heat-activated material shall apply if a valve coating is specified as "fusion" or "fusion bonded" epoxy. The epoxy lining and coating shall have a minimum 7.0 mils dry film thickness except where it is limited by valve operating tolerances. Exposed valves shall be finished in accordance with Section 09 06 90 PROTECTIVE COATINGS.

2.8.4 Check Valves

2.8.4.1 Swing Check Valves

Swing check valves shall conform to the following:

a. Swing check valves, 2 inches and smaller, shall have a bronze body, in accordance with ASME B16.11 socket-welding, ASME B16.11 threaded or ASME B16.5 flanged ends. Valves shall have a swing type, bronze disc. Valves shall be rated for 200 psig service.

b. Swing check valves, 2 inch through 36 inch, shall conform to AWWA C508, and have ASME B16.1 Class 125 flanged end connections. Valves shall have a cast iron or ductile iron body, bronze or cast iron - mounted disc, solid bronze hinges, and a stainless steel hinge shaft. Valves 2 inch through 12 inch shall be rated for 175 psig service and valves 14 through 36 inch shall be rated for 150 psig service at 140 degrees F. Valves shall be fitted with an adjustable outside lever and weight. An increasing-pattern body valve may be used where increased outlet piping size is shown.

2.8.4.2 Thermoplastic Check Valve

Thermoplastic check valves, 0.25 inch through 16 inch, shall be a ball-check design, manufactured of polyvinyl chloride (PVC) with flanged end connections. Valves shall be rated for 150 psig service. Valves shall have fluoro-elastomeric O-ring seals and seats.

2.8.4.3 Ball Check Valve

Ball check valves, 1 inch and larger, shall be in accordance with ASME B16.11 socket-welding, ASME B16.11 threaded, or ASME B16.5 flanged ends, and cast iron polyvinyl chloride (PVC) bodies with a cleanout and sinking type hollow steel or butadiene acrylonitrile covered metal ball. Valves shall be rated for 100 psig service and shall be suitable for vertical or horizontal flow.

2.8.5 Ball Valves

2.8.5.1 General Purpose Ball Valves

General purpose ball valves shall conform to the following:

a. Ball valves, 2 inch and smaller, shall be end entry type with bronze bodies and threaded, in accordance with ASME B1.20.1, regular ports. Valves shall have polytetrafluoroethylene (PTFE) seats and packing, brass balls and hand lever operators. Valves shall be rated for 600 psig service at 150 degrees F and shall conform to ASME B16.34 Class 300. A union shall be installed adjacent to the valves to provide access to the seat.

b. Ball valves, 2.5 inch to 4 inches, shall be end entry type with brass bodies and ASME B16.11 threaded ends. Valves shall have polytetrafluoroethylene (PTFE) packing and seats, a stainless steel ball, full bore ports, and hand lever operators. Valves shall be rated for 400 psig service at 150 degrees F and shall conform to ASME B16.34 Class 300.

c. Ball valves, 6 to 12 inch, shall conform to ASME B16.34 Class 300, and have a carbon steel body, stainless steel ball and stem, polytetrafluoroethylene (PTFE) packing and gasket, and flanged ends, full port. Valves shall be rated for 750 psig service, and have pneumatically actuated or electrically actuated operators.

2.8.5.2 Thermoplastic Ball Valve

Thermoplastic ball valves, 6 inch and smaller, shall be rated for 150 psig service at 120 degrees F, and have ASTM D1784, minimum cell classification, polyvinyl chloride (PVC bodies, balls, and stems. Valves shall be end entry, double union design, with threaded, in accordance with ASME B1.20.1, flanged ends connections, a ethylene propylene diene monomer (EPDM) seat, and polytetrafluoroethylene (PTFE) O-ring stem seals. Valves shall have hand lever or electrically actuated operators.

2.8.6 Globe Valves

2.8.6.1 General Requirements For Globe Valves

Globe valves, 3 inch and smaller, shall be globe style valve and shall have bronze bodies, with bronze trim, and bronze bonnets. Valves shall conform to ASME B16.34, and shall have ASME B16.11 threaded ASME B16.5 flanged or ASME B16.1 flanged end connections. Valves shall include union bonnets, inside screws, rising stems, conventional discs constructed of stainless steel rings. Valves shall be rated for 200 psig service. Valves shall be equipped with handwheel or electrically actuated operators.

2.8.6.2 Needle Valve

Needle valves, 1 inch and smaller, shall be of a straight pattern and shall have brass or TP316 stainless steel bodies and trim. Valves shall conform to ASME B16.34 with ASME B16.11 male threaded, in accordance with ASME B1.20.2M (ASME B1.20.1) end connections. Valves shall include threaded bonnets, TP316 stainless steel or bronze stems, plug, soft tip, or non-rotating ball stem tips constructed of graphite packing. Valves shall be rated for 300 psig service. Valves shall be equipped with handwheel operators.

2.8.6.3 Hose Valve

Hose valves, 0.75 through 3 inch, shall be globe style or angle pattern hose valves with bronze bodies, bronze trim, inside screws, rising stems, and polytetrafluoroethylene (PTFE) disc. The outlet ports shall be cast brass in accordance with ASME B1.20.2M (ASME B1.20.1) pipe threads, male by male, nipple adapter with hexagonal wrench feature. Valves shall be rated for 200 (psig) service.

2.8.7 Plug Valves

2.8.7.1 Eccentric Valve

Nonlubricated type eccentric valves, 3 inch and smaller, shall be rated for 175 psig service at 140 degrees F. Valves shall have drip-tight shutoff with pressure from either direction, and cast iron bodies, in accordance with ASME B16.1 flanged or ASME B16.11 threaded end connections, all metal,

matching body plugs with round ports,nickel seats, self-lubricating stainless steel stem bearings, and polytetrafluoroethylene (PTFE) U-cup seals. Valves shall conform to ASME B16.34. Valves shall be equipped with handwheel or electrically actuated operators, where indicated on the drawings.

2.8.8 Butterfly Valves

2.8.8.1 Standard Service Butterfly Valve

Butterfly valves, 2 to 36 inches, shall have ductile iron bodies, lugged styled with ASME B16.5 flanged . Valves shall conform to AWWA C504 Class 150. Discs shall be contoured ASTM A536 Grade 65-45-12 ductile iron. The valve shafts shall be 416 stainless steel with self-lubricating, corrosion-resistant sleeve type bearings. Valve seats for (24 inch) and smaller valves shall be attached to either the valve body or the disc and shall be constructed of polytetrafluoroethylene (PTFE). Valve seats for valves for 30 inch to 36 inch shall be field replaceable in accordance with AWWA C504. Valves shall have hand wheel, gear operators.

2.8.8.2 Thermoplastic Butterfly Valves

Thermoplastic butterfly valves, 1.5 inch and larger, shall have lugged style bodies constructed of polyvinyl chloride (PVC). Valves shall have polyvinyl chloride (PVC) discs, ethylene propylene diene monomer (EPDM) backed seats, ethylene propylene diene monomer (EPDM) seals, and lever or gear manual actuated or electrically actuated operators. Valves shall be rated for 150 psig service at 140 degrees F.

2.8.9 Self-Contained Automatic Valves

2.8.10 Operators

2.8.10.1 Manual Operator

The force in a manual operator shall not exceed 39.3 pound under any operating condition, including initial breakaway. The operator shall be equipped with gear reduction when force exceeds 39.3 pound. The manual operator shall be a self-locking type or shall be equipped with a self-locking device. A position indicator shall be supplied on quarter-turn valves. Worm and gear operators shall be a one-piece design with worm-gears of gear bronze material. Worm shall be hardened alloy steel with the thread ground and polished. Traveling nut type operators shall have threader steel reach rods with an internally threaded bronze or ductile iron nut.

2.8.10.1.1 Exposed Operators

Exposed operators shall have galvanized and painted handwheels. Lever operators are allowed on quarter-turn valves 8 inch and smaller. Cranks shall be supplied on gear type operators. If located off of the operator floor, chain wheel operator with tiebacks, extension stem, floor stands, and other accessories shall be provided to permit operation from normal operation level. Valve handles shall be capable of padlocking, and wheels shall be lockable with a chain and padlock.

2.8.10.2 Air Sets

The air set shall include a pressure regulator with internal relief, filter, outlet pressure gauge, and adjustable reduced pressure range as required by the valve actuator. The air set shall have an aluminum body and handwheel, safety vented lockout isolation valve, and gauge range 1.33 to 2 times maximum operating pressure.

2.8.10.3 Limit Switches

Limit switches shall be single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac, housed in a NEMA 250 Type 4 enclosure, and adjustable for open and closed valve positions.

2.8.10.4 Solenoid Valve

A solenoid valve shall pilot the control actuator in the appropriate configuration for the type of actuator being controlled. A pilot operated diaphragm type solenoid valve shall have a brass body and resilient seat and operate with minimum operating pressure differential no greater than 10.2 psi and maximum operating pressure differential no less than 150 psi. Internal parts shall be corrosion-resistant. The solenoid valve shall have Class F molded coils for operation on 120 volts, 60-Hz, ac, unless otherwise indicated. The solenoid enclosure shall conform to NEMA 250 Type 4. Solenoids on double acting cylinders for open-close and throttling valves shall be four-way with dual coils. Solenoids on spring return cylinders for open-close and throttling valves shall be three-way, spring return. An air exhaust muffler shall be furnished in the exhaust port of all actuator pilot solenoid valves.

2.8.10.5 Electric Operator

Electric operators shall be provided complete with actuators, speed controls and accessories. The actuators shall operate on 120 VAC, 60 Hz with a 75 percent duty cycle and shall be equipped with an AC thermal overload protector with automatic rest, reversing (bi-directional) operation for use with quarter-turn valves, or rotating equipment to full rotation. Gearing shall be a two-stage planetary, permanently lubricated self-locking gear train with self-lubricating bearings; connections via male output staff. The start-up torque shall be 120 foot-pound. The stall torque shall be 150 foot-pound. Two travel stop limit switches with cams, internal, independent, adjustable, and actuated by cams shall be mounted on the drive shaft. A side mounted hand turn wheel shall be provided for a manual override. The actuators shall have a NEMA 250 Type 4 enclosure with a corrosion resistant, baked epoxy finish as standard. The actuator shall operate in a temperature range of -40 to plus 150 degrees F. Actuators shall fail in last position unless otherwise indicated. Electric operators shall be furnished with features noted on the in the contract drawings. Limit switches shall be provided on all actuators.

2.8.10.5.1 Limit Switches

Limit switches shall be single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac, housed in a NEMA 250 Type 4 enclosure, and adjustable for open and closed valve positions.

2.8.10.5.2 Positioners

The positioners for modulating actuators shall control valve positions as a function of the input signals. The positioner shall operate on 120 VAC, 60 Hz. voltage. The mode of operation shall be direct acting or reverse acting. Modulating valve positioners shall operate on a 4 to 20 mA input signal unless otherwise indicated. Corrosion-resistant enclosures for positioners shall be splash-and moisture-proof with gasketed covers.

2.8.11 Valve Accessories

2.8.11.1 Extension Bonnet for Valve Operator

All extension bonnets shall be provided as necessary, complete with stem and accessories applicable to the specific valve and operator.

2.8.11.2 Floor Stand and Extension Stem

A floor stand and extension stem shall be the nonrising, indicating type; complete with stem, coupling, handwheel, stem guide brackets, and yoke attachment. The stem guide shall be spaced such that stem L/R ratio does not exceed 200. Anchors shall be supplied as required.

2.8.11.3 Floor Box and Stem

A floor box and stem shall be the plain type, for support of nonrising type stem; complete with stem, operating nut, and stem guide brackets. The stem guide shall be spaced such that stem L/R ratio does not exceed 200. Anchors shall be supplied as required.

2.8.11.4 Chain Wheel and Guide

A chain wheel and guide shall be the handwheel direct-mount type, complete with galvanized or cadmium-plated chain.

2.9 DRAINS

Valved drains may not be shown on the detailed drawings for individual pipelines; their absence will not relieve the Contractor of the responsibility for providing and installing them as indicated in the piping and instrumentation diagrams to complete the piping system for the use intended.

2.9.1 Locations

Drains shall be located as indicated on the contract drawings.

2.9.2 Sizes

For pipelines 2.5 inch and larger, drains shall be 0.75 inch and equipped with ball valves. For pipelines 2 inch and smaller, drains shall be 1/2 inch and equipped with ball valves.

## 2.10 MISCELLANEOUS PIPING COMPONENTS

### 2.10.1 Air Release and Vacuum Breakers

Air release vents shall be located, and vented, such that a hazardous atmosphere will not be created upon operation.

#### 2.10.1.1 Locations

Air release and vacuum breakers shall be located as indicated on the contract drawings.

#### 2.10.1.2 Vacuum Breakers

Vacuum breakers 2 inch and smaller shall be an angle type with all bronze or cast iron bodies and bonnets, and shall be installed at least 6 inch above the flood line of associated equipment and shall conform to ASSE 1001 for pipe applied units.

#### 2.10.1.3 Air and Vacuum Valve

The air and vacuum valve shall conform to ASSE 1001, and automatically exhaust air during the filling of a system while allowing air to re-enter during draining or when vacuum occurs. The valve shall be rated for 150 psig working pressure and built with a standard elongated body. The valve shall have a cast iron body and cover, with stainless steel float and trim. End connections shall be as follows: for 1/2 through 3 inch ASME B1.20.1 pipe threaded inlet and outlet, for 4 inch and larger ASME B16.1 Class 150 flanged inlet with outlet. The air and vacuum valve shall be fitted with blowoff valve, quick disconnect couplings, and a minimum 6.6 feet of hose in order to permit back flushing after installation without dismantling the valve.

#### 2.10.1.4 Air Release Valve

The air release valve shall automatically exhaust entrained air that accumulates in a system and shall be ASSE approved. The valve shall be rated for 150 psig working pressure and built with a standard elongated body. The valve shall have a cast iron body and cover, with stainless steel float and trim. Valve end connections shall be ASME B1.20.1 pipe threaded or ASME B16.1 Class 150 flanged. The air and vacuum valve shall be fitted with blowoff valve, quick disconnect couplings, and a minimum 6.6 feet of hose in order to permit back flushing after installation without dismantling the valve.

#### 2.10.1.5 Combination Air Valve

The valve combines the operating functions of both an air and vacuum valve and an air release valve. The air and vacuum portion shall automatically exhaust air during filling of a piping system and allow air to re-enter during draining or when a vacuum occurs. Air release portion shall automatically exhaust entrained air that accumulates in the piping system. The valve shall be a single body unit. The valve shall be rated for 150 psig working pressure and built with a special short body. The valve shall have a cast iron body and cover, with stainless steel float and trim. Valve end connections shall be ASME B1.20.1 pipe threaded or ASME B16.1 Class 150 flanged. The air and vacuum valve to be fitted with a blowoff valve, quick

disconnect couplings, and a minimum 6.6 feet of hose in order to permit back flushing after installation without dismantling the valve.

2.10.2 Backflow Preventer

The backflow preventer shall be identical in size to pipe. Total head loss through the complete backflow assembly shall not exceed 10.1 psi at rated flow.

2.10.3 Strainers

Strainers shall be duplex with a Y-pattern body. Port sizes shall be 1 inch and be ASME B1.20.1 threaded, female. The strainers shall be rated for 150 psig working pressure at 150 degrees F and conform to ASTM F1199. The body shall be cast bronze with a screwed bronze cap. The screen shall be heavy-gauge stainless steel 80 mesh and be equipped with a ASME B1.20.1 pipe threaded blowoff hole.

2.10.4 Indicating Devices

2.10.4.1 Pressure Gauges

Pressure and vacuum gauges shall be mounted on a rigid surface and shall be flush mounted. Differential strainer gauges shall be line-mounted, with high-impact glass-fiber-reinforced polypropylene or release back plate cases equipped with safety pressure blowout backs and dry dials with white laminated phenol with black markings. The gauge sensors shall be C-Type Bourdon tube or actuated and constructed of Grade A phosphor bronze, brazed joints stress relieved, for 160 psi maximum graduation and drawn alloy steel, welded joints stress relieved, for 200 psi to 800 psi maximum graduation . The gauges shall be equipped with brass or TP316L stainless steel threaded 0.25 inch female connections. The dials of the gauges shall be 6 inch in diameter with scale readings in (psig and inches of mercury) ranging from zero to approximately twice the anticipated process operating or equipment pressure. A micrometer adjustable pointer shall be provided with accuracy to conform to ASME B40.100, Grade 2A.

2.10.5 Expansion Joints

Provide all structural work and equipment required to control expansion and contraction of piping. Verify that the anchors, guides, and expansion joints provided, adequately protect the piping systems.

2.10.5.1 Expansion Joint for Metallic Pipe

The expansion joint shall be a bellows type with stainless steel wetted materials of construction. The expansion joint shall be sized to match the associated piping. The maximum allowable working pressure shall be 150 psig at 120 degrees F. The expansion joint shall be sized for a maximum axial compressing deflection of 1 inches End connections shall be as specified for the associated pipe joints. Required accessories for a complete assembly shall be provided including: swivel joints, limit stops, internal guides, anti-torque device.

2.10.5.2 Expansion Joint for Nonmetallic Piping

A bellows expansion joint shall have a minimum of 2 convolutions to accommodate an axial deflection of 1 inch, with ductile iron flanged, faced and drilled to ASME B16.1 Class 125 end connections, and metal reinforcing bands. The maximum allowable working pressure shall be 140 psig at 120 degrees F. Bolting shall be limited to restrain the force developed by 1.5 times the specified maximum allowable operating pressure. The expansion joint shall be sized to match the associated piping.

2.10.6 Pressure Relief Devices

Pressure relief devices shall conform to the requirements of ASME B31.3.

2.10.6.1 Pressure-Relief Valve

Pressure-relief valves shall conform to the following:

a. Pressure-relief valves, 2 inch and smaller, shall be a direct diaphragm, spring controlled type with cast iron bodies and spring cases. Trim shall be bronze and seats, nitrile. Diaphragms shall be elastomeric, neoprene. Miscellaneous parts such as the valve stems, nuts, and springs shall be stainless steel. End connections shall be ASME B16.11 threaded or welding. The valves shall open when the upstream pressure reaches a maximum set point.

b. Pressure relief valves, 2.5 inch and larger, shall be hydraulically operated, diaphragm actuated, pilot controlled globe valves with externally mounted strainers and test cocks. Bodies shall be cast iron and trim shall be bronze or stainless steel. Stem shall be stainless steel. End connections shall be ASME B16.11 threaded or welding. The valves shall open when the upstream pressure reaches a maximum set point.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Construction Manager of any discrepancy before performing the work.

3.2 PREPARATION

3.2.1 Protection

Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

3.2.2 System Preparation

3.2.2.1 Pipe and Fittings

Pipe and fittings shall be inspected before exposed piping is installed or buried piping is lowered into the trench. Clean the ends of pipes

thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.

#### 3.2.2.2 Damaged Coatings

Repair damaged coating areas in the field with material equal to the original coating, except for damaged glass-lined pipe which shall be promptly removed from the site. Do not install damaged piping materials. Field repair of damaged and uncoated areas of galvanized piping shall conform to ASTM A780/A780M.

#### 3.2.2.3 Field Fabrication

Notify the Construction Manager at least 2 weeks prior to the field fabrication of pipe or fittings and at least 3 days prior to the start of any surface preparation or coating application work. Field welding shall be performed in accordance with Section 40 05 13.96 WELDING PROCESS PIPING. Welding electrodes shall be provided in accordance with Table 3.1 of AWS D1.1/D1.1M as required for the applicable base metals and welding process. Fabrication of fittings shall be performed in accordance with the manufacturer's instructions.

## 3.3 EXPOSED PIPING INSTALLATION

Exposed piping shall be run as straight as practical along the alignment shown on the contract drawings and with a minimum of joints. Piping and appurtenances shall be installed in conformance with reviewed shop drawings, manufacturer's instructions and ASME B31.3. Piping shall be installed without springing or forcing the pipe.

### 3.3.1 Anchors and Fasteners

Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.

### 3.3.2 Piping Expansion and Contraction Provisions

The piping shall be installed to allow for thermal expansion and contraction resulting from the difference between installation and operating temperatures. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial shall have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI TR-21. Anchors shall be installed as shown in the contract drawings to withstand expansion thrust loads and to direct and control thermal expansion. An intermediate pipe guide shall be installed for every pipe at each metal channel framing support not carrying an anchor or alignment guide. Where pipe expansion joints are required, pipe alignment guides shall be installed adjacent to the expansion device and within four pipe diameters. Expansion devices shall be installed in accordance with the manufacturer's instructions.

### 3.3.3 Piping Flexibility Provisions

Thrust protection shall be provided as required. Flexible couplings and expansion joints shall be installed at connections to equipment, and where

shown on the contract drawings. Additional pipe anchors and flexible couplings beyond those shown on the contract drawings, shall be provided to facilitate piping installation, in accordance with reviewed shop drawings.

3.3.4 Couplings, Adapters and Service Saddles

Pipes shall be thoroughly cleaned of oil, scale, rust, and dirt in order to provide a clean seat for gaskets. Gaskets shall be wiped clean prior to installation. Flexible couplings and flanged coupling adapter gaskets shall be lubricated with soapy water or the manufacturer's standard lubricant before installation on the pipe ends. Couplings, service saddles, and anchor studs shall be installed in accordance with manufacturer's instructions. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Torque-limiting wrenches shall be used to tighten bolts.

3.3.5 Piping Equipment/Component Installation

Piping components and indicators shall be installed in accordance with manufacturer's instructions. Required upstream and downstream clearances, isolation valves, and miscellaneous devices shall be provided for an operable installation. Straight runs of piping upstream and downstream of flow measuring devices shall be as shown in the contract drawings. The upstream and downstream lengths of undisturbed piping shall be in accordance with flow indicator manufacturer's recommendations.

3.3.5.1 Local Indicators

All direct-reading indicator devices and pressure gauges shall be installed so that they can be easily read from floor level, and are readily accessible for maintenance and service. Pressure gauges shall be installed where indicated in the contract drawings. Field calibration of all indicators shall be performed at time of installation to ensure measuring and reading accuracy. Differential pressure gauges shall be installed across the process equipment indicated in the contract drawings, in accordance with the manufacturer's recommendations, and arranged for easy observation.

3.3.6 Pipe Flanges

Pipe flanges shall be set level, plumb, and aligned. Flanged fittings shall be installed true and perpendicular to the axis of the pipe. The bolt holes shall be concentric to the centerline of the pipe

3.3.7 Valve Locations

Valves shall be located in accordance with the contract drawings where actuators are shown. Where actuators are not shown, valves shall be located and oriented to permit easy access to the valve operator, and to avoid interferences.

3.3.8 Pipe Tap Connections

Taps to pipe barrels are unacceptable. Taps to steel piping shall be made only with a welded threadolet connection.

### 3.3.9 Plastic Pipe Installation

Submit a statement signed by the manufacturer's representative certifying that the Contractor's personnel are capable of properly installing the piping system on the project. All plastic pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations.

a. Heat joining shall be performed in accordance with ASTM D2657. Electrofusion joining shall be performed in accordance with ASTM F1290. Schedule 40 pipe shall not be threaded. Schedule 80 threaded nipples shall be used where necessary to connect to threaded valves or fittings. Strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to over tighten these fittings.

b. Pipe shall not be laid when the temperature is below 40.1 degrees F, nor above 90 degrees F when exposed to direct sunlight. Any plastic pipe installed above grade and outdoors shall be ultraviolet (UV) protected or UV resistant.

c. The pipe ends that are to be joined shall be shielded from direct sunlight prior to and during the laying operation. Adequate ventilation shall be provided when working with pipe joint solvent cement and the handling of solvent cements, primers and cleaners shall be in accordance with ASTM F402.

d. Provide and install supports and hangers in accordance with the manufacturer's recommendations and as specified and indicated. Where plastic pipe is subjected to severe temperature fluctuations, provisions for expansion and contraction must be provided. This shall be accomplished with the use of expansion joints and offset piping arrangements. All lines shall be hydrostatically tested at the pressures listed in the Pipe Schedule shown on the contract drawings.

e. Submit 6 copies each of operation and maintenance manuals in indexed booklet form. Detail in the Operation Manuals the step-by-step procedures required for specialized startup, operation and shutdown of piping systems, and include the manufacturer's name, model number, parts list and brief description of piping equipment such as valves and other appurtenances and their basic operating features. List in the Maintenance Manuals routine maintenance procedures and troubleshooting guides for the equipment, and include piping layout and valve locations.

#### 3.3.9.1 PVC Piping

Solvent-cemented joints shall be constructed in accordance with ASTM D2855.

## 3.4 BURIED PIPE PLACEMENT

Thermoplastic piping systems shall be installed underground in accordance with ASTM D2774.

### 3.4.1 Excavation and Backfilling

Earthwork shall be performed as specified in Section 31 00 00 EARTHWORK. Backfilling shall be accomplished after inspection by the Construction

Manager. Exercise care when lowering pipe into the trench to prevent damage or twisting of the pipe.

### 3.4.2 Fittings

Press connections shall be made in accordance with manufacturer's installation instructions using tools approved by the manufacturer. The tubing shall be fully inserted into the fitting and then marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing is fully inserted before the joint is pressed. At valves and connections, the trench bottom shall be dug out with sufficient length, width, and depth to ensure clearance between the undisturbed trench bottom and the valves and such connections.

### 3.4.3 Thrust Restraint

Thrust restraint devices are generally not shown in the contract drawings; their absence will not relieve Contractor of the responsibility for providing them as required to provide complete systems for the use intended. Provide thrust blocks and ties where required, whether or not shown on the contract drawings. At a minimum, thrust restraint shall be provided at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.

### 3.4.4 Marking Tape

Pipe marking tape shall be provided and installed in accordance with the requirements of Section 31 00 00 EARTHWORK.

### 3.4.5 Plastic Pipe Installation

Plastic pipe shall be cut, fabricated, and installed in strict conformance with the pipe manufacturer's recommendations. Offset loops from the trench centerline shall be as recommended by the manufacturer for the maximum temperature variation between the pipe temperature at the time of solvent welding and operating temperature. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial shall have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI TR-21. Flexible plastic pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between the plastic pipe at the flanged joint and the rigid structures is possible.

## 3.5 CONNECTING DISSIMILAR PIPE

Connect dissimilar pipe materials by means of a rubber gasketed coupling specified under Detail Pipe Specification - Corrugated Metal Pipe and Fittings. Flexible transition couplings, dielectric fittings, and isolation joints shall be installed in accordance with the manufacturer's instructions.

## 3.6 EXTERNAL CORROSION PROTECTION

Protect all pipe and piping accessories from corrosion and adverse environmental conditions.

### 3.6.1 Underground Metallic Piping

Buried metallic piping shall be protected from corrosion using protective coatings and cathodic protection. Cathodic Protection shall be provided for metallic underground piping systems as specified in Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE). Where dissimilar metals are joined underground, gas-tight isolation joints shall be used.

### 3.6.2 Above Grade Metallic Piping

Nonferrous and stainless steel piping shall not be painted except for aluminum alloy piping. Where dissimilar metals are joined, isolation joints shall be used.

#### 3.6.2.1 Ferrous Piping

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, mill scale or other foreign substances shall be mechanically cleaned by commercial sand blasting conforming to SSPC SP 6/NACE No. 3 and primed in accordance with Section 09 06 90 PROTECTIVE COATINGS vinyl type wash coat. Primed surfaces shall be finished with two coats of exterior paint in accordance with Section 09 06 90 PROTECTIVE COATINGS. Cathodic Protection shall be provided as shown in the contract drawings for above ground ferrous piping systems as specified in Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE).

## 3.7 CLOSURES

Closure pieces shall be installed as necessary to end pipe runs and shall conform to ASME B16.9 or ASME B16.11. Elastomer sleeves bonded to pipe ends are not acceptable. Pressure piping shall have closures of butt-welded caps, blind flanges, or plain end pieces, with thickness matching the nominal wall thickness of the associated pipe, mounted on double flexible couplings, unless otherwise shown on contract drawings or approved by the Construction Manager. Pipes with restrained joints shall have pipe closures installed with thrust tie-rod assemblies unless otherwise shown on the contract drawings.

## 3.8 VALVE INSTALLATION

Flanged valve bolt holes shall be installed so as to straddle the vertical centerline of pipe. Flanged faces shall be cleaned prior to inserting the gasket and bolts, and then the nuts shall be tightened progressively and uniformly. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation.

### 3.8.1 Valve Orientation

The operating stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations 4.5 feet or less above finished floor, unless otherwise shown on contract drawings. The operating stem of a manual valve shall be installed in a horizontal position in horizontal runs of pipe having centerline elevations between 4.5 feet and 6.75 feet above finish floor, unless otherwise shown on contract drawings. Automatic valves shall

be installed in accordance with the manufacturer's instructions and approved drawings.

3.8.1.1 Butterfly Valves

Orientation of butterfly valves shall take into account changes in pipe direction. Valve shafts shall be oriented so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of the disc.

3.8.1.2 Plug Valves

If a plug valve seat position is not shown in the contract drawings, locate the seat position as follows: for horizontal flow, the flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve; and for vertical flow, the seat shall be installed in the highest portion of the valve.

3.8.2 Line Size Ball Valves

A line size ball valve and union shall be installed upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

3.8.3 Chain Wheel and Guide

Chain wheel and guide assemblies or chain lever assemblies shall be installed on manually operated valves located over 6.73 feet above finished floor elevation. Where chains hang in normally traveled areas, appropriate "L" type tie-back anchors shall be used.

3.9 AIR RELEASE, DRAINS AND SAMPLE PORTS

Install specified vents at piping high points for entrapped air release and install drains in the low points of pipelines regardless of whether shown on contract drawings.

3.10 PIPE IDENTIFICATION, PAINTING AND COLOR CODING

Color, coating, and lettering requirements for exposed piping shall be in accordance with Section 09 06 90 PROTECTIVE COATINGS

3.11 FIELD QUALITY CONTROL

3.11.1 Hydrostatic Tests

Where any section of a pipeline is provided with concrete thrust blocking for fitting, the hydrostatic tests shall not be made until at least 5 days after the installation of the concrete thrust blocking, unless otherwise approved by the Construction Manager.

3.11.1.1 Buried Piping

After the pipe is laid, the joints completed and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 2 hours to a hydrostatic test pressure as listed in the Pipe

Schedule in the contract drawings. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced as necessary. Defective pipe, joints, fittings, and valves found during the pressure test shall be removed and replaced with new material, and the test repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Construction Manager when one or more of the following conditions are encountered: (1) wet or unstable soil conditions in the trench; (2) compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions; or (3) maintaining the trench in an open condition would delay completion of the Contract. The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 31 00 00 EARTHWORK.

3.11.1.2 Exposed Piping

Hydrostatic testing shall be conducted in accordance with ASME B31.3. Piping systems shall be tested under normal service conditions (as indicated in the Pipe Schedule in the contract drawings) to demonstrate compliance. The test pressure shall not be less than 1.5 times the design pressure. Water shall be used as the hydrostatic test fluid. Provide clean test water of such quality to prevent corrosion of the piping system materials. Air release vents shall be opened at all high points of the piping system in order to purge air pockets while the piping system is filling.

3.11.1.2.1 Rigid Piping

For rigid piping hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3, but shall not exceed the yield strength of the piping system. The maximum velocity during filling shall be in accordance with the manufacturer's instructions. Venting during filling may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents. Test all parts of the piping system. The hydrostatic test pressure shall be maintained continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage. All joints and connections shall be examined for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking. Correct visible leakage and retest. Unless otherwise directed by the Construction Manager, the piping system shall be left full of water after leaks are repaired.

3.11.1.2.2 Non-Rigid, Non-Metallic Piping and Metallic Piping with a Non-Metallic Liner

For non-rigid, non-metallic piping and metallic piping with a non-metallic liner hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3, but shall not exceed 1.5 times the maximum pressure rating of the lowest rated component in the piping system. The maximum velocity during filling shall be in accordance with the manufacturer's instructions. The system shall be initially pressurized to 50 percent of the normal service conditions and inspected. Any leaks shall be repaired by the Contractor. The system shall then be pressurized to the test pressure.

Small amounts of water shall be added as required on a hourly basis for a maximum of 3 hours in order to maintain the test pressure. After 4 hours, the test pressure shall be lowered by 10.2 psi. If the hydrostatic pressure remains steady for 1 hour, then no leakage is indicated. Inspect for leaks, repair and retest if necessary. The piping system shall be allowed to relax for 8 hours before retesting.

3.11.1.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a delay, underground piping jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Tests for above ground pressure piping shall be conducted after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

3.11.2 Pipe Leakage Tests

Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.

Unless approved by the Construction Manager, leakage testing shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the piping shall be subjected to the working pressure indicated in the Pipe Schedule. Leakage is defined as the quantity of the test liquid, water, that is supplied to the piping system, or any valved or approved section thereof, in order to maintain pressure within plus or minus 5 psi of the specified leakage test pressure after the piping has been filled with the test liquid and all air is expelled. When leakage is allowed, no piping installation will be accepted if leakage exceeds the allowable leakage determined by the following formula:

| **L = Cf x N x D x P0.5** | | |
|---|---|---|
| Cf | conversion factor | 0.0001351 |
| L | allowable leakage | gallons per hour |
| N | number of joints in the length of piping tested | |
| D | nominal pipe diameter | inches |
| P | average test pressure during the test | psig |

Should any test disclose leakage greater than that allowed, the leaks shall be located and repaired until the leakage is within the specified allowance, without additional cost.

3.11.3 Valve Testing

Submit copies of all field test reports within 24 hours of the completion of the test. Valves may either be tested while testing pipelines, or as a separate step. It shall be demonstrated that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications. Count and record the

number of turns required to open and close each valve, and account for any discrepancies with manufacturer's data. Air and vacuum relief valves shall be examined as the associated pipe is being filled to verify venting and seating is fully functional. Set, verify, and record set pressures for all relief and regulating valves. Self-contained automatic valves shall be tested at both maximum and minimum operating ranges, and reset upon completion of test to the design value. Automatic valves that are not self-contained shall be tested in conjunction with control system testing.

## 3.12 FINAL CLEANING

### 3.12.1 Interim Cleaning

Prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. The piping shall be examined to assure removal of these and other foreign objects prior to assembly and installation.

### 3.12.2 Flushing

Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. Provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity shall be 2.5 fps. For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, the pipeline shall be cleaned in-place from the inside by brushing and sweeping, then flushing the pipeline at a lower velocity. Cone strainers shall be installed in the flushing connections of attached equipment and left in place until cleaning is completed. Accumulated debris shall be removed through drains, or by removing spools or valves.

## 3.13 WASTE WATER DISPOSAL

Submit the method proposed for disposal of waste water from hydrostatic tests and disinfection, and all required permits, prior to performing hydrostatic tests. The water used for testing, cleaning, flushing and/or disinfection shall be disposed of in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. The method proposed for disposal of waste water shall be provided to, and approved by, the Construction Manager prior to performing any testing, cleaning, flushing, and disinfection activities.

## 3.14 TABLES

See Table 1 within Attached Document, entitled: Table 1 Piping Schedule

## 3.15 MANUFACTURER'S FIELD SERVICES

Submit a signed statement certifying that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance. Obtain manufacturer's technical assistance for Contractor training, installation inspection, start up, and

owner operating and maintenance training. Follow manufacturer's instructions for installation.

-- End of Section --

**PIPE COLOR-CODING SCHEDULE**

| Piping System | Color |
|---|---|
| Air Intake Lines | Ivory |
| Compressed Air Lines | Safety Red |
| Compressed Air Receivers | Dunes Tan |
| Exhaust Lines (Bare) | Aluminum |
| Exhaust Lines (Lagged) | Ivory |
| Fire Main Piping and Valves | Fire Hydrant Red |
| Diesel Fuel Lines | Safety Yellow |
| Natural Gas Lines | Safety Yellow |
| Jacket Water Lines | Safety Green |
| Lube Oil Lines | Safety Blue |
| Raw Water Lines | Safety Black |
| Exterior Piping (except where identification is necessary) | Dunes Tan |
| Vacuum Lines | Alpine Green |

| PIPING APPLICATION SCHEDULE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Process Abbrev.** | **Service** | **Nominal Diameter (inches)** | **Material** | **Pressure Class Special Thickness Class Schedule Wall Thickness** | **Pipe Spec. Section** | **Joints/ Fittings** | **Test Pressure/ Method** | **Lining** | **Coating** | **Service Conditions** | **Comments** |
| RPD | Reservoir Pump Discharge | | | | | | | | | | |
| | Aboveground | All | CS | As Required | 40 05 22 | FLG or W | 50 psig | EC | System S-4 per Section 09 06 90 | Exposed | S-470 |
| | Underground | All | CS | As Required | 40 05 22 | W (except as indicated on the drawings) | 50 psig | FBE/EC | FBE/EC | Buried | S-470 |
| APD | Agricultural Pump Discharge | | | | | | | | | | |
| | Underground | 30 | CS | 1/2 inch | 40 05 22 | W (except as indicated on the drawings) | 20 psig | FBE/EC | System S-4 per Section 09 06 90 | Buried | S-479 |
| | Aboveground | 30 | CS | 1/2 inch | 40 05 22 | W (except as indicated on the drawings) | 20 psig | FBE/EC | System S-2 per Section 09 06 90 | Exposed | S-479 |
| RPDD | Reservoir Pump Discharge Drain | | | | | | | | | | |
| | Underground | less than 12" | PVC | Sch. 40 | 40 05 13 | FLG or SW | GR | None | None | buried | |

| PIPING APPLICATION SCHEDULE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Process Abbrev.** | **Service** | **Nominal Diameter (inches)** | **Material** | **Pressure Class Special Thickness Class Schedule Wall Thickness** | **Pipe Spec. Section** | **Joints/ Fittings** | **Test Pressure/ Method** | **Lining** | **Coating** | **Service Conditions** | **Comments** |
| LP | Propane Gas | | | | | | | | | | |
| | Aboveground | All Sizes | Black Steel Grade B | Sch. 40 | 40 05 13 | SCRD or FLG | 15 psig | None | System S-7 per Section 09 06 90 | Exposed | |
| | Underground | All Sizes | Black Steel Grade B | Sch. 40 | 40 05 13 | SCRD or FLG | 15 psig | None | System S-4 per Section 09 06 90 | Buried | |
| WSD | Water Supply Discharge | 72" | CS | As Required | 40 05 13 | W (except as indicated on the drawings) | 40 psig | FBE/EC | FBE/EC | Buried | S-476 |

| BUTTERFLY VALVE APPLICATION SCHEDULE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Valve Type** | **Application** | **Nominal Diameter (inches)** | **Material** | **Pressure Class Special Thickness Class Schedule Wall Thickness** | **Valve Spec. Section** | **Joints/ Fittings** | **Test Pressure/ Method** | **Lining** | **Coating** | **Service Conditions** | **Comments** |
| Butterfly Valve | As indicated on drawings | 36" or less | See section 40 05 13 | See section 40 05 13 | Section 40 05 13 | FLG | Same as connectin g pipe | As specified | As specified | Exposed | |

**Abbreviations:**

**Material**

CS: Carbon Steel
PVC: Polyvinyl Chloride

**Joints/Fittings**
FLG: Flanged
MJ: Mechanical Joints
SCRD: Screwed
SW: Solvent Weld
TH: Threaded
W: Welded

**Linings/Coatings**

FBE: Fusion Bond Epoxy
EC: Epoxy Coated
CM: Cement Mortar
WAE: Waterborne Acrylic Emulsion

-- End of Section --

# SECTION 40 05 13.96

# WELDING PROCESS 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.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

| | |
|---|---|
| ASNT SNT-TC-1A | (2016) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A2.4 | (2012) Standard Symbols for Welding, Brazing and Nondestructive Examination |
| AWS A3.0M/A3.0 | (2010) Standard Welding Terms and Definitions |
| AWS B2.1/B2.1M | (2014) Specification for Welding Procedure and Performance Qualification |
| AWS QC1 | (2007) Standard for AWS Certification of Welding Inspectors |
| AWS Z49.1 | (2012) Safety in Welding and Cutting and Allied Processes |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B31.3 | (2014) Process Piping |
| ASME BPVC SEC I | (2010) BPVC Section I-Rules for Construction of Power Boilers |
| ASME BPVC SEC II-C | (2010) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals |
| ASME BPVC SEC IX | (2010) BPVC Section IX-Welding and Brazing Qualifications |
| ASME BPVC SEC V | (2010) BPVC Section V-Nondestructive Examination |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C206 | (2017) Field Welding of Steel Water Pipe |

## 1.2 DEFINITIONS AND SYMBOLS

Definitions shall be in accordance with AWS A3.0M/A3.0. Symbols shall be in accordance with AWS A2.4.

## 1.3 PERFORMANCE REQUIREMENTS

Quality of all joint preparation, welding, and examination is the Contractor's responsibility for. Clearly identify and record all materials used in the welding operations. The inspection and testing defined in this specification are minimum requirements. Additional inspection and testing shall be the responsibility of the Contractor when it is deemed necessary to achieve the quality required.

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pressure Piping

SD-03 Product Data

Welding Materials

Welding Operations

SD-07 Certificates

Qualifications

## 1.5 QUALIFICATIONS

Welding procedures, welders, and welding operators previously qualified by test may be accepted for the work without requalification, provided that all of the following conditions are fulfilled:

a. Copies of the welding procedures, the procedure qualification test records, and the welder and welding operator performance qualification test records are submitted and approved in accordance with paragraph SUBMITTALS.

b. Testing was performed by an approved testing laboratory or technical consultant or by the Contractor's approved quality assurance organization.

c. The welding procedures, welders, and welding operators were qualified in accordance with ASME BPVC SEC IX, or AWS B2.1/B2.1M, AR-2 level; and base materials, filler materials, electrodes, equipment, and processes conformed to the applicable requirements of this specification.

d. The requirements of paragraph "Renewal of Qualification" below are met and records showing name of employer and period of employment using the process for which qualified are submitted as evidence of conformance.

### 1.5.1 Welding Procedures Qualification

Record in detail and qualify the Welding Procedure Specifications for every proposed welding procedure. Qualification for each welding procedure shall conform to the requirements of ASME B31.3 and to this specification. The welding procedures shall specify end preparation for butt welds including cleaning, alignment, and root openings. Preheat, interpass temperature control, and postheat treatment of welds shall be as required by approved welding procedures, unless otherwise indicated or specified. The type of backing rings or consumable inserts, if used, shall be described and if they are to be removed, the removal process shall be described. Copies of the welding procedure specifications and procedure qualification test results for each type of welding required shall be submitted in accordance with paragraph SUBMITTALS. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds. Welding procedures shall be identified individually and shall be referenced on the detail drawings or keyed to the contract drawings.

### 1.5.2 Welder and Welding Operator Performance

Each welder and welding operator assigned to work shall be qualified in accordance with ASME B31.3.

#### 1.5.2.1 Certification

Before assigning welders or welding operators to the work, provide the District with their names together with certification that each individual is performance-qualified as specified. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

#### 1.5.2.2 Identification

Identify each particular weld with the personal number, letter, or symbol assigned to each welder or welding operator. To identify welds, written records indicating the location of welds made by each welder or welding operator shall be submitted, and each welder or welding operator shall apply the personal mark adjacent to the welds using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the District that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 foot intervals. Identification by die stamps or electric etchers will not be allowed.

#### 1.5.2.3 Renewal of Qualification

Requalification of a welder or welding operator is required under any of the following conditions:

a. When a welder or welding operator has not used the specific welding process for a period of 3 months; the period may be extended to 6 months if the welder or welding operator has been employed on some other welding process.

b. When a welder or welding operator has not welded with any process during a period of 3 months, all the personal qualifications shall be considered expired, including any extended by virtue of a., above.

c. There is specific reason to question the person's ability to make welds that will meet the requirements of the specifications.

d. The welder or welding operator was qualified by an employer, other than those firms performing work under this contract, and a qualification test has not been taken within the preceding 12 months.

e. Renewal of qualification for a specific welding process under conditions a., b., and d., above, needs to be made on only a single test joint or pipe of any thickness, position, or material to reestablish the welder's or welding operator's qualification for any thickness, position, or material covered under previous qualification.

### 1.5.3 Inspection and NDE Personnel

All inspection and NDE personnel shall be qualified in accordance with the following requirements.

#### 1.5.3.1 Inspector Certification

Welding inspectors shall be qualified in accordance with AWS QC1.

#### 1.5.3.2 NDE Personnel

NDE personnel shall be certified, and a written procedure for the control and administration of NDE personnel training, examination, and certification shall be established. The procedures shall be based on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A.

## 1.6 REGULATORY REQUIREMENTS

This section covers the welding of pressure piping systems. Submit detail drawings showing location, length, and type of welds; and indicating postweld heat treatment and NDE as required. Deviations from applicable codes, approved procedures, and approved detail drawings will not be permitted without prior written approval. Materials or components with welds made offsite will not be accepted if the welding does not conform to the requirements of this specification, unless otherwise specified. Develop procedures for welding all metals included in the work. Welding shall not be started until welding procedures, welders, and welding operators have been qualified. Qualification testing shall be performed by an approved testing laboratory, or by the Contractor if approved by the District. Notify the District at least 24 hours in advance of the time and place of the tests. When practicable, perform the qualification tests at or near the worksite. Maintain current records of the test results obtained in the welding procedure, welding operator, welder performance qualifications, and nondestructive examination (NDE) procedures readily available at the site for examination by the District. The procedures for making transition welds between different materials or between plates or pipes of different wall thicknesses shall be qualified. ASME B31.3 requirements for branch connections may be used in lieu of detailed designs. Unless otherwise specified, the choice of welding process shall be the responsibility of the Contractor. Safety precautions shall conform to AWS Z49.1.

## 1.7 DELIVERY, STORAGE, AND HANDLING

All filler metals, electrodes, fluxes, and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to insure safe handling.

### 1.7.1 Material Control

Materials shall be stored in a controlled access and clean, dry area that is weathertight and is maintained at a temperature recommended by the manufacturer. The materials shall not be in contact with the floor and shall be stored on wooden pallets or cribbing.

#### 1.7.1.1 Damaged Containers

Low-hydrogen steel electrodes shall be stored in their sealed shipping container. If the seal is damaged during shipment or storage, and the damage is not immediately detected, the covered electrodes in that container shall be rebaked in accordance with the manufacturer's instructions prior to issuance or shall be discarded. If a container is damaged in storage and the damage is witnessed, the electrodes from that container shall be immediately placed in a storage oven. The storage oven temperature shall be as recommended by the manufacturer or the welding material specification.

#### 1.7.1.2 Partial Issues

When a container of covered electrodes is opened and only a portion of the content is issued, the remaining portion shall, within 1/2 hour, be placed in a storage oven.

### 1.7.2 Damaged Materials

Materials which are damaged shall be discarded. Covered electrodes which are oil or water-soaked, dirty, or on which the flux has separated from the wire shall be discarded.

# PART 2 PRODUCTS

## 2.1 WELDING MATERIALS

Provide welding materials which comply with ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

# PART 3 EXECUTION

## 3.1 WELDING OPERATIONS

Perform welding in accordance with qualified procedures, which shall include those identified in AWWA C206 for field welding, using qualified welders and welding operators. Submit detailed procedures which define methods of compliance to contract drawings and specifications. Inspection and material procurement records. System and material testing and certification records. Written records and drawings indicating location of welds made by each welder or welding operator.

Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The District will determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural members shall conform to Section 05 05 23.16 STRUCTURAL WELDING.

3.1.1 Base Metal Preparation

Oxy-fuel cutting shall not be used on austenitic stainless steel or nonferrous materials.

3.1.2 Weld Joint Fit-Up

Parts that are to be joined by welding shall be fitted, aligned, and retained in position during the welding operation by the use of bars, jacks, clamps, or other mechanical fixtures. Welded temporary attachments shall not be used except when it is impractical to use mechanical fixtures. When temporary attachments are used, they shall be the same material as the base metal, and shall be completely removed by grinding or thermal cutting after the welding operation is completed. If thermal cutting is used, the attachment shall be cut to not less than 1/4 inch from the member and the balance removed by grinding. After the temporary attachment has been removed, the area shall be visually examined.

3.1.3 Preheat and Interpass Temperatures

Preheat temperatures shall meet the requirements specified by ASME B31.3. However, in no case shall the preheat be below 50 degrees F for ferritic steel or austenitic stainless steel, or 32 degrees F for nonferrous alloys. The maximum interpass temperatures shall not exceed 300 degrees F for austenitic stainless steels, nickel alloys, and copper alloys; and 500 degrees F for carbon steels. Preheat techniques shall be such as to ensure that the full thickness of the weld joint preparation and/or adjacent base material, at least 3 inches in all directions, is at the specified temperature. Preheating by induction or resistance methods is preferred. When flame heating is used, only a neutral flame shall be employed. Oxy-fuel heating shall not be used on austenitic stainless steel or nickel-alloy materials; however, air-fuel heating is acceptable if controlled to insure that the surface temperature does not exceed 150 degrees F. Interpass temperatures shall be checked on the surface of the component within 1 inch of the weld groove and at the starting location of the next weld pass, and for a distance of about 6 inches ahead of the weld, but not on the area to be welded.

3.1.4 Production Welding Instructions

a. Welding shall not be done when the ambient temperature is lower than 0 degree F.

b. Welding is not permitted on surfaces that are wet or covered with ice, when snow or rain is falling on the surfaces to be welded, or during periods of high winds, unless the welders and the work are properly protected.

c. Gases for purging and shielding shall be welding grade and shall have a dew point of minus 40 degrees F or lower.

d. Back purges are required for austenitic stainless steels and nonferrous alloys welded from one side and shall be set up such that the flow of gas from the inlet to the outlet orifice passes across the area to be welded. The oxygen content of the gas exiting from the purge vent shall be less than 2 percent prior to welding.

e. The purge on groove welds shall be maintained for at least three layers or 3/16 inch.

f. Removable purge dam materials shall be made of expandable or flexible plugs, such as plexiglass, plywood (which shall be dry when used), etc. Wood dams shall be kiln-dried quality. Nonremovable purge dams and purge dam adhesives shall be made of water soluble materials. Purge dams shall not be made of polyvinyl alcohol.

g. Any welding process which requires the use of external gas shielding shall not be done in a draft or wind unless the weld area is protected by a shelter. This shelter shall be of material and shape appropriate to reduce wind velocity in the vicinity of the weld to a maximum of 5 mph (440 fpm).

h. Welding of low-alloy and hardenable high-alloy steels may be interrupted provided a minimum of at least 3/8 inch thickness of weld deposit or 25 percent of the weld groove is filled, whichever is greater, and the preheat temperature is maintained during the time that welding is interrupted. If the temperature falls below the minimum preheat temperature before all welding has been completed on a joint, or, where required, before post weld heat treatment, a liquid penetrant or magnetic particle examination shall be performed to insure sound deposited metal before reheating. Welding of other materials may be interrupted without restriction provided a visual inspection is performed before welding is resumed.

i. Tack welds to be incorporated in the final welds shall have their ends tapered by grinding or welding technique. Tack welds that are cracked or defective shall be removed and the groove shall be retacked prior to welding. Temporary tack welds shall be removed, the surface ground smooth, and visually inspected. For low-alloy and hardenable high-alloy steels, the area shall be magnetic particle examination inspected.

j. When joining ferritic steel pressure piping components to austenitic stainless steel pressure piping components and postweld heat treatment is required, the following requirements apply:

(1) The weld-end preps of ferritic steel components, which are to be welded to austenitic stainless steel, shall be buttered with one of the following weld filler metals and shall conform to the specified requirements: ASME BPVC SEC II-C, SFA 5.14, Classification ERNiCr-3; or ASME BPVC SEC II-C, SFA 5.11, Classification ENiCrFe-2.

(2) The ferritic steel weld-end prep shall be buttered, receive a postweld heat treatment as required by ASME B31.3 and then be machined with the applicable weld-end preparation. After machining, the buttered layer shall be a minimum of 1/4 inch thick.

(3) Pressure piping transition joints shall be completed using ERNiCr-3 or ENiCrFe-2 weld filler metals. No further postweld heat treatment shall be performed.

k. When joining ferritic steel pressure piping components to austenitic stainless steel pressure piping components and postweld heat treatment is not required, prepare and weld the joint using either ERNiCr-3 or ENiCrFe-2 filler metals. For service temperatures of 200 degrees F or less, stainless filler metal 309 ASME BPVC SEC II-C, SFA 5.4 or 5.9 is permissible in lieu of the nickel-based alloys.

l. Grinding of completed welds is to be performed only to the extent required for NDE, including any inservice examination, and to provide weld reinforcement within the requirements of ASME B31.3. If the surface of the weld requires grinding, reducing the weld or base material below the minimum required thickness shall be avoided. Minimum weld external reinforcement shall be flush between external surfaces.

### 3.1.5 Postweld Heat Treatment

a. Postweld heat treatment shall be performed in accordance with ASME B31.3. Temperatures for local postweld heat treatment shall be measured continuously by thermocouples in contact with the weldment.

b. Postweld heat treatment of low-alloy steels, when required, shall be performed immediately upon completion of welding and prior to the temperature of the weld falling below the preheat temperature. However, postweld heat treatment may be postponed after the completion of the weld, if, immediately after the weld is completed, it is maintained at a minimum temperature of 300 degrees F or the preheat temperature, whichever is greater, for 2 hours per inch of weld thickness.

c. For low-alloy steels, the cooling rates shall be such that temper embrittlement is avoided.

## 3.2 EXAMINATIONS, INSPECTIONS, AND TESTS

Visual and NDE shall be performed by the Contractor to detect surface and internal discontinuities in completed welds. The services of a qualified commercial inspection or testing laboratory or technical consultant, approved by the District, shall be employed by the Contractor. All tack welds, weld passes, and completed welds shall be visually inspected. In addition, magnetic particle examination shall be performed on root passes. Radiographic, Liquid penetrant, Magnetic particle, or Ultrasonic examination shall be required as indicated in TABLE I. When inspection and testing indicates defects in a weld joint, the weld shall be repaired by a qualified welder in accordance with paragraph CORRECTIONS AND REPAIRS.

### 3.2.1 Random NDE Testing

When random radiographic, liquid penetrant, magnetic particle, or ultrasonic examination is required, test a minimum of 10 percent of the total length or number of piping welds. The welds inspected shall be selected randomly, but the selection shall include an examination of welds made by each welding operator or welder. If the random testing reveals that any welds fail to

meet minimum quality requirements, an additional 10 percent of the welds in that same group shall be inspected. If all of the additional welds inspected meet the quality requirements, the entire group of welds represented shall be accepted and the defective welds shall be repaired. If any of the additional welds inspected also fail to meet the quality requirements, that entire group of welds shall be rejected. The rejected welds shall be removed and rewelded, or the rejected welds shall be 100 percent inspected and all defective weld areas removed and rewelded.

3.2.2 Visual Inspection

Weld joints shall be inspected visually as follows:

3.2.2.1 Before Welding

For compliance with requirements for joint preparation, placement of backing rings or consumable inserts, alignment and fit-up, and cleanliness.

3.2.2.2 During Welding

For cracks and conformance to the qualified welding procedure.

3.2.2.3 After Welding

For cracks, contour and finish, bead reinforcement, undercutting, overlap, and size of fillet welds.

3.2.3 NDE Testing

NDE shall be in accordance with written procedures. Procedures for radiographic, liquid penetrant, magnetic particle or ultrasonic tests and methods shall conform to ASME BPVC SEC V. The approved procedure shall be demonstrated to the satisfaction of the District. In addition to the information required in ASME BPVC SEC V, the written procedures shall include the timing of the NDE in relation to the welding operations and safety precautions.

3.2.4 Inspection and Tests by the District

The District will perform inspection and supplemental nondestructive or destructive tests as deemed necessary. The cost of supplemental NDE will be borne by the District. The correction and repair of defects and the reexamination of weld repairs shall be performed by the Contractor at no additional cost to the District. Inspection and tests will be performed as required for visual inspection and NDE, except that destructive tests may be required also. When destructive tests are ordered by the District and performed by the Contractor, and the specimens or other supplemental examinations indicate that the materials and workmanship do not conform to the contract requirements, the cost of the tests, corrections, and repairs shall be borne by the Contractor. When the specimens or other supplemental examinations of destructive tests indicate that materials or workmanship do conform to the specification requirements, the cost of the tests and repairs will be borne by the District. When destructive tests are made, repairs shall be made by qualified welders or welding operators using welding procedures which will develop the full strength of the members cut. Welding shall be subject to inspection and tests in the mill, shop, and field. When materials or workmanship do not conform to the specification requirements,

the work may be rejected at any time before final acceptance of the system containing the weldment.

## 3.3 ACCEPTANCE STANDARDS

### 3.3.1 Visual

The following indications are unacceptable:

a. Cracks.

b. Undercut on surface which is greater than 1/32 inch deep.

c. Weld reinforcement greater than 3/16 inch.

d. Lack of fusion on surface.

e. Incomplete penetration (applies only when inside surface is readily accessible).

f. Convexity of fillet weld surface greater than 10 percent of longest leg plus 0.03 inch.

g. Concavity in groove welds.

h. Concavity in fillet welds greater than 1/16 inch.

i. Fillet weld size less than indicated or greater than 1.25 times the minimum indicated fillet leg length.

### 3.3.2 Magnetic Particle Examination

The following relevant indications are unacceptable:

a. Any cracks and linear indications.

b. Rounded indications with dimensions greater than 3/16 inch.

c. Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 6 square inches of surface with the major dimension of this area not to exceed 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

### 3.3.3 Liquid Penetrant Examination

Indications with major dimensions greater than 1/16 of an inch shall be considered relevant. The following relevant indications are unacceptable:

a. Any cracks or linear indications.

b. Rounded indications with dimensions greater than 3/16 inch.

c. Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 6 square inches of surface with the major dimension of this area not to exceed 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

3.3.4 Radiography

Welds that are shown by radiography to have any of the following discontinuities are unacceptable:

a. Porosity in excess of that shown as acceptable in ASME BPVC SEC I, Appendix A-250.

b. Any type of crack or zone of incomplete fusion or penetration.

c. Any other elongated indication which has a length greater than:

(1) 1/4 inch for "t" up to 3/4 inch inclusive. Where "t", here and below, pertains to the thickness of the weld being examined; if a weld joins two members having different thickness at the weld, "t" is the thinner of these two thicknesses.

(2) 1/3 "t" for "t" from 3/4 inch to 2-1/4 inch, inclusive.

(3) 3/4 inch for "t" over 2-1/4 inch.

d. Any group of indications in line that have an aggregate length greater than "t" in a length of "12t", except where the distance between the successive indications exceeds 6L where L is the longest indication in the group.

3.3.5 Ultrasonic Examination

Where discontinuities are interpreted to be cracks, lack of fusion, and incomplete penetration, they are unacceptable regardless of length. Linear-type discontinuities are unacceptable if the amplitude exceeds the reference level and discontinuities have lengths which exceed the following:

a. 1/4 inch for "t" up to 3/4 inch. Where "t", here and below, is the thickness of the weld being examined; if the weld joins two members having different thicknesses at the weld, "t" is the thinner of these two thicknesses.

b. 1/3 inch for "t" from 3/4 to 2-1/4 inch.

c. 3/4 inch for "t" over 2-1/4 inch.

3.4 CORRECTIONS AND REPAIRS

Defects shall be removed and repaired as specified in ASME B31.3 unless otherwise specified. Disqualifying defects discovered between weld passes shall be repaired before additional weld material is deposited. Wherever a defect is removed, and repair by welding is not required, the affected area shall be blended into the surrounding surface eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, the area shall be examined by the same test method which first

revealed the defect to ensure that the defect has been eliminated. After rewelding, the repaired area shall be reexamined by the same test method originally used for that area. Any indication of a defect shall be regarded as a defect unless reevaluation by NDE or by surface conditioning shows that no disqualifying defects are present. The use of any foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

-- End of Section --

# SECTION 40 05 22

# DISCHARGE PIPE

## PART 1 GENERAL

### 1.1 SCOPE

Summary of Work: The Contractor shall furnish all labor, materials, and equipment to provide and install large diameter steel water pipe, fittings, couplings, and appurtenances for discharge of water from the water supply pump station S-476 and the reservoir pump station S-470.

### 1.2 REFERENCES

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C200 | (2012) Steel Water Pipe - 6 In. (150 mm) and Larger |
| AWWA C206 | (2017) Field Welding of Steel Water Pipe |
| AWWA C207 | (2013) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in. |
| AWWA C208 | (2012) Standard for Dimensions for Fabricated Steel Water Pipe Fittings |
| AWWA C504 | (2015) Standard for Rubber-Seated Butterfly Valves |
| AWWA M11 | (2004; 4th Ed; Errata 2013) Manual: Steel Water Pipe: A Guide for Design and Installation |
| AWWA C604 | (2011) Installation of Buried Steel Water Pipe—4 In. (100 mm) and Larger |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ANSI/ASME B16.1 | Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800 |
| ANSI/ASME B16.21 | Nonmetallic Flat Gaskets for Pipe Flanges |
| ANSI/ASME B16.5 | Steel Pipe Flanges and Flanged Fittings |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A36 | Standard Specification for Carbon Structural Steel |

| | |
|---|---|
| ASTM A126 | (2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM A139 | Standard Specification for Electric Fusion Welded Steel Pipe (NPS 4 and Over) |
| ASTM A240 | Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| ASTM A276 | (2016) Standard Specification for Stainless Steel Bars and Shapes |
| ASTM A283 | Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates |
| ASTM A536 | (1984; R 2014) Standard Specification for Ductile Iron Castings |
| ASTM A564 | (2013) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes |
| ASTM A572 | Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| ASTM A582 | Standard Specification for Free-Machining Stainless Steel Bars |
| ASTM A1011 | Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| ASTM D429 | (2014) Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates |
| ASTM F593 | (2013a; E 2016) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F1476 | Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications |

## 1.3 SUBMITTALS

Submit as specified in Section 01 33 00 SUBMITTALS.

Compliance Submittals as per paragraph entitled, "Submittal Requirements." Submit the following for acceptance prior to fabrication:

SD-03 Product Data

Technical Data

SD-07 Certificates

Certificates and Affidavits

1.4 SUBMITTAL REQUIREMENTS

The following technical data of the discharge pipe shall be submitted acceptance to the District for approval prior to fabrication:

1. Pipe and joint details

2. Special, fitting and coupling details

3. Laying and installation schedule

4. Specifications, data sheets and materials

5. Design calculations (prepared and signed and sealed by a Professional Engineer licensed in the State of Florida)

6. Wall thimble details and materials

7. Coupling details, materials, installation instructions

1.4.1 Certificates and Affidavits

Furnish the following prior to shipment:

1. Affidavit of compliance with applicable standards

2. Test certificates

1.5 MANUFACTURER'S QUALIFICATIONS

The Manufacturer shall have a minimum of five (5) years experience in the design and manufacture of pipe, fittings, or appurtenances of the type and size specified herein.

1.6 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 GENERAL PIPE REQUIREMENTS

Furnish pipe of materials, joint types and sizes as indicated on the Drawings, the Piping and Butterfly Valve Application Schedule of Section 40 05 13, or as specified, and air release valves as specified.

Pipe shall be designed to withstand all stresses resulting from external loads and internal pressures. The pipe shall be fabricated to accommodate thrust rods or other means of constraint as specified.

Flanged wall thimbles shall be provided for all penetrations through structure walls. Flanged connections shall be provided for the discharge pipe.

Pipe Marking: All pipe and fittings shall be marked conforming to the applicable standard specification under which the pipe is manufactured and as otherwise specified.

## 2.2 STEEL PIPE

Materials: The pipe shall be fabricated from one of the following materials:

1. Sheet or coil conforming to the requirements of ASTM A1011, Grades 30, 33, 36, or 40

2. Plate in coil form conforming to the requirements of ASTM A36, ASTM A283, Grades C or D, or ASTM A572, Grade 42

3. Coil conforming to the requirements of ASTM A139, Grades A or B.

Design of Pipe: Design shall conform to AWWA C200, AWWA M11, and as specified except that hydrostatic test of fittings after fabrication will not be required. Deflection of underground pipe inside diameter shall be maximum 2% under trench load of F-20 live load in accordance with AASHTO specifications. Working stress of steel shall be maximum 50% of yield stress.

1. Wall thickness shall be designed and as tabulated hereafter:

| **Nominal Pipe Diameter (in.)** | **Minimum Thickness (in)** |
|---|---|
| <48 in. | 1/2 in. (S-479 Pipes<br>3/8 in. (All Others) |
| 48 in. to <60 in. | 1/2 in. |
| 60 in. to <84 in. | 5/8 in. |

## 2.3 PUMP DISCHARGE CONTROL VALVES

### 2.3.1 Design Requirements

1. General purpose AWWA butterfly valves:

   a. Design standard: Provide valves designed and manufactured in accordance with AWWA C504.

   b. Class:

      1) Provide butterfly valves in accordance with AWWA Class 150B, unless otherwise specified.

2.3.2 Performance requirements

1. Tight shutoff at the pressure rating of the valve with pressure applied in either direction.

2. Suitable for the following service conditions:

   a. Throttling.

   b. Frequent operation.

   c. Operation after long periods of inactivity.

   d. Installation in any position and flow in either direction.

Manufacturers: One of the following or equal:

1. DeZurik/Sartell Model BAW.

2. Henry Pratt Company.

2.3.3 Valve Body

1. Material: Cast iron, ASTM A126 , Grade B, or ductile iron, ASTM A536, Grade 65-45-12.

2. Body design:

   a. Flanged body valves:

      1) Usage: Comply with limitations specified in the Butterfly Valve Application Schedule.

      2) Flanges: In accordance with ANSI/ASME B16.1 Class 125 flanges for Class 150B valves, in accordance with ANSI/ASME B16.1 Class 250 flanges for Class 250B valves.

2.3.4 Disc

1. Material: Cast iron or ductile iron with Type 316 stainless steel edge that matches seat in valve body.

2. Secure valve disc to shaft by means of smooth-sided, taper or dowel pins, Type 316 stainless steel, or Monel.

3. Extend pins through shaft and mechanically secure in place.

2.3.5 Shaft and bearings

1. Shaft design:

   a. Valves greater than 36-inch size: 2 piece, stub shaft design.

2. Shaft seal: Vee type, chevron design.

3. Shaft material for Class 150B valves: Type 316 stainless steel, ASTM A276.

4. Shaft material for Class 250B valves: Type 17-4 pH stainless steel, ASTM A564.

5. Shaft bearings: Self-lubricating sleeve type:

   a. Valves greater than 36-inch size: Teflon with stainless steel or fiberglass backing.

2.3.6 Seats

1. Seat materials:

   a. In low-pressure air applications: EPDM.

2. For valves greater than 36 inches in nominal size, retain seats mechanically or by adhesive:

   a. Mechanical retainage: Retain seat by a clamping ring with segmented clamping ring locks with adjusting locking screws.

      1) Clamping ring, ring locks, and adjusting locking screws: Type 316 stainless steel.

      2) Provide means to prevent ring locks and screws used to retain seats from loosening due to vibration or cavitation.

   b. Adhesive retainage: Inset the seat within a groove in the valve body and retain in place with epoxy injected behind the seat so that the seat expands into the body.

   c. Do not provide valves with seats retained by snap rings or spring-loaded retainer rings.

3. Resilient seat: Withstand 75 pound per inch pull when tested in accordance with ASTM D429, Method B.

2.3.7 Valve packing

1. Valves greater than 36 inch nominal size: Adjustable V-type packing with bronze packing gland or self-adjusting V-type packing. NBR or EPDM to match seat material.

2.3.8 Coating

1. Shop coat interior and exterior metal surfaces of valves, except as follows:

   a. Interior machined surfaces.

   b. Surfaces of gaskets and elastomeric seats and stem seals.

   c. Bearing surfaces.

   d. Stainless steel surfaces and components.

2. Interior surfaces: See Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING for lining requirements.

3. Exterior surfaces: See Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING for coating requirements.

2.3.9 Electric Operators

2.3.9.1 General

a. All valves shall be equipped with operators. The valve operator types, as specified herein, describe only the general characteristics of the operator. The operator shall be compatible with the valve that it will be used with and shall be of the same Manufacturer, or a product that is recommended by the valve Manufacturer. All valve operators shall open by turning counterclockwise.

2.3.9.2 Type El Actuators

a. The actuators shall be furnished and sized by the valve supplier and shall be factory mounted. The actuators shall be the electric motor gear train type capable of producing not less than 1-1/2 times the required operating torque. Actuator motors shall be the reversible type suitable for three-phase, 208-volt AC power supply and shall have built-in overload protection. Actuators shall include integral terminal strips, and enclosures shall be NEMA 4. Actuators gear train and shaft shall be heat-treated high alloy steel or die-cast hard-anodized aluminum. Gear train shall be permanently lubricated at the factory. Actuators shall be suitable for full 90-degree rotation of the valve and shall be provided with position gauge and manual override. Actuators shall operate the valve from FULLY OPEN to FULLY CLOSED positions, or the reverse in approximately 5 seconds.

2.3.9.3 Accessories

Tagging: Each valve operator shall be provided with a 1-1/2 inch minimum diameter heavy brass or stainless steel tag. Each tag shall bear the valve number shown on the drawings. The tags shall be attached to the operators with key rings so that ring and tag cannot be removed. The numbers and letters shall be of block type, with 1/4-inch high numbers and letters stamped thereon.

2.3.10 Floor Boxes

1. Manufacturers: One of the following or equal:

    a. Waterman industries, Inc.

2. Floor boxes: Cast-iron; with:

    a. Counter type indicator.

    b. Hinged, lockable lid with directional arrow.

    c. 2-inch square AWWA operating nut.

    d. Packing gland providing drip-tight seal around valve shaft.

2.3.11 Accessory Equipment

1. Stems: Stainless steel; sized to match output of actuator; minimum gate or valve operating stem diameter; maximum 200 slenderness ratio.

2. Stem couplings: Stainless steel; internally threaded to match stem; lockable to stem by set screw.

3. Stem guides: Cast-iron with silicon bronze bushing; maximum 200 slenderness ratio; capable of being mounted with wall bracket; adjustable in 2 directions.

4. Wall brackets: Cast-iron, capable of withstanding output of actuator, adjustable in 2 directions.

5. Fasteners: Type 316 stainless steel.

6. Anchor bolts: Type 316 stainless steel.

7. Geared valve actuators: Provided with cut gears, either spur or worm; sized to operate valves at most adverse design condition; with maximum 40-pound pull at handwheel or chain wheel rim.

2.3.12 Joints

1. Flanged:

   a. Provide flanged joints for locations indicated or required by the pump Manufacturer.

   b. Joints shall conform to AWWA C200 and AWWA C207.

   c. Flanges shall have a pressure rating not less than that required for pipe. Flanges shall be pressure rated AWWA C207 Class B and be drilled ANSI/ASME B16.1 Class 25.

2. Lap Welded Slip Joint:

   a. Provide lap welded slip joints for all exterior and interior locations unless otherwise specified or indicated on the Drawings. For those locations, such as overhead crossings, the pipe joints shall be designed and installed to withstand all stresses resulting from external loads and internal pressures. The use of flanged joints for this reach shall be used if the pipe Manufacturer deems necessary.

   b. Joints shall conform to AWWA C200.

   c. Field welding shall conform to AWWA C206.

2.3.13 Fittings and Specials

1. Fabricate from tested pipe to conform to AWWA C208 except where otherwise indicated or specified.

2. Reinforce tees, laterals, and outlets conforming to applicable provisions of AWWA M11.

3. Include all adapters, outlets, taps, plugs, and other specials as required to complete installation as specified or indicated.

4. Provide openings for air vent connections with threaded bosses or flanged outlets sized and located where indicated.

5. Fittings shall be tested by dye penetrant method.

2.3.14 Protective Coating

1. Shop Painting:

   a. Manufacturer shall prepare surfaces, prime and finish paint all iron and steel surfaces suitable for service intended as per Section 09 06 90 PROTECTIVE COATINGS.

   b. Stainless steel surfaces shall not be painted.

2. Field Painting:

   a. Contractor shall touch-up coatings damaged during shipment or installation.

   b. Manufacturer shall furnish Contractor with an adequate quantity of touch-up paint.

   c. Coordinate painting with pump and flap valve Manufacturers to insure consistency.

2.4 AIR RELEASE VALVES

1. Manufacturers: One of the following or equal:

   a. APCO 200A, series manufactured by DeZurik, Sartell, Minnesota.

   b. Series 38, 38HP, 45, 45HP, 50, or 50HP manufactured by Val-Matic, Elmhurst, Illinois.

2. Design:

   a. Pressure rating: 150 pounds per square inch gauge.

   b. Inlet: Screwed, 2-inch NPT.

   c. Orifice size: less than 5/8-inch diameter.

3. Materials:

   a. Valve body: Cast iron, ASTM A126 , Grade B, or ductile iron, ASTM A536 , Grade 65-45-12.

   b. Seat, float arm, and trim ASTM A582 , Type 316 stainless steel.

   c. Lever frame, float, link, washer, and lock washer: ASTM A240 , Type 316 stainless steel.

## 2.5 HARNESSED COUPLING

Provide a flexible mechanical coupling or split-sleeve type coupling that either conforms to ASTM F1476, Type II, Class 3, stainless steel (as manufactured by Teekay or Straub Couplings), ASTM F1476, Type 1 (as manufactured by Victaulic), or Dresser Couplings style 38 or approved equal, to connect the pump discharge elbow to the transition section. Install a minimum of four harness bolts (sized by the pump manufacturer) at each coupling.

## 2.6 WALL THIMBLE

A wall thimble shall be provided for embedment in the ~~intake~~the S-476 discharge structure ~~back~~ wall and connection to the discharge piping as shown on the Drawings. ~~The thimble shall have a seal ring centered in wall when embedded and shall have flanged ends to mate to the discharge piping. In addition, furnish a flanged vent nozzle with an ANSI/ASME B16.5 standard 125 pound flange as shown on the Drawings. The Manufacturer shall size the vent to provide the necessary air release on pump start up.~~

## 2.7 GASKETS AND BOLTING MATERIALS

Provide all gaskets, bolts, lubricant, and other accessories required to install pipe, fittings and specials complete and ready for service.

Gaskets for flanged joints shall conform to ANSI/ASME B16.21, 1/8-inch-thick full-face synthetic rubber. Provide full-face gaskets for all pump and equipment connections.

Bolts for flanged joints shall conform to ASTM F593 Type 316 stainless steel. Nut and bolt heads shall be hexagonal.

# PART 3 EXECUTION

## 3.1 INSTALLATION OF PIPE MATERIALS

Trenching and Backfilling: As specified in Section 31 00 00 EARTHWORK.

Pipe Installation:

1. Pipe larger than 24" shall be joined in the trench and/or pipe cradle. Pipe less than 24" can be joined prior to placement in the trench provided proper care is taken during placement to ensure the soundness of the joined sections.

2. All pipe joints shall be lap welded slip joints unless indicated otherwise.

3. Flanged joints where specified shall be made with gaskets and bolting materials and shall be made according to Manufacturer's recommendations and the requirements of AWWA M11. All bolts shall be tightened using procedures and recommended torque rates described in AWWA C604.

Couplings: Install according to Manufacturer's recommendations.

## 3.2 INSTALLATION OF VALVES

### 3.2.1 General

a. Boltholes of flanged valves shall straddle the vertical centerline of the pipe run. Prior to installing flanged valves, the flange faces shall be thoroughly cleaned. After cleaning, insert gasket and bolts, and tighten the nuts progressively and uniformly. If flanges leak under pressure, loosen or remove the nuts and bolts, and retest the joints. Joints shall be watertight at pressures before acceptance.

b. Thoroughly clean threads of screwed joints by wire brushing, swabbing, or other approved methods. Apply approved joint compound to threads prior to making joints. Joints shall be watertight at test pressures before acceptance.

### 3.2.2 Placing

a. Generally, unless otherwise indicated on the drawings, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above grade shall be installed with their operating stems vertical. valves installed in horizontal runs of pipe having centerline elevations between 4 feet-6 inches and 6 feet-9 inches above grade shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems oriented to facilitate the most practicable operation.

b. Isolation valves: a line size ball valve and union shall be installed upstream of each in-line electrical device for isolation during maintenance.

### 3.2.3 Testing

a. Valves shall be tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test. Repair joints that show signs of leakage prior to final acceptance. If there are any special parts of control systems or operators that might be damaged by the pipeline test, they shall be properly protected. The Contractor will be held responsible for any damage caused by the testing.

b. If requested by the District, the valve Manufacturer shall furnish an affidavit stating the materials options furnished and/or that he has complied with these and other referenced specifications.

-- End of Section --

# SECTION 40 05 57.23

# ELECTRIC ACTUATORS

## PART 1 GENERAL

### 1.1 SUMMARY

A. This Section specifies the requirements for motorized operators for SECTION 35 20 16.54 SLIDE GATES and SECTION 35 20 16.53 ROLLER GATES, as specified in the Contract Drawings.

### 1.2 REFERENCES

Applicable Standards:

1. American National Standards Institute (ANSI):

    a. ANSI BI.1-Unified Screw Threads (UN and UNR Thread Form).

    b. ANSI B36.10-Welded and Seamless Wrought Steel Pipe.

2. American Water Works Association (AWWA):

    a. AWWA C513-05 Open-Channel, .Fabricated-Metal Slide Gates

    b. AWWA C560-00 Cast Iron Slide Gates

    c. AWWA C561-04 Fabricated Stainless Steel Slide Gates

    d. AWWA C540 - Power-Actuating Devices for Valves and Sluice Gates.

3. America Society for Testing and Materials (ASTM):

    a. ASTM A126 Class B - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

    b. ASTM A67 - Stainless and Heat-Resisting Chromium-Nickel-Steel Plate, Sheet and Strip.

    c. ASTM A176 Class B - Stainless and Heat-Resisting Steel Bars and Shapes.

    d. ASTM A582 - Specification for Free-Machining Stainless and Heat-Resisting Steel Bars.

    e. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

    f. ASTM B211 - Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

    g. ASTM F593 Alloy 304, S.S. Fasteners.

    h. ASTM B584 Bronze Seat Facings.

4. National Electric manufacturers Association (NEMA):

   a. NEMA MG 1-10.40 Nameplate Marking for Medium Single-Phase and Polyphase Induction Motors.

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed layout

Stem replacement detail

Control schematic and wiring drawings

SD-03 Product Data

Catalog data or illustrations

Torque output catalog data

Spare parts list

Protective coating system

SD-05 Design Data

Actuator Motor

SD-07 Certification

Actuator Certification

SD-08 Manufacturer's Instructions

Assembly and disassembly or repair instructions

Testing procedures

Manufacturer's recommendations

SD-11 Closeout Submittals

Equipment Tests

1.4 SUBMITTALS REQUIREMENTS

Include, but not limited to, the following:

1. Principal Parts and Materials: Provide catalog data or illustrations showing principal parts and materials.

2. Torque output catalog data or torque output calculations, demonstrating torque output of the actuator in comparison to the torque required to

operate the gate. The torque required shall be calculated by the gate Manufacturer, considering the stem and nut details and transmission efficiency, subject to approval by the District.

3. Actuator Motor: Calculations for the motor horsepower and complete information on actuator motor.

4. Actuator Certification that all parts of the actuator are designed to withstand the required torque loads with a minimum factor of safety of five (5).

5. Spare parts list.

6. Assembly and disassembly or repair instructions.

7. Detailed layout dimensions, including support frame and details of connection to the stem and nut assembly.

8. Protective coating system.

9. Testing procedures.

10. Control schematic and wiring drawings.

11. Stem replacement detail of connection to the gate if existing stem needs replacement and new stem is supplied by the actuator supplier.

12. Manufacturer's recommendations sizing for feeder breaker, starter, overload relay, local disconnect switch, and power cables for actuator motor provided.

## 1.5 QUALITY REQUIREMENTS

Manufacturers shall be experienced in the design and manufacture of actuators and accessories for a minimum period of ten (10) years.

## 1.6 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS

# PART 2 PRODUCTS

## 2.1 ACCEPTABLE GATE OPERATOR MANUFACTURERS

1. Limitorque

2. Auma

3. EIM

4. District approved equal.

## 2.2 BASIC ACTUATOR

A. The electric gate actuator shall include the motor, actuator unit gearing, limit switch gearing, position limit switches, torque

switches, declutch lever, and handwheel as a self-contained unit and shall connect to the gate via a threaded stem and stem nut.

B. The actuator shall open and close the gate at a nominal speed of six (6) inches per minute.

2.3 ENCLOSURE

A. The gate actuator motor shall be totally enclosed. The actuator enclosure shall be NEMA 4 (watertight) for outdoor service. (Cast Iron or Cast Steel)

B. Enclosure shall be factory painted with protective coating System S-3 as specified in Section 09 06 90 PROTECTIVE COATING

C. Electrical Controls: The actuator shall be furnished with power and control terminal strips, limit switches, torque switches, all housed in a control compartment meeting NEMA 4 (watertight). The enclosure shall have a bonded o-ring seal and a hinged cover. Cover bolting shall be captive stainless steel fasteners.

1. The use of printed circuit boards as a substitute for interconnecting control wiring inside the operator is not acceptable.

2.4 OPEN-CLOSE SERVICE CONTROLS

The reversing contactor, pushbuttons, indicating lights, etc. shall be located within the control panel in the control building with separate push button controls located adjacent to the actuator. The CONTRACTOR shall coordinate the interconnecting control wiring between the operator furnished, the control panel in the control building and push button controls located adjacent to the actuator whether furnished by the actuator supplier, electrical Contractor or general Contractor.

2.5 MOTOR

A. Motor shall be of sufficient rating to open or close the gate at the maximum design head conditions and through a complete gate duty cycle without exceeding its design parameters. Gate duty cycle is defined as the time required moving the gate from a full closed position to a full open position and back to a full closed position at nominal speed of six (6) inches per minute.

1. For gate duty cycle of 30 minutes or less, motor shall be totally enclosed non-ventilated (TENV) with minimum NEMA Class F insulation or totally enclosed fan cooled (TEFC) with minimum NEMA Class F insulation.
2. For gate duty cycle greater than 30 minutes, motor shall be totally enclosed fan cooled (TEFC) with minimum NEMA Class F insulation.

B. The motor shall be an independent sub-assembly such that the power gearing shall not be an integral part of the motor assembly, to allow for motor or gear changes dictated by system operation requirements. The motor shall be equipped with internal thermal class B contacts and 120 volt AC heaters.

C. The Contract Drawings shall determine the electric service for the gate motor. Three phase motor shall be rated for 208 VAC use. The motor shall be capable of operating at plus or minus ten (10) percent of specified voltage. Motor bearings shall be of the anti-friction type and permanently lubricated. Motor frame shall be NEMA C-face mounting.

D. The Contractor shall furnish feeder breaker, starter, overload relay, local disconnect switch, and power cables properly sized for the gate motor provided. The Contractor shall coordinate the selection of these items with the motor Manufacturer and shall submit recommendations to the District for review.

## 2.6 POWER GEARING

The actuator shall be a multiple reduction unit with power gearing consisting of spur, helical, or bevel gears, and worm gearing. The spur, helical, or bevel gearing and worm shall be of hardened alloy steel, and the worm gear shall be alloy bronze. All gearing shall be accurately cut. Non-metallic, aluminum or cast gearing shall not be allowed. Anti-friction bearings shall be used throughout.

## 2.7 LUBRICATION

All rotating power train components shall be immersed in grease with provisions for inspection and re-lubrication without disassembly. Lubricants shall be suitable for ambient conditions of minus 20 degrees Fahrenheit to 150 degrees Fahrenheit. Adequate seals shall be provided on all shafting.

## 2.8 SELF-LOCKING FEATURE

Actuator gearing and/or stem threading shall be self-locking.

## 2.9 LOST MOTION DEVICE

The actuator shall have a built in device, incorporated in the power train and located between the worm gear and actuator drive sleeve, to permit load impact under dynamic efficiency conditions, to allow the motor to reach full speed before engaging the gate load.

## 2.10 MANUAL OPERATION

A metallic hand wheel shall be provided for manual operation with an arrow to indicate open rotation. The hand wheel shall not rotate during motor operation. An inoperative motor shall not prevent manual operation. When in the manual operating mode, the actuator will remain in this mode until the motor is energized, at which time the actuator will automatically return to electric operation. Movement from motor operation to hand wheel operation shall be accomplished by a positive padlockable declutch lever which mechanically disengages the motor and related gearing. It shall be impossible for simultaneous manual and motor operation to occur. Friction type declutch mechanism are not acceptable.

## 2.11 STEM NUT

The gate actuator shall have a removable stem nut or drive bushing of high tensile bronze or other material compatible with the valve stem material. The stem shall be machine cut ACME type.

## 2.12 POSITION LIMIT SWITCHES

Position limit switches and the associated gearing shall be integral part of the valve actuator. Limit switch gearing shall be of the intermittent type, made of bronze or stainless steel, grease lubricated, and totally enclosed to prevent dirt and foreign matter from entering the gear train. Switches shall be adjustable, allowing for trip points from fully open to fully closed positions of gate travel. They shall not be subject to breakage or slippage due to over-travel. Limit switch contacts shall be heavy duty, silver-plated with wiping action. The actuators shall have 2 NC and 2 NO switches for each end of travel position. Switch design shall permit visual verification of switch position without disassembly.

## 2.13 TORQUE SWITCH

Each gate actuator shall be equipped with a switch that will interrupt the control circuit in both the opening and closing directions when gate torque overload occurs or when gates require torque seating in the closed or open position. Two silver plated contacts shall be provided for each direction. One contact used for gate control and the other contact used for remote indication. The torque switch shall have graduated dials for both open and close directions of travel and each shall be independently adjustable, with a positive means to limit the adjustability so as not to exceed the actuator output torque capability. Switch design shall permit visible verification of switch position without disassembly.

## 2.14 SWITCH CONTACT RATINGS

The position limit switch and torque switch shall be rated 240 volts, five (5) amps continuous per NEMA standard ICS 2-125.

## 2.15 STEM LUBRICATION

Furnish automated stem oiler, Essex Brass model #377 with reservoir to lubricate the gate stem when motor is running in either the open or the close direction. The stem lubricator and/or drive nut shall be designed such that lubricating oil is distributed along the full length of the drive nut, ensuring that all threads from top to bottom, and regardless of the direction of stem travel, are lubricated. The lubricating system shall be capable of using 220 weight petroleum based lubricants.

## 2.16 POSITION INDICATOR

Local position indication shall be provided by a dial window indicator located on the limit switch compartment cover, and labeled in 10 percent increments from 0 to 100 percent open.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. Comply with provisions of AWWA C560, C540 and as specified.

B. Provide Manufacturer's field services as specified in DIVISION 01.

C. Perform equipment tests during and after start-up to determine if equipment is performing as specified.

1. A Manufacturer's certified field service technician shall perform the start up of the gate operator. The technician shall accurately set the actuator's limit switches. The lower limit shall be set to interrupt the control circuit when the slide firmly makes contact with the bottom seal but before the torque switch opens. The upper limit shall be set to interrupt the control circuit when the bottom of the gate clears the top seal. The technician shall set the torque switch values to levels recommended by the gate Manufacturer.

D. Lubricate all bearings and gears before placing gates in operation.

-- End of Section --

# SECTION 40 17 30.00 40

# WELDING GENERAL 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.

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B31.1 | (2016; Errata 2016) Power Piping |
| ASME B31.3 | (2014) Process Piping |
| ASME B31.5 | (2016) Refrigeration Piping and Heat Transfer Components |
| ASME BPVC SEC IX | (2010) BPVC Section IX-Welding and Brazing Qualifications |
| ASME BPVC SEC V | (2010) BPVC Section V-Nondestructive Examination |
| ASME BPVC SEC VIII D1 | (2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |

PIPE FABRICATION INSTITUTE (PFI)

| | |
|---|---|
| PFI ES 1 | (2010) Internal Machining and Solid Machined Backing Rings for Circumferential Butt Welds |
| PFI ES 21 | (2010) Internal Machining and Fit-up of GTAW Root Pass Circumferential Butt Welds |
| PFI ES 3 | (2009) Fabricating Tolerances |
| PFI ES 31 | (1992; R 2004) Standard for Protection of Ends of Fabricated Piping Assemblies |
| PFI ES 35 | (1998; R 2003) Nonsymmetrical Bevels and Joint Configurations for Butt Welds |
| PFI ES 7 | (2013) Minimum Length and Spacing for Welded Nozzles |
| PFI TB1 | (2013) Pressure - Temperature Ratings of Seamless Pipe Used in Power Plant Piping Systems |

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 |

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Welding Equipment

Welding Rods and Accessories

SD-04 Samples

Welder's Pre-Qualification Samples

SD-06 Test Reports

Radiographs

SD-07 Certificates

Certified Welding Procedure Specifications (WPS)

Certified Brazing Procedure Specifications (BPS)

Certified Procedure Qualification Records (PQR)

Certified Welder Performance Qualifications (WPQ)

Certified Brazer Performance Qualifications (BPQ)

Certificates of Conformance

1.3 QUALITY REQUIREMENTS

Within sixty calendar days after receipt of Notice to Proceed, submit for approval to the District Certified Welding Procedure Specifications (WPS), Certified Brazing Procedure Specifications (BPS) and Certified Procedure Qualification Records (PQR).

Fifteen calendar days prior to any employee welding on project material, submit for approval to the District two copies of each Certified Welder Performance Qualifications (WPQ) and Certified Brazer Performance Qualifications (BPQ).

For safety, conform all work performed to 29 CFR 1910 and 29 CFR 1926.

1.3.1 Personnel Qualifications

No pre-qualified welding procedures are allowed. Provide qualification of welding procedures and welders by tests prescribed in accordance with ASME BPVC SEC IX, not withstanding the fact the code or specification may allow pre-qualified procedures.

Submit welder's pre-qualification samples prepared by qualified welding operators performing work on contract prior to start. Only after acceptance of samples, are qualified welding operators permitted to begin work.

1.3.2 Pressure Vessels Qualification

Ensure qualification documents WPS, BPS, PQR, WPQ and BPQ are in accordance with ASME BPVC SEC IX.

1.3.3 Piping Qualifications

1.3.3.1 High Pressure Piping

Ensure qualification documents for 125 psig or above, (WPS, BPS, PQR, WPQ and BPQ) are in accordance with ASME BPVC SEC IX.

1.3.3.2 Low Pressure Piping

Perform all plumbing work by a state licensed plumber registered in the state where the work is being performed.

Submit certificates of conformance for the following:

a. Refrigeration Piping: Qualification documents for below 125 psig, WPS, BPS, PQR, WPQ and BPQ for "Refrigeration Piping" in accordance with ASME B31.5.

b. Other Low Pressure Piping: Qualification documents, WPS, BPS, PQR, WPQ and BPQ in accordance with ASME BPVC SEC IX.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Welding Equipment

Submit manufacturer's catalog data for welding equipment and welding rods and accessories. Ensure all equipment meets referenced standards contained in this section.

PART 3 EXECUTION

3.1 ERECTION

3.1.1 Pressure Vessels

3.1.1.1 New Construction

Ensure the fabrication, welding, brazing and inspection meet the requirements of ASME BPVC SEC VIII D1.

3.1.2 Piping

3.1.2.1 High Pressure (125 Psig or Above)

High Pressure Piping: Fabricate, assemble, and weld, braze other high pressure piping systems in accordance with ASME B31.3, and Power Piping Codes, PFI ES 1, PFI ES 3, PFI ES 7, PFI ES 21, PFI ES 31, PFI ES 35, and PFI TB1, of the Piping Fabrication Institute's companion code requirements.

3.1.2.2 Low Pressure (Below 125 Psig)

Low Pressure Piping: Fabricate, assemble, and weld, braze other low pressure piping systems in accordance with the ASME B31.1.

3.1.3 Heat Input Requirements

3.1.3.1 Preheat

Do not weld at ambient temperature below 32 degrees F, or when the surfaces are wet or exposed to rain, snow, or high wind. Ensure the temperature of the metals in the area where the welding is performed is not less than 50 degrees F. When the ambient conditions are such that the normal temperature of the base metal is below 50 degrees F, preheat the area surrounding the joint to provide a base metal temperature of 100 degrees F for a distance of at least 3-inches in all directions from the joint to be welded. Preheat in accordance with ASME BPVC SEC VIII D1 and ASME BPVC SEC V.

3.1.3.2 Interpass

In a multipass weld, the interpass temperature is the temperature of the weld metal before the next pass is started. Ensure interpass requirements are in accordance with ASME BPVC SEC VIII D1.

3.1.3.3 Postweld

Do not apply a postweld heat treatment to weldments unless noted in the applicable code welding documentation, WPS, PQR and WPQ.

3.2 FIELD QUALITY CONTROL

3.2.1 Nondestructive Testing (NDT)

3.2.1.1 General

Perform fabrication and erection inspections prior to assembly, during assembly, during welding and after welding to ensure that materials and workmanship meet the requirements of the contract documents.

Submit radiographs to the District. Verify each specified radiograph, as a minimum, has the following additional information permanently included in the image:

a. Agency Weld No. (including repair cycle no.)

b. Agency Drawing No.

c. Agency View No.

d. Agency Contract No.

Final interpretation and acceptance of all radiographs of welded joints, with the exception of code stamped pressure vessel welds, will be by the District.

Final acceptance of all welded, brazed joints will be by the District.

Prior to the District's inspection, remove all slag and scale from all welds. Procedures which produce notches in either the weld metal or adjacent base metal are not acceptable.

Immediately repair unacceptable welds and make ready for District re-inspection at no additional cost to the District.

After weld joints have been satisfactorily completed and accepted by the District, clean the joint area to a bright, unpitted, and unscarred surface and protect in accordance with the contract documents.

3.2.1.2 Pressure Vessels

a. Test Method

Perform all nondestructive testing in accordance with the requirements of ASME BPVC SEC V.

b. Acceptance Requirements

Ensure acceptance requirements are in accordance with ASME BPVC SEC V.

3.2.1.3 Piping

a. Test Method

Perform NDT of all piping systems, except plumbing systems, in accordance with the requirements of ASME BPVC SEC V.

For high pressure (125 psig or above) systems, fully examine no less than 10 percent of all butt welds by random radiography. Select welds to be examined to ensure that the work product of each welder or welding operator doing the production welding is included. If any of the butt welds examined reveals an unacceptable indication, examine and accept by radiography, all butt welds welded by that welder(s).

b. Acceptance Requirements

High Pressure (125 psig or above):

a. Other high pressure piping systems - ASME B31.3.

Low Pressure {Below 125 psig):

a. Other low pressure piping systems - ASME B31.1.

## 3.3 PROTECTION OF ADJACENT MATERIALS

Protect machinery, materials, floor, furnishings, finishes and other items adjacent to the welding, brazing operations to prevent any damage from these operations.

-- End of Section --

# SECTION 40 61 14

# GENERAL PROVISIONS FOR MECHANICAL WORK

## PART 1 GENERAL

### 1.1 SCOPE

The provisions of Part 1, General Documents, and DIVISION 01, General Requirements, apply to this section. These general provisions for mechanical work shall apply to all sections of DIVISION 40.

### 1.2 CODES AND STANDARDS

All Work shall comply with the Building Codes and Ordinances of the local governmental jurisdiction. Work shall also comply with the codes and standards of the following agencies and organizations as specifically referenced hereinafter.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ASME INTERNATIONAL (ASME)

ASTM INTERNATIONAL (ASTM)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2)
National Electrical Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

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

### 1.3 WARRANTY

The warranty shall meet the requirements specified in SECTION 01 61 03 EQUIPMENT AND MATERIALS.

## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

The equipment to be furnished under these specifications shall be essentially the standard products of the Manufacturer. Where two (2) or more units of the same class of equipment are required under these specifications, these shall be the product of a single Manufacturer.

### 2.2 MANUFACTURER'S DESCRIPTIVE LITERATURE

The Contractor shall, before ordering equipment, submit to the District for approval four (4) copies of the Manufacturer's descriptive literature for all equipment and materials he proposes to use to show that it meets the requirements set forth in these specifications. He shall also submit a

layout plan showing the arrangement of his equipment, piping, ducts, etc. if it varies from the Contract Drawings. The District must approve any variations.

## 2.3 SPECIFICATIONS AND DRAWINGS

The Contract Drawings indicate the extent and general arrangement of the mechanical systems. The specifications and Drawings shall be considered as supplementary one to the other. Materials and labor indicated, called for or implied by one and not the other shall be supplied and installed as though specifically called for in both. Equipment, ductwork and piping arrangement shall fit into space allocated, providing clearances for servicing and maintenance. Capacities of all equipment shall be not less than those indicated on the Drawings.

## 2.4 ELECTRICAL WORK

### 2.4.1 General

The Mechanical Contractor shall, unless otherwise specified herein, furnish all equipment specified herein with motors, motor controllers and controls. The Mechanical Contractor shall set motors in place and shall furnish motor controllers to the Electrical Contractor for installation.

### 2.4.2 Motors

Motors shall be built in compliance with applicable NEMA Standards and shall be in conformance with DIVISION 26.

### 2.4.3 Motor Controllers

Each motor shall be provided with NEMA standard motor controller suitable for use intended, and in conformance with DIVISION 26.

# PART 3 EXECUTION

## 3.1 GENERAL

Work shall be started as soon as possible. Work lines and established grades shall be in strict accordance with the Drawings. The Contractor shall be responsible for furnishing to all trades, in ample time, any information they may require to construct all bases, trenches, pits, chases and openings in floors, walls, and finishes and to provide clearances to accommodate the Work. He shall set all sleeves, anchor bolts or inserts required to fasten equipment before adjacent concrete is poured.

The Contractor shall be responsible for the actions of his employees and for compliance with all laws and ordinances governing the Work. He shall layout his work and establish elevations in strict accordance with the Drawings, be responsible for the accuracy of the laying out, and give his personal superintendence to the Work. He shall have at all times a competent representative on the premises who shall be acceptable to the District.

A continuous cleanup shall be maintained during the progress of the Work and appointed storage areas shall be used for surplus materials and supplies. The premises shall be kept free from accumulations of waste materials and rubbish. At completion, refuse shall be removed from the site.

## 3.2 INTERFERENCES

The plans are generally diagrammatic and the Contractor shall harmonize the Work of the different trades so that interference between piping, equipment and structural work will be avoided. All necessary offsets in piping and all fittings, etc. required to properly install the Work shall be furnished complete in place. Piping, ducts, etc. shall be kept as close as possible to ceilings, walls, columns, etc., as indicated on mechanical drawings, so as to take the minimum amount of space. All offsets, fittings, etc. required shall be furnished and installed without additional expense to the District. In case interference develops, the District will decide which equipment shall be relocated, regardless of which apparatus was first installed.

## 3.3 WORKMANSHIP

All materials and equipment shall be installed in accordance with the approved recommendations of the Manufacturer and the referenced standards to conform with the Contract documents and shall be subject to the approval of the District. The installation shall be accomplished by workers skilled in the type of work involved. Workers shall have current certifications, when required, for a particular trade.

## 3.4 DRAWINGS

The Contractor shall prepare accurate sleeve and insert drawings for checking and approval, showing all sleeves, boxes and inserts for installation of the Work covered in these specifications. The above drawings shall be prepared well in advance of the construction and be coordinated with the work of all trades.

The Contractor shall furnish the District with "as-built" drawings. He shall keep day-to-day records of changes in locations of piping, fixtures and other items, and upon completion of the Work, incorporate these changes on clean copies of the original drawings.

## 3.5 CONTRACTOR'S DIFFERENCES

If the Contractor proposes to deviate from the specifications or Drawings, he shall call attention to any deviations in his proposal; otherwise, it will be assumed that he accepts and agrees to follow the Contract Drawings and specifications.

## 3.6 VIBRATION AND NOISE CONTROL

Excessive vibration or objectionable noise created in any part of building by operation of any equipment installed under this Contract will not be permitted. Contractor shall isolate various items of equipment from building structure and take all steps that may be necessary to eliminate excessive vibration and objectionable noise produced by any equipment installed under this Contract.

## 3.7 EXAMINATION OF SITE

The Contractor shall examine the site and the Drawings before bidding and inform himself fully regarding the limitations of space available for the

installation of materials and equipment, as well as all conditions regarding service connections, grades, ground conditions, and all factors involved in his bidding and in the completion of the Work.

## 3.8 EXCAVATION AND BACKFILL

### 3.8.1 Excavation

Trenches for all underground pipelines shall be excavated to the required depths. The bottom of trenches shall be tamped hard and graded to secure the required fall. Bell holes shall be excavated so that pipe will rest on solid ground for its entire length. Rock, where encountered, shall be excavated to a depth of 6" below the bottom of the pipe and, before pipe is laid, the space between the bottom of the pipe and rock shall be filled with approved backfill material. Wastewater and potable water pipes shall be laid in separate trenches.

### 3.8.2 Backfilling

After pipelines have been tested, inspected and approved by the District, and prior to backfilling, forms shall be removed and the excavation shall be cleaned of trash and debris. Materials for backfilling shall consist of the excavation or borrow of sand, gravel or other approved material and shall be free of trash, lumber, or other debris. Backfill shall be placed in horizontal layers of 6 inches in thickness, each layer being properly moistened and compacted. Backfill shall be brought to a suitable elevation above grade to provide for settlement and shrinkage.

## 3.9 PIPE SLEEVES

Pipe sleeves shall be provided where pipes and tubing pass through masonry or concrete walls, roofs, and partitions. Sleeves shall be placed during construction of the building. Sleeves in outside walls below and above grade, in floor, or in roof slabs shall be zinc-coated steel pipe. Sleeves in partitions shall be zinc-coated sheet steel having a nominal weight of not less than 0.906 pound per square foot. Plastic sleeves may be used when approved by the District. Space between pipe, tubing, or insulation and the sleeve shall not be less than 1/4 inch. Sleeves shall be held securely in proper position and location before and during construction. All sleeves shall be of sufficient length to pass through entire thickness of walls, partitions or slabs. Space between the pipe or tubing and the sleeve shall be firmly packed with oakum and caulked on both ends of the sleeve with insulating cement. Sleeves located in waterproofed construction shall be provided with flanges and clamping rings.

## 3.10 INSPECTION

Inspection shall continue during installation and testing. The right is reserved to inspect any equipment at the Manufacturer's facility during or after manufacture, and to require reasonable witness tests before shipment. All equipment rejected at the Manufacturer's facility shall be corrected or replaced prior to shipment. A final inspection of the equipment shall be performed prior to installation to determine conformity to the type, class, grade, size, capacity, and other characteristics specified herein or indicated. All equipment rejected shall be corrected or replaced prior to installation.

## 3.11 TESTS

All materials, equipment and systems that are required to be tested by these specifications or by any applicable regulation shall be tested in the presence of the District or District's representative. All items requiring pressure or leakage tests shall be tested before being concealed from view. All defects disclosed by tests shall be rectified and the tests repeated. The Contractor shall provide all labor, materials and equipment used for tests.

## 3.12 OPERATING INSTRUCTIONS

The Contractor shall submit operation instruction manuals for the District. Manuals shall include Manufacturer s data books, parts lists, wiring diagrams, maintenance procedures and start-up/shut-down instructions. Manuals shall be provided for all equipment. The Mechanical Contractor shall also provide all necessary instruction to the District's personnel concerning operation of the mechanical system.

-- End of Section --

# SECTION 40 95 00

# PROCESS 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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

MOTOROLA (Motorola)

| | |
|---|---|
| Motorola R56 | Standards and Guidelines for Communication Sites (Chapters 4 & 5) |

BUILDING INDUSTRY CONSULTING SERVICE INTERNATIONAL (BICSi)

| | |
|---|---|
| TDMM | (2014) Telecommunications Distribution and Methods Manual |

### 1.2 DEFINITIONS

Definitions, Symbols, and engineering unit abbreviations shall conform to IEEE Stds Dictionary, as applicable.

### 1.3 SYSTEM DESCRIPTION

The process Control System shall be used to monitor the dam and relief system stability using 65 standalone RTU's and 338 piezometers and the four (4) spillways/weirs and control the eight (8) gate structures and one (1) agricultural pump station as specified and in accordance with the drawings. The control system shall provide for operator interaction, overall control system supervision, and process equipment control. Monitoring will only require one-way communications from piezometer and transducer RTU's to the S-470 Microwave Tower. Strain gauge monitoring at S-471 and S-473 will be provided with communication using a third party. Provide hardware configured and sized to support expansion as specified and shown on the drawings. The Process Control system shall consist of all the Geotech RTUs in the field with a wireless connection via base station to the Geotech Embankment and Pressure Relief System Monitoring LoggerNet Server located in the S470 Microwave tower shelter and Geotech Embankment Monitoring PC Workstation (LoggerNet)located in S470 Pump Station Control Room. The C43 Process Control system shall communicate offsite with both the SFWMD WPB HQ and USACE Jacksonville, FL. See attached figures 1, 2, and 3 - C43 Geotech Embankment Monitoring High Level Diagrams for Information Flow, Network Connection, and Network Protocol.

1.3.1 General Requirements

The existing control system from Package 3; see Section 27 05 13.00 10 TWO-WAY RADIO DATA TRANSMISSION SYSTEM shall consist of the following:

Geotech Embankment and Pressure Relief System Monitoring Base Station rack installed in the S470 Microwave tower shelter containing components such as GOES transceiver, cellular transceiver, Embankment Monitoring 900Mhz radio base station, Campbell Scientific CR1000 or District approved equal, and other components to make it a complete working and functioning Geotech Embankment and Pressure Relief System Monitoring Base Station system as described in the package 3 Contract. Also reference attached figures 1, 2, and 3 - C43 Geotech Embankment and Pressure Relief System Monitoring High Level Diagrams for Information Flow, Network Connection, and Network Protocol. Strain gauge monitoring at S-471 and S-473 will be provided with Contractor installed conduits and pull boxes while wiring and communication being provided by a third party.

The Contractor in Package 4 shall be required to integrate the Geotech Embankment and Pressure Relief System Monitoring RTU's in the field into the existing Geotech Embankment and Pressure Relief System monitoring base station located in the S470 microwave tower shelter site. The contractor shall be responsible for any Field RTU configuration and integration into the base station for proper communications.

The New additional control system components in Package 4 shall include at a minimum the following:

Any correspondence which show or describes the Network details and/or the process control system including any IP address shall have the following included in header (Footnote fine print is acceptable) and in the content of the correspondence (Bolded text should appear in any printed documents, electronic documents, Visio, PDF, emails, slides, ETC which carry the sensitive information): **"This information is exempt from public records disclosure and confidential under Section 119.071(3)(a)(1), Florida Statute".**

The Contractor shall work with the SFWMD IT Security group on any systems that go offsite through WAN or onsite through LAN networks of the C43 Project.

1. Geotech Embankment and Pressure Relief System Monitoring Server System with O.S.:

   Contractor shall be responsible for a complete working and operational Geotech Embankment and Pressure Relief System Monitoring Server System.

   a. Contractor shall purchase, configure, and install the Geotech Server hardware system; model Dell R640 Server (dual -48VDC power supply), and KVM (Console Tray Monitor and Keyboard, -48VDC).

   b. Contractor to supply and be responsible for the Server Operating system, software, and application installation, configuration, and testing. Contactor shall purchase the license for the latest SFWMD IT accepted version of O.S. Windows Server 2016, Standard and Campbell Scientific LoggerNet Sever software. Contractor shall supply the O.S. and License(s) for the Geotech Server to SFWMD IT.

c. Contractor to install Server and associated equipment in existing "Spread Spectrum Radio and Server" rack located in the C43 S470 Microwave tower shelter.

d. Contractor to install Geotech server in S470 microwave tower shelter per Floor plan diagram on Sheet E12104.

e. Contractor shall complete the installation, configuration, commissioning, testing, and SFWMD acceptance.

f. Contractor shall be responsible for working with SFWMD IT group on the requirements for the Server database design and Server Data base Backup design and server software maintenance requirements, and configurations.

g. Contractor shall be responsible for local microwave shelter LAN connectivity for SFWMD WPB HQ WAN (offsite)

   i. Contractor to work with SFWMD DAM Safety Officer to verify that data is received.

h. Contractor shall be responsible for the communications connectivity for USACE Jacksonville FL WAN (offsite).

   i. Contractor to work with USACE to verify that data is received.

i. Contractor shall install, configure Geotech LoggerNet System per C43 Geotech Embankment and Pressure Relief System Monitoring High Level Diagrams in attached figures 1, 2, and 3, requirements per DCM-9 and ADAS design Reports.

j. Contractor shall be responsible for the server hardware power connections from the existing top of rack -48VDC power distribution panel. See Floor Plan for location of the existing rack.

k. Contractor shall develop all the Geotech data templates, test plan, and conduct tests to show that the LoggerNet Server is properly configured to receive and store Geotech data from the Field RTUs and retransmit to the SFWMD WPB HQ and USACE remote sites.

l. Contractor shall be responsible for installation and testing of onsite Geotech server database design.

   i. Contractor shall propose a server database design and a test plan design to be submitted to the SFWMD IT group for review and acceptance.

2. Geotech Embankment and Pressure Relief System Monitoring Workstation PC:

   a. Dell Optiplex 7060 Mini Tower Standard Power Supply, C2.

   b. Contractor to purchase latest version of Campbell Scientific LoggerNet Server Client software and license.

c. Install in C43 S470 Pump Station Control Room per floor plan drawings on Sheet E12104.

d. Contractor responsible for Workstation installation, configuration, commissioning, testing, and District acceptance of system.

e. Contractor responsible for connectivity to LoggerNet Server located in S470 microwave tower shelter site.

f. Contractor responsible for a complete working and operational Geotech Embankment and Pressure Relief System Monitoring Workstation PC.

3. SFWMD WPB HQ Geotech LoggerNet System:

a. Contractor shall provide and install any new hardware, software, installation, configuration, testing, and acceptance requirements, etc. required by District SCADA/IT.

b. Geotech Embankment and Pressure Relief System Monitoring Data; Registration, Verification, and Archiving (onsite and offsite.

i. Contractor shall be responsible to work with SFWMD DAM Safety Officer to determine requirements.

4. USACE Jacksonville Geotech LoggerNet System:

a. Contractor shall provide and install any new hardware, software, installation, configuration, testing, and acceptance requirements, etc. as required by USACE in Jax, FL.

b. Contractor responsible on verifying that USACE can receive the Geotech data via GOES and Cellular (Verizon) systems.

c. Contractor shall be responsible to determine the requirements to work with the USACE integration, configuration, and testing.

5. Geotech Embankment and Pressure Relief System Monitoring Base Stations:

a. Contractor shall reconfigure the existing base station CR1000 or District approved equal program to accept all the new Geotech RTU's.

i. Contractor shall submit configuration and test plans for new CR1000 or District approved equal system configurations.

b. Contractor shall provide a backup for all new programs on the CR1000 or District approved equal Base station.

c. Contractor shall install a new Barometric pressure sensor required for piezometer calculations and final unit scaling.

6. Geotech Embankment and Pressure Relief System Monitoring RTU Site:

a. Contractor shall configure the new RTU CR1000 or District approved equal program to collect Geotech data and transmit to the existing base station located in the S470 microwave tower shelter.

i. Contractor shall submit configuration and test plans for new RTU CR1000 or District approved equal system configurations.

b. Contractor shall provide a backup for all new programs on the CR1000 RTU's or District approved equal.

1.3.2 Operation

Contractor shall reference the C43 Geotech Embankment and Pressure Relief System Monitoring High Level Diagrams for the required Information Flow, Network Connection, and Network Protocol diagrams. See attached figures 1, 2, and 3. Contractor shall coordinate with the District and USACE on all TBDs shown in the diagrams. Contractor is responsible for a complete working and functioning Process Control System (Geotech Embankment and Pressure Relief System Monitoring System) as described in the Specifications and Plans which encompasses the end to end communications between the C43 project site and SFMWD West Palm Beach (WPB)HQ Control Room and the USACE office located in Jacksonville FL. The Contractor shall supply O&M manuals and technical configuration drawings for the final As-Built documentation.

Any correspondence which show or describes the Network details and/or the process control system including any IP address shall have the following included in header (Footnote fine print is acceptable) and in the content of the correspondence (Bolded text should appear in any printed documents, electronic documents, Visio, PDF, emails, slides, ETC which carry the sensitive information): **"This information is exempt from public records disclosure and confidential under Section 119.071(3)(a)(1), Florida Statute".**

1.3.3 Points

Inputs to and outputs from the process control system shall be in accordance with the drawings. Each connected analog output (AO), analog input (AI), digital output (DO), digital input (DI), pulse accumulator (PA) input and other input or output devices connected to the process control system shall represent a "point" where referred to in this specification.

1.3.4 Data Transmission Systems (DTS)

Existing Data Transmission system from Package 3 includes the following:

1. Microwave radio system communications from C43 S470 microwave tower shelter to SFWMD HQ located in West Palm Beach (WPB) FL:

a. This primary transmission path for SFWMD for offsite data communications.

b. See the C43 Geotech Embankment and Pressure Relief System Monitoring High Level Diagrams for Information Flow, Network Connection, and Network Protocol diagrams. See attached figures 1, 2, 3.

2. GOES Embankment monitoring; GOES satellite transmitter installed in base station rack; installed in the C43 microwave tower shelter to GOES NOAA satellite.

    a. This primary transmission path for USACE Jacksonville FL for offsite data communications.

    b. See the C43 Geotech Embankment and Pressure Relief System Monitoring High Level Diagrams for Information Flow, Network Connection, and Network Protocol diagrams. See attached figures 1, 2, and 3.

3. GOES Embankment monitoring; Cellular Transceiver (Verizon) installed in base station rack.

    a. This secondary transmission path for USACE Jacksonville FL for offsite data communications.

    b. See the C43 Geotech Embankment and Pressure Relief System Monitoring High Level Diagrams for Information Flow, Network Connection, and Network Protocol diagrams. See attached figures 1, 2, and 3.

4. Fiber Optics SM and MM installed between the S470 Pump Station and S470 Microwave Tower Shelter.

    a. Will allow communications between the Geotech Embankment and Pressure Relief System Monitoring Server System and the Geotech Embankment and Pressure Relief System Monitoring Workstation PC.

5. Utility T1 line terminated into S470 shelter via Firewall/router (pkg3) to allow offsite non-critical communications during construction period and secondary communications path to SFWMD WPB HQ.

6. The Construction Trailer communications shall be via unlicensed microwave link included in pkg.3. See pkg 3 for details.

New Data Transmission system to be installed by Contractor for Package 4 shall include the following:

1. Geotech Embankment and Pressure Relief System Monitoring radios (900MHz) via wireless link to S470 Microwave tower shelter base station.

2. 900 MHz RTU radios via wireless link to S470 Microwave tower shelter base station.

3. VHF RTU radios via wireless link to S470 Microwave tower shelter base station.

4. UHF RTU radios via wireless link to S470 Microwave tower shelter base station.

Data transmission systems for communication between PLCs and between SFWMD IT Ethernet Switches and the Microwave Equipment Shelter are existing as noted on drawings. The Contractor shall work with District IT on IP

addresses of different networks (embankment monitoring, control structures, etc.). These networks shall have different IP address schemes.

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Digital System Hardware and Software

Geotech Server Hardware and Software

Geotech PC Workstation Hardware and Software

Communications Information flow schematics and drawings

SD-03 Product Data

product data for Digital System Hardware and Software

Geotech Embankment and Pressure Relief System Monitoring Server

Geotech Embankment and Pressure Relief System Monitoring PC Workstation

Submit in booklet form, indexed to the unique identifiers, consisting of data sheets that document compliance with the specification. Where multiple components are shown on a catalog cut, mark the application specific component.

SD-04 Samples

Geotech Embankment and Pressure Relief system Design

Server database design

User interface display and design

Program design for RTUs

Server and Database Backup design

Interconnect and communications design

Factory Acceptance and Test Plan Design

SD-06 Test Reports

Adjusting and Commissioning

Performance Verification Test (PVT)

Endurance Test

SFWMD integration, configuration, and testing

USACE integration, configuration, and testing

PC Workstation installation, integration, testing, and acceptance

WAN/LAN Server installation, integration, testing, and acceptance

SD-10 Operation and Maintenance Data

Operations and Maintenance Manuals

RTU, Server, Workstation Instrumentation and Process Control System, and Calibration Sheets

## 1.5 PRODUCT SUBMITTAL INFORMATION

Utilizing the Geotech Embankment and Pressure Relief System Design, the Contractor shall provide all the equipment, software, and coordination stated in the following paragraphs to acquire a complete working system.

### 1.5.1 Digital System Hardware and Software

Submit the following product data for digital system hardware and software information:

1. Bill of materials with software names, vendors, and complete listings of included software modules.
2. Standard Manufacturer's literature describing the products.
3. Description of function of software in Process Control and Information System.
4. Graphic display software.
5. Graphic display screens, tables, databases, spreadsheet templates, etc. to be developed by Contractor for Geotech Server and PC Workstation for a complete working and functioning system.
6. Database configuration for operator work stations and database management system.
7. Equipment backup configuration and requirements.
8. Limitations or constraints of software.
9. Minimum system (processor and memory) requirements.
10. Third party software as required.
11. Operation and maintenance requirements.
12. PLC ladder files structure and programming.

### 1.5.2 Geotech Server Hardware and Software

Submit the following Server system hardware and software information:

1. Bill of materials with software names, vendors, and complete listings of included software modules.

2. Standard Manufacturer's literature describing the products.

3. Description of function of software in Process Control and Information System.

4. Graphic display software.

5. Graphic display screens, tables, databases, spreadsheet templates, etc. to be developed by Contractor for Geotech Server and PC Workstation for a complete working and functioning system.

6. Database configuration for operator work stations and database management system.

7. Equipment backup configuration and requirements.

8. Limitations or constraints of software.

9. Minimum system (processor and memory) requirements.

10. Third party software as required.

11. Operation and maintenance requirements.

### 1.5.3 Geotech PC Workstation Hardware and Software

Submit the following PC Workstation hardware and software information:

1. Bill of materials with software names, vendors, and complete listings of included software modules.

2. Standard Manufacturer's literature describing the products.

3. Description of function of software in Process Control and Information System.

4. Graphic display software.

5. Graphic display screens, tables, databases, spreadsheet templates, etc. to be developed by Contractor for Geotech Server and PC Workstation for a complete working and functioning system.

6. Database configuration for operator work stations and database management system.

7. Server and Database Backup design and requirements.

8. Limitations or constraints of software.

9. Minimum system (processor and memory) requirements.

10. Third party software as required.

11. Operation and maintenance requirements.

1.6 WARRANTY

The warranty shall meet the requirements specified in Section 01 61 03 EQUIPMENT AND MATERIALS.

PART 2 PRODUCTS

2.1 GEOTECH EMBANKMENT AND PRESSURE RELIEF SYSTEM MONITORING SERVER AND PC WORKSTATION SOFTWARE

Geotech Embankment and Pressure Relief System monitoring software shall be Campbell Scientific LoggerNet datalogger support software, latest version, full and complete package as required for the proper operation of the Server and PC Workstation systems.

Geotech Embankment and Pressure Relief System monitoring PC Workstation Operating System (O.S.) shall be Window 10.

Geotech Embankment and Pressure Relief System Monitoring Server Operating System (O.S.) shall be Windows Server 2016, Standard, 16CORE, Factory Inst, No MED, NO CAL.

All software that will be purchased will have SFWMD as owner of software so that it may be added to the SFWMD IT account/registration/MLAs/support agreements with the corresponding vendor. Contact SFWMD IT point of contact and/or Mike Carney (SFWMD IT,561-682-6142, mcarney@sfwmd.gov), or designee at time of quotation/purchase to verify that software is up to date with SFWMD standards and requirements. Ex. Any LoggerNet Server, LoggerNet Server Client, and Microsoft O.S. (ex. Windows 10 and Windows Server 2016), other software. Also coordinate at time of purchase with SFWMD IT (Mike Carney) for quotes with corresponding vendor to allow seamless transition to SFWMD account/registration/MLAs/support. All software and licenses shall be transferred to SFMWD IT ownership at time of purchase.

2.1.1 Geotech Embankment and Pressure Relief System Monitoring Server System

The Contractor shall purchase and install Geotech Embankment and Pressure Relief System Monitoring Server and other equipment installed in the Server Rack. It shall at a minimum consist of the following for a complete working and function Geotech Embankment and Pressure Relief System Monitoring Server System:

1. Dell R640 Server Configuration Chassis 2.5" Chassis with up to 8 Hard Drives and 2PCIe slots, 2CPU only

    a. Processor Intel® Xeon® Bronze 3104 1.7G, 6C/6T, 9.6GT/s, 8M Cache, No Turbo, No HT (85W) DDR4-2133

    b. Additional Processor Intel® Xeon® Bronze 3104 1.7G, 6C/6T, 9.6GT/s, 8M Cache, No Turbo, No HT (85W) DDR4-2133

    c. Processor Thermal Configuration Standard Heatsink for 2 CPU

    d. Memory DIMM Type and Speed 2666MT/s RDIMMs

e. Memory Configuration Type: Performance Optimized

f. Memory: 16GB RDIMM, 2666MT/s, Dual Rank

g. RAID: C3, RAID 1 for 2 HDDs or SSDs (Matching Type/Speed/Capacity)

h. RAID/Internal Storage Controllers: PERC H330 RAID Controller, Minicard

i. Quantity two (2): Hard Drive 1.6TB SSD SATA Mix Use 6Gbps 512n 2.5in Hot-plug Drive, Hawk-M4E,3 DWPD,8760 TBW

j. Operating System Windows Server® 2016, Standard, 16CORE, Factory Inst, No MED, NO CAL

k. Embedded Systems Management iDRAC9, Enterprise

l. PCIe Riser Config 3,1x16 LP,1x16 FH

m. Network Daughter Card Broadcom 57416 2 Port 10Gb Base-T + 5720 2 Port 1Gb Base-T, rNDC

n. Fans 8 Standard Fans for R640

o. Power Supply Dual, Hot-plug, Redundant Power Supply (1+1), 1100W - 48VDC Only

p. BIOS and Advanced System Configuration Settings: Performance BIOS Setting

q. Advanced System Configurations UEFI BIOS Boot Mode with GPT Partition

r. Rack Rails: ReadyRails static Rails for 2/4 post racks

2. KMM, Console Tray monitor and Keyboard: Raloy 1U RF117HD 17" Monitor and Keyboard

   a. Touchpad: RF117HDe

   b. Signal Input: VGA +DVI-D

   c. Power Supply: 48VDC (-48VDC)

3. Contractor shall run power from top of rack from -48VDC power distribution using dual A+B sides to power server and KMM.

Geotech Server Spares Requirements:

1. Quantity three (3) Hard Drive 1.6TB SSD SATA Mix Use 6Gbps 512n 2.5in Hot-plug, Hawk-M4E,3 DWPD,8760 TBW

2. Quantity one (1) rack mounted network switch which shall match the network switch provided in BP3. The switch shall be a complete system including any cards, modules, software, MLA Hardware Maintenance Contract, and firmware.

At time of purchase the Contractor will be required to work with SFWMD IT for an updated quotation and update of Geotech Server hardware specifications due to short end of life of this type of hardware. The updated hardware shall be equivalent.

Contractor shall work with SFWMD IT Point of Contact (POC) or designee at time of quotation/purchase to verify that Hardware is up to date with SFWMD standards and requirements and is also transitioned to SFWMD ownership so that the hardware/software/license(s) may be added to the SFWMD IT account/registration/MLAs/support agreements with the corresponding vendor.

Embankment monitoring server shall be provided and installed as required for the proper operation of the system.

### 2.1.2 Geotech Embankment and Pressure Relief System Monitoring PC Workstation

At time of purchase the Contractor will be required to work with SFWMD IT for an updated quotation and update of Geotech Embankment and Pressure Relief System Monitoring Workstation PC hardware specifications due to short end of life/availability of this type of hardware. The updated hardware shall be equivalent.

Contractor shall work with SFWMD IT POC or designee at time of quotation/purchase to verify that Hardware is up to date with SFWMD standards and requirements and is also transitioned to SFWMD ownership so that the hardware/software may be added to the SFWMD IT account/registration/MLAs/support agreements with the corresponding vendor.

After Contractor purchases the PC Workstation and required software they shall notify the SFWMD IT and shall hand over the PC workstation and software to the SFMWD IT group so that SFWMD IT can install imaging on the hard drive. Once imaging and required software has been installed the SFWMD IT group will place the PC workstation in the S470 Pump Station Control room per plans location so that the Contractor can continue with the PC Workstation installation, integration, testing, and acceptance. Contractor shall at time of SFWMD IT imaging the PC Workstation transfer the Windows 10 and latest version of LoggerNet Server Client software and licenses. Any other software for a complete system such as software and licenses should be handed over at time of imaging as well for SFWMD IT to install.

#### 2.1.2.1 Geotech Embankment and Pressure Relief System Monitoring PC Workstation Options

Provide Geotech Embankment and Pressure Relief System Monitoring PC Workstations with the following options:

| | |
|---|---|
| Base Unit: | Dell Optiplex 7060 Mini Tower Standard Power Supply, C2 |
| Processor: | Intel i7-8700 Core Processor, 3.4GHz, 8M,8th Generation |
| Memory: | 16GB, DDR4 Memory 2666MHz, UDIMM Non-ECC |
| Keyboard: | Dell KB522 Business Multimedia Keyboard |
| Monitor: | Dell Professional P2418D, QFD screen, 23.8in Viewable Image Size, Qty 2. Monitors per Workstation. |

| | |
|---|---|
| Base Unit: | Dell Optiplex 7060 Mini Tower Standard Power Supply, C2 |
| Video Card: | AMD Radeon R7 340X, 2GB (DP, SL-DVI-I) |
| Hard Drive: | 1TB SATA Solid State Drive |
| Hard Drive Controller: | C1 All SATA or SSD Hard Drives, Non-RAID for 1or 2 Hard Drive, Dell Optiplex 7060 |
| Floppy Disk Drive | No Floppy Drive, Dell Optiplex |
| Operating System: | Windows 10 |
| Mouse: | Dell Laser Scroll USB 2 Button Optical Mouse, Precision T3500 (330-3945) |
| TBU: | Mini-Tower Chassis Configuration with 1394 Card, Dell Optiplex 7060 |
| DVD-ROM Drive: | 8x DVD +/- RW 9.5 MM Optical Drive |
| Speakers: | Dell Stereo USB Monitor Soundbar AC511 |
| Diskette: | Documentation, English, Dell Precision (330-3156) |
| Controller Option: | Integrated Intel chipset SATA 3.0Gb/s controller, Dell Optiplex 7060 |
| Software | Latest version of Campbell Scientific LoggerNet Server Client software and license. |
| Feature | No Resource CD for Dell Optiplex |
| Service: | ProSupport: 7x24 Technical Support 3 Years |
| Service: | ProSupport: 7x24 Technical Support, NBD Onsite 3 Years |
| Misc: | Chassis Intrusion Switch, Dell Optiplex |
| Misc: | Quick Reference Guide, English Dell Optiplex |
| Misc: | Shipping Material for System Dell Optiplex |
| | CFI, Rollup, Integration Service Tag or Label, Only - No Other CFI Services (366-1036) |
| | CFI, Rollup, Asset Report Only (366-1042) - Quantity 2 |
| | CFI Routing SKU (365-0257) |
| | Americas Merge Center Service (490-0000) |
| | Americas Merge Center, Custom Service, Fulfillment Services (490-0413) |
| | Display Port to DVI (1920x1200) Adapter for Dell Systems Optiplex, Customer Install (330-2915) |
| | Back-UPS RS 1300 LCD UPS System (A1707420) |
| | SP-01 1YR EWP (A1543066) |
| | Custom Project Management, Client, Quantity 1 (987-1509) |
| | Dell Managed Deployment, DMS AST-RCVRY SVCS LSNT, NODISPATCH (985-9419) - Qty 2 |

## 2.2 PRINTER

Printer shall be quantity of two (2)HP-8720, all-in-one or District approved equivalent at time of purchase. One printer shall be installed in the S470 Pump Station Control room and the second printer installed in the S470 Microwave shelter.

At time of purchase the Contractor will be required to work with SFWMD IT for an updated quotation and update printer specifications for an All-in-one printer for installation in the S470 Pump Station Control and the second printer installed in the S470 Microwave shelter locations.

Contractor shall work with SFWMD IT POC or designee at time of quotation/purchase to verify that Printer Hardware is up to date with SFWMD standards and requirements and is also transitioned to SFWMD ownership so that the hardware/software may be added to the SFWMD IT account/registration/MLAs/support agreements with the corresponding vendor.

## 2.3 WAN/LAN NETWORK SYSTEM

Connect to the existing local area network (LAN) as required for the proper operation of all systems installed by Contractor.

Contractor shall follow BICSi Telecommunication Distribution and Methods Manual (TDMM) for the WAN/LAN server installation, integration, testing, and acceptance. All connections shall be properly installed and labeled as required by BICSi TDMM Industry Best Practices.

The Contractor will be required to work and correspond with SFWMD IT Group on IP address used for systems configured by the Contractor.

Any correspondence which show or describes the Network details and/or the process control system including any IP address shall have the following included in header (Footnote fine print is acceptable) and in the content of the correspondence (Bolded text should appear in any printed documents, electronic documents, Visio, PDF, emails, slides, ETC which carry the sensitive information): **"This information is exempt from public records disclosure and confidential under Section 119.071(3)(a)(1), Florida Statute".**

## 2.4 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A self-contained UPS for each operator workstation shall be provided. The units shall be sized to provide a minimum of 30 minutes of operation of the Geotech Embankment and Pressure Relief System Monitoring PC Workstation. The UPS shall incorporate surge suppression, noise filtering (normal and common mode) short circuit protection and voltage regulation (brownout and overvoltage protection). UPS shall be complete with all necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power. The UPS shall comply with Motorola R56 for grounding and bonding and with the Federal Communications Commission Standard 15J part A for radio noise emissions. The UPS shall be APC Back UPS Pro 1000, minimum, or approved equal.

# PART 3 EXECUTION

## 3.1 EQUIPMENT REQUIREMENTS

### 3.1.1 RTU, Server, PC Workstation, and Offsite Control Room Programming

The Contractor shall provide all necessary Factory Acceptance and Test Plan Design for the proper operation of the equipment and complete functionality of the project as intended.

## 3.2 SERVER AND RTU SOFTWARE INSTALLATION

Load software required for a complete and operational process control system, including databases (for points specified and shown), operational parameters, and system, command, and application Program design for RTUs. Adjust, tune, debug, and commission all software and parameters for controlled systems to assure proper operation in accordance with the sequences of operation and database tables. Contractor shall work with the SFWMD IT data group for Server configuration, IP Address configuration, testing, and acceptance requirements.

## 3.3 CONTROL DRAWINGS

Control drawings, non-fading half-size in laminated plastic, shall be provided 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 and posted beside the diagrams. Diagrams and instructions shall be submitted prior to posting.

## 3.4 FIELD TESTING AND ADJUSTING EQUIPMENT

### 3.4.1 Testing, Adjusting, and Commissioning

After the successful completion of the witnessed factory acceptance test as specified, the Contractor will be authorized to proceed with the installation of the Geotech Embankment and Pressure Relief System Monitoring System equipment, hardware, and software. After the Server system and RTUs (RTU data collection) system installation has been completed, test, adjust, and commission each monitoring loop. Then test each of the systems accordingly and verify proper operation of each item in the sequences of operation, including hardware and software. Calibrate field equipment, RTUs and field instrumentation devices, adjust instrumentation, parameters, logic (virtual) points, including setpoints, gain constants, constraints, and verify data interconnect and communications design before the system is placed online. Calibrate each instrumentation device connected to the data collection system network by making a comparison between the reading at the device and the display at the Server and workstation, using a standard at least twice as accurate as the device to be calibrated. Deliver trend logs/graphs of all points showing to the District that stable measurement instrumentation has been achieved. Points on common systems shall be trended simultaneously. One log shall be provided showing concurrent samples taken once a minute for a total of 4 hours. One log shall be provided showing concurrent samples taken once every 30 minutes, for a total of 24 hours. Verify operation of systems in the specified failure modes upon data collection system network failure or loss of power

and verify that systems return to normal operation from return of power. Deliver a report describing results of functional tests, diagnostics, calibrations and commissioning procedures including written certification to the District 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.

### 3.4.2 Performance Verification Test (PVT)

Submit 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. Refer to the actions and expected results to demonstrate that the data collection 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.

Demonstrate that the completed data collection system complies with the contract requirements. All physical and functional requirements of the project including communication requirements shall be demonstrated and shown. Demonstrate that each system operates as required in the sequence of operation. The PVT as specified shall not be started until after receipt of written permission by the District, based on the 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, furnish test reports and other documentation.

### 3.4.3 Endurance Test

Use the endurance test to demonstrate the overall system reliability of the completed system. The endurance test shall be conducted in phases. The endurance test shall not be started until the District notifies the Contractor in writing that the PVT is satisfactorily completed, training as specified has been completed, outstanding deficiencies have been satisfactorily corrected, and that the Contractor has permission to start the endurance test. Provide an operator to man the system 8 hours per day during daytime operations, including weekends and holidays, during Phase I endurance testing, in addition to any District personnel that may be made available. The District may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the District or by the Contractor, commence an assessment period as described for Phase II. Upon successful completion of the endurance test, deliver test reports and other documentation, as specified, to the District prior to acceptance of the system.

#### 3.4.3.1 Phase I (Testing)

The test shall be conducted 24 hours per day, 7 days per week, for 14 consecutive calendar days, including holidays, and the system shall operate as specified. Make no repairs during this phase of testing unless authorized by the District in writing.

3.4.3.2 Phase II (Assessment)

After the conclusion of Phase I, identify failures, determine causes of failures, repair failures, and deliver a written report to the District. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, convene a test review meeting at the job site to present the results and recommendations to the District. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the District. As a part of this test review meeting, demonstrate that failures have been corrected by performing appropriate portions of the performance verification test. The District reserves the right to cancel the test review meeting if no failures or deficiencies occur during the Phase I testing. If the District chooses to do so, the Contractor will be notified in writing. Based on the Contractor's report and the test review meeting, the District will determine if retesting is necessary and the restart point. The District reserves the right to require that the Phase I test be totally or partially rerun. Do not commence any required retesting until after receipt of written notification by the District. After the conclusion of any retesting which the District may require, the Phase II assessment shall be repeated as if Phase I had just been completed.

Upon successful completion of Phase I and Phase II testing, District endurance phase shall include 30 days commissioning for the District to operate the Geotech Embankment and Pressure Relief System Monitoring System independent of the Contractor before the station can be turned over. The Contractor will oversee the operation and assist as needed. For additional commissioning requirements see Specification Section 01 87 02 EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING.

3.5 FIELD TRAINING

Field training oriented to the specific system shall be provided for designated personnel. Furnish a copy of the training manual for each trainee plus two additional copies. 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 District 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. Submit the training manual and schedule to receive approval from the District at least 30 days before the training. Include training for Qty. (3) Clewiston F.S./District personnel and as identified by the District PM. Training shall be onsite at the S470 P.S.

3.5.1 Preliminary Operator Training

Prior to the start of field testing, preliminary operator training shall be taught at the project site for 3 consecutive training days. 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 Program design for RTUs, control sequences, and control loops; database entry and modification; reports generation; alarm reporting; diagnostics; and historical files.

3.5.2 Additional Operator Training

Following the field testing, additional classroom training for operators shall be taught for 3 consecutive training days; individual instruction sessions of 4-hour periods in the morning (or afternoon) of the same weekday for 2 consecutive weeks and an additional 1-day classroom session for answering operator questions. Individual 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 Geotech Embankment and Pressure Relief System Monitoring System and specific instructions for operating the installed system. Schedule activities during this period so that the specified amount of time on the equipment will be available for each student. The final session will address specific topics that the students need to discuss and to answer questions concerning the operation of the 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 Geotech Embankment and Pressure Relief System Monitoring 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.

3.5.3 Maintenance Training

Following the endurance test, a minimum period of five training days shall be provided by a factory representative or a qualified Contractor trainer for ten designated personnel 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.

3.5.4 Specialized Training

Following the maintenance training, a minimum period of five total training day(s) shall be provided by a factory representative or a qualified Contractor trainer for ten people on the input devices.

3.5.5 Operations and Maintenance Manuals

Lesson plans and training data, in manual format, for the training phases, including type of training to be provided, with a list of reference material, shall be delivered for approval.

3.5.5.1 Group V Technical Data Package

The Group V technical data package shall consist of the system documentation. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems and of the nearest service representative for each item of equipment and each system. The manuals shall have a table

of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies, bound in hardback loose-leaf binders, shall be delivered within 30 days after completion of the endurance test, and shall include all modifications made during installation, checkout, and acceptance. Manuals delivered shall include:

a. Hardware Manual: two copies.

b. Operator's Manual: six copies.

c. Maintenance Manual: two copies.

3.5.5.2 Hardware and Software Manual

A manual describing equipment and software applications furnished, including:

a. General description and specifications.

b. Installation and checkout procedures.

c. Equipment electrical schematics, layout drawings, and database architecture.

d. Alignment and calibration procedures.

e. Manufacturer's repair parts list indicating sources of supply.

f. Interface definition.

g. Communications Information flow schematics and drawings.

h. User interface display and design.

i. SFWMD integration, configuration, and testing

j. USACE integration, configuration, and testing

3.5.5.3 Operator's Manual

The operator's manual shall fully explain procedures and instructions for operation of the system.

3.5.5.4 Maintenance Manual

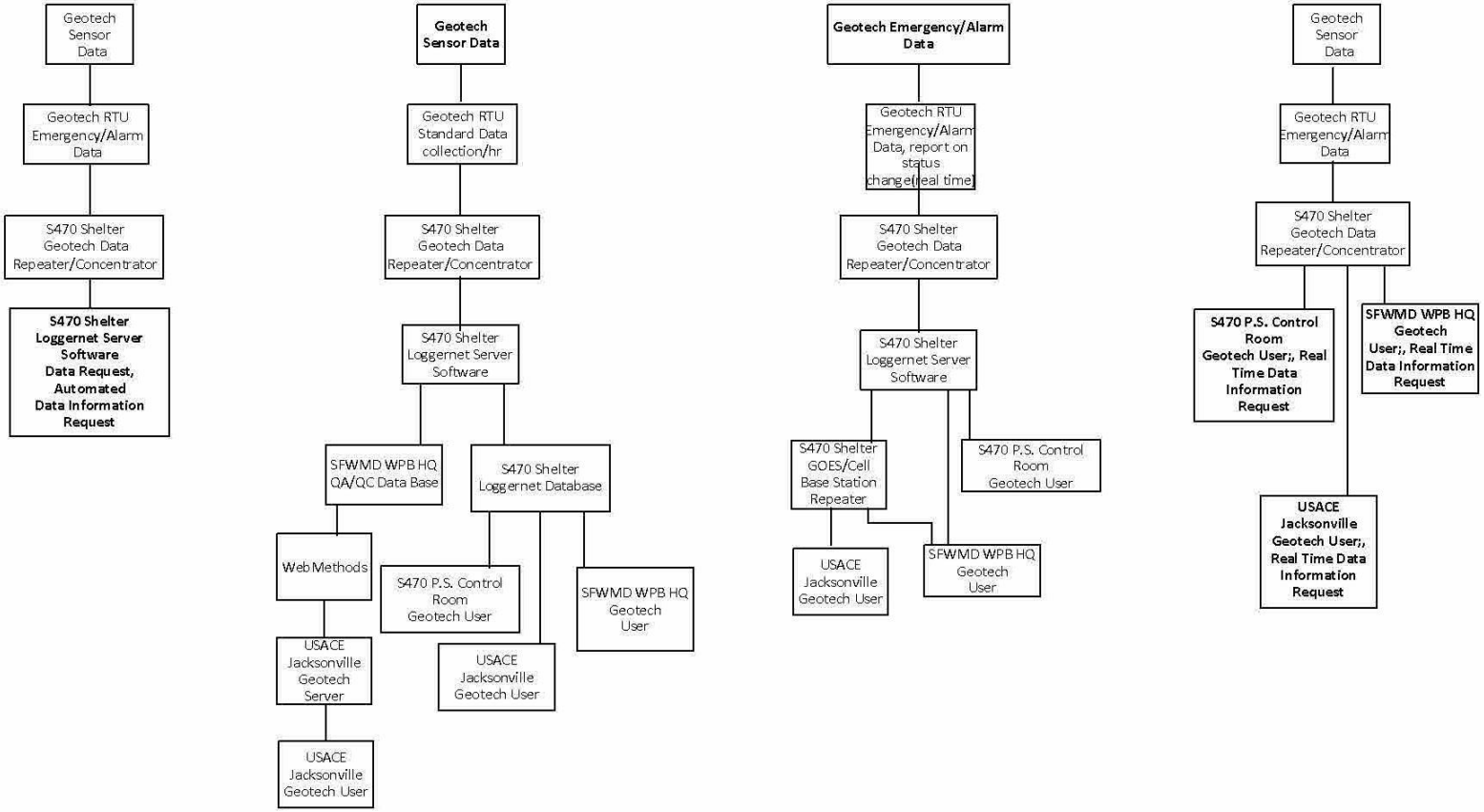
The maintenance manual shall include descriptions of maintenance for all equipment including inspection of RTU, Server, Workstation Instrumentation and Process Control System, and Calibration Sheets. Also includes periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

3.6 REFERENCED FIGURES

See attached figures 1, 2, and 3 to see the high-level relationship between the Geotech Monitoring Information System, the Geotech Monitoring Network

Connections, and the Geotech Monitoring Network Protocol involved in the communication system.

-- End of Section --




| FIG. 1 | C43 and C44 Embankment Geotech Monitoring High Level Information Flow Diagram | |
|---|---|---|
| Scale: Not to Scale | South Florida Water Management District | SFWMD<br>March 15, 2018 |

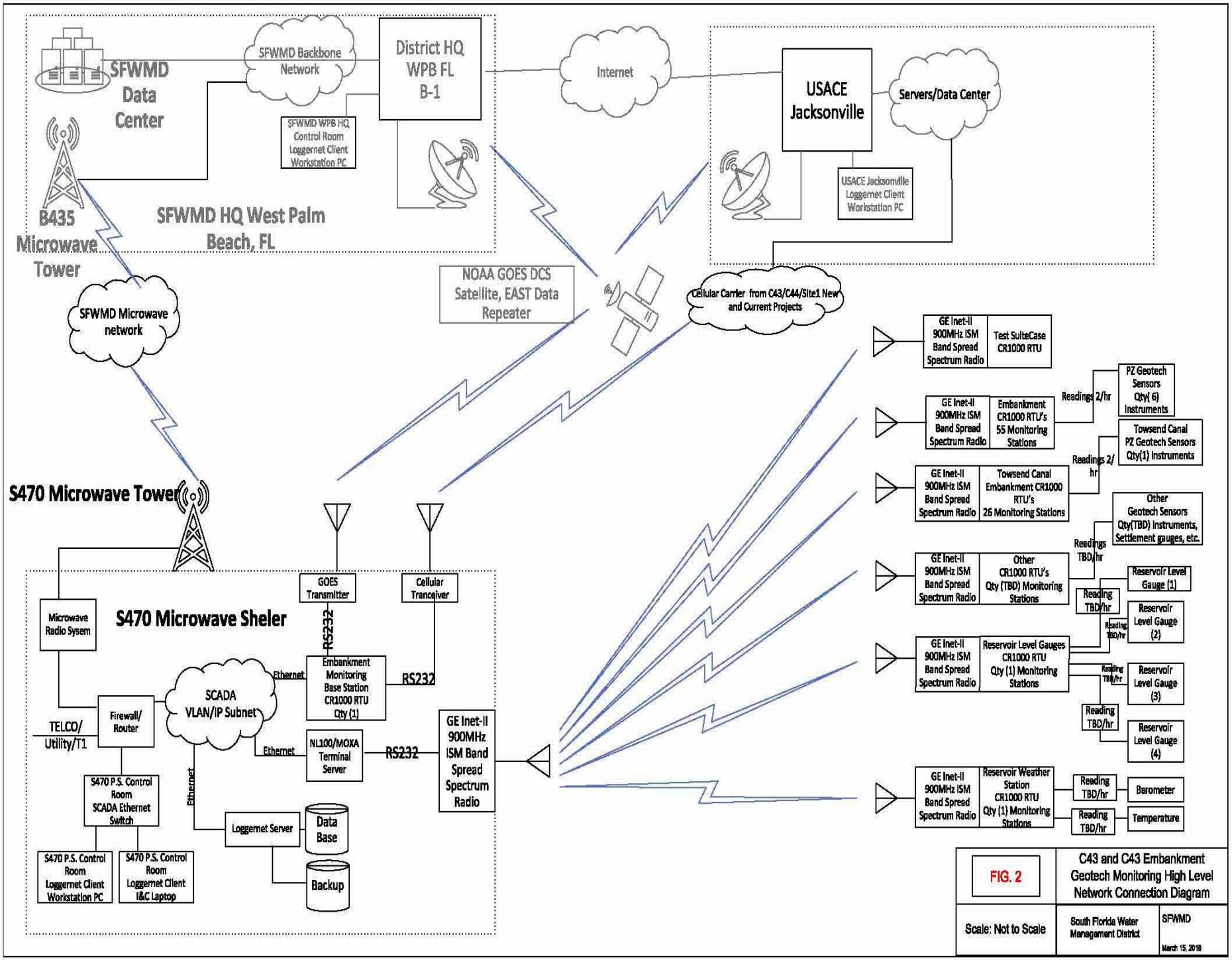



FIG. 2

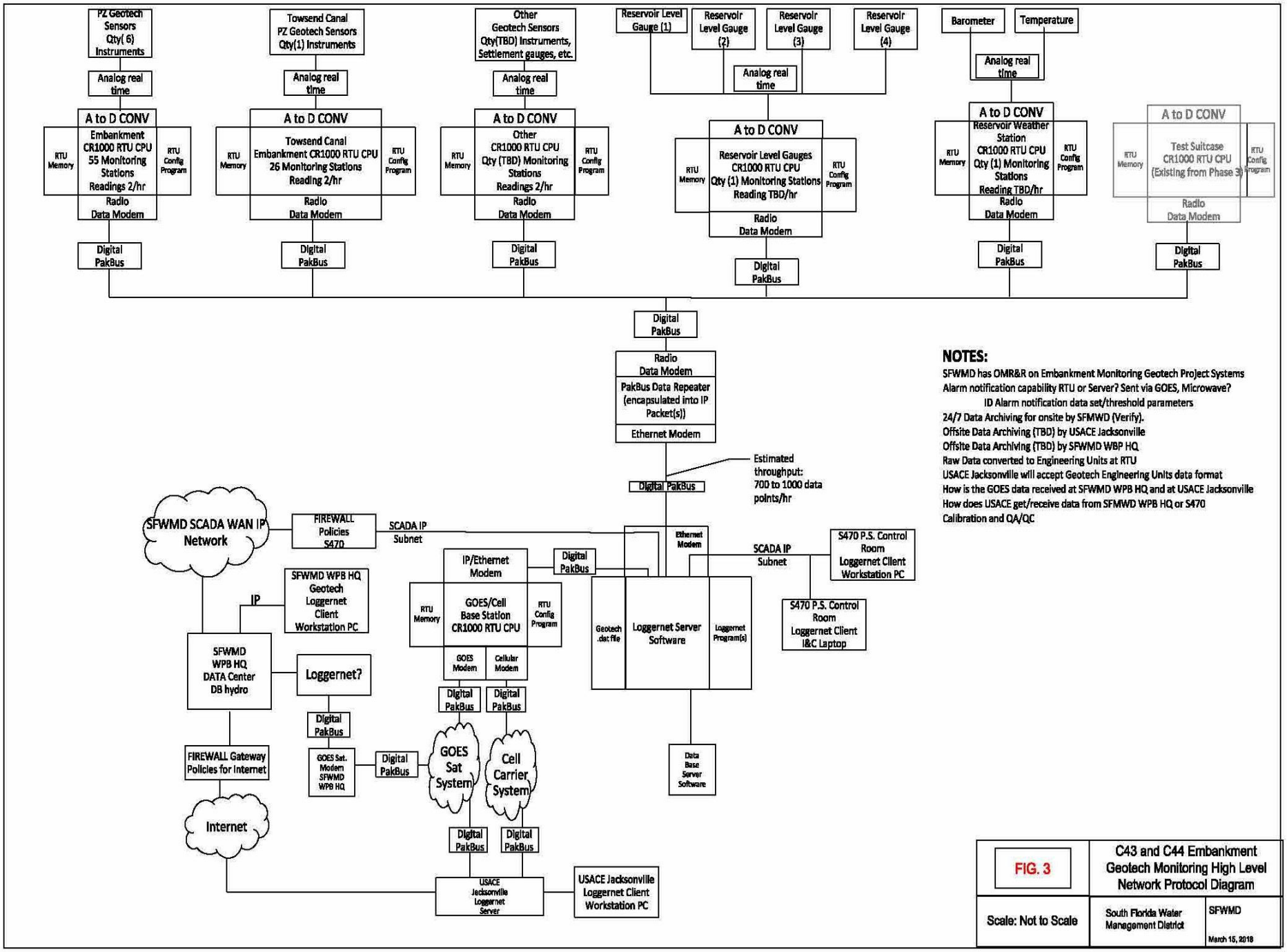
C43 and C43 Embankment Geotech Monitoring High Level Network Connection Diagram

Scale: Not to Scale

South Florida Water Management District

SFWMD

March 15, 2018




## NOTES:

SFWMD has OMR&R on Embankment Monitoring Geotech Project Systems
Alarm notification capability RTU or Server? Sent via GOES, Microwave?
ID Alarm notification data set/threshold parameters
24/7 Data Archiving for onsite by SFMWD (Verify).
Offsite Data Archiving (TBD) by USACE Jacksonville
Offsite Data Archiving (TBD) by SFWMD WBP HQ
Raw Data converted to Engineering Units at RTU
USACE Jacksonville will accept Geotech Engineering Units data format
How is the GOES data received at SFWMD WPB HQ and at USACE Jacksonville
How does USACE get/receive data from SFMWD WPB HQ or S470
Calibration and QA/QC

| | | |
|---|---|---|
| FIG. 3 | C43 and C44 Embankment Geotech Monitoring High Level Network Protocol Diagram | |
| Scale: Not to Scale | South Florida Water Management District | SFWMD<br>March 15, 2018 |